

**REGULATION 2015**  
**B.TECH - AERONAUTICAL ENGINEERING**  
**CURRICULUM AND SYLLABUS**

| SEMESTER I                                  |          |                                                             |   |   |   |   |
|---------------------------------------------|----------|-------------------------------------------------------------|---|---|---|---|
| Code No.                                    | Category | Course Title                                                | L | T | P | C |
| Theory                                      |          |                                                             |   |   |   |   |
| BEN101                                      | HS       | English-I                                                   | 2 | 1 | 0 | 3 |
| BMA101                                      | BS       | Mathematics –I                                              | 3 | 0 | 0 | 3 |
| BPH 101                                     | BS       | Engineering Physics – I                                     | 3 | 0 | 0 | 3 |
| BCH101                                      | BS       | Engineering Chemistry – I                                   | 3 | 0 | 0 | 3 |
| BCS101                                      | ES       | Fundamentals of Computing and Programming                   | 3 | 0 | 0 | 3 |
| BSS101                                      | HS       | Personality Development                                     | 1 | 1 | 0 | 2 |
| BBT 102                                     | BS       | Biology for Engineers                                       | 2 | 0 | 0 | 2 |
| BCE101                                      | ES       | Basic Civil Engineering                                     | 2 | 0 | 0 | 2 |
| BME101                                      | ES       | Engineering Graphics-E                                      | 2 | 2 | 0 | 4 |
| Practical                                   |          |                                                             |   |   |   |   |
| BCM1L1                                      | ES       | Basic Civil and Mechanical Engineering Practices Laboratory | 0 | 0 | 2 | 1 |
| BSS1L4/<br>1L5/IL6                          | HS       | NCC/NSS/NSO to be conducted during week ends                | 1 |   |   |   |
| E- Civil, Mechanical, Aeronautical Branches |          |                                                             |   |   |   |   |

**Total No. of Contact Hours: 27**

**Total No. of Credits: 27**

\*\* Engineering graphics – Final examination will be evaluated by internal faculty.

\* Laboratory classes on alternate weeks. The lab examinations will be held only in the second semester (including the first semester experiments also).

| SEMESTER II                                                                                                                                                                     |          |                                                        |   |   |     |   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------------------------------|---|---|-----|---|
| Code No.                                                                                                                                                                        | Category | Course Title                                           | L | T | P   | C |
| THEORY                                                                                                                                                                          |          |                                                        |   |   |     |   |
| BEN 201                                                                                                                                                                         | HS       | English-II                                             | 2 | 1 | 0   | 3 |
| BMA201                                                                                                                                                                          | BS       | Mathematics- II                                        | 3 | 1 | 0   | 3 |
| BPH 201                                                                                                                                                                         | BS       | Engineering Physics – II                               | 3 | 0 | 0   | 3 |
| BCH201                                                                                                                                                                          | BS       | Engineering Chemistry – II                             | 3 | 0 | 0   | 3 |
|                                                                                                                                                                                 | HS       | Foreign/Indian Language                                | 3 | 0 | 0   | 3 |
| BME202                                                                                                                                                                          | ES       | Engineering Mechanics                                  | 2 | 1 | 0   | 3 |
| BEE201                                                                                                                                                                          | ES       | Basic Electrical and Electronics Engineering           | 2 | 0 | 0   | 2 |
| Practical                                                                                                                                                                       |          |                                                        |   |   |     |   |
| BCS2L2                                                                                                                                                                          | ES       | Computer Practices Lab                                 | 0 | 0 | 2   | 1 |
| BEE2L1                                                                                                                                                                          | ES       | Basic Electrical and Electronics Engineering Practices | 0 | 0 | 2   | 1 |
| BPC2L1*                                                                                                                                                                         | BS       | Physics and Chemistry Laboratory                       | 0 | 0 | 2/2 | 1 |
| BSS2L7                                                                                                                                                                          | HS       | Yoga to be conducted during week ends                  | 1 |   |     |   |
| # Any one of the following courses: BFR201 – French, BGM201 – German, BJP201- Japanese, BKR201 – Korean, BCN201 – Chinese, BTM201 – Tamil                                       |          |                                                        |   |   |     |   |
| *Laboratory Classes on alternate weeks for Physics and Chemistry. The lab examinations will be held only in the second semester (including the first semester experiments also) |          |                                                        |   |   |     |   |

**Total No. of Contact Hours: 26**

**Total No. of Credits: 24**

| SEMESTER III |               |          |                                              |   |   |   |   |
|--------------|---------------|----------|----------------------------------------------|---|---|---|---|
| SL. NO       | SUBJECT CODE0 | CATEGORY | COURSE TITLE                                 | L | T | P | C |
| THEORY       |               |          |                                              |   |   |   |   |
| 1            | BMA301        | BS       | Mathematics – III                            | 3 | 1 | 0 | 4 |
| 2            | BAN301        | PC       | Fundamentals of Aeronautics and Astronautics | 3 | 0 | 0 | 3 |
| 3            | BAN302        | PC       | Fundamentals of Fluid Mechanics              | 3 | 1 | 0 | 4 |
| 4            | BAN303        | PC       | Fundamentals of Aero - Thermodynamics        | 3 | 1 | 0 | 4 |
| 5            | BAN304        | PC       | Fundamentals of Structural Mechanics         | 3 | 1 | 0 | 4 |
| 6            | BAN305        | PC       | Mechanics of Machines                        | 3 | 0 | 0 | 3 |
| PRACTICALS   |               |          |                                              |   |   |   |   |
| 7            | BCE3L1        | ES       | Fluid Mechanics and Machineries Laboratory   | 0 | 0 | 4 | 2 |
| 8            | BCE3L2        | ES       | Strength of Materials Laboratory             | 0 | 0 | 4 | 2 |
| 9            | BME3L1        | ES       | Machine Drawing                              | 0 | 0 | 4 | 2 |

**Total No. of Contact Hours: 34Total No. of Credits: 28**

| SEMESTER IV |              |          |                                      |   |   |   |   |
|-------------|--------------|----------|--------------------------------------|---|---|---|---|
| SL. NO      | SUBJECT CODE | CATEGORY | COURSE TITLE                         | L | T | P | C |
| THEORY      |              |          |                                      |   |   |   |   |
| 1           | BMA402       | BS       | Numerical Methods                    | 3 | 1 | 0 | 4 |
| 2           | BAN401       | PC       | Aircraft Structures – I              | 3 | 1 | 0 | 4 |
| 3           | BAN402       | PC       | Aerodynamics – I                     | 3 | 1 | 0 | 4 |
| 4           | BAN403       | PC       | Aircraft Propulsion                  | 4 | 0 | 0 | 4 |
| 5           | BAN404       | PC       | Aircraft Systems and Instrumentation | 3 | 0 | 0 | 3 |
| 6           | BCE407       | HS       | Environmental Studies                | 3 | 0 | 0 | 3 |
| PRACTICALS  |              |          |                                      |   |   |   |   |
| 7           | BAN4L1       | PC       | Aircraft Structures Laboratory       | 0 | 0 | 4 | 2 |
| 8           | BME4L1       | ES       | Manufacturing Engineering Laboratory | 0 | 0 | 2 | 1 |
| 9           | BAN4L2       | PC       | Computer Aided Design and Drafting   | 0 | 0 | 2 | 1 |

**Total No. of Contact Hours: 30Total No. of Credits: 26**

| SEMESTER V |              |          |                                     |   |   |   |   |
|------------|--------------|----------|-------------------------------------|---|---|---|---|
| SL. NO     | SUBJECT CODE | CATEGORY | COURSE TITLE                        | L | T | P | C |
| THEORY     |              |          |                                     |   |   |   |   |
| 1          | BAN501       | PC       | Aircraft Structures – II            | 3 | 1 | 0 | 4 |
| 2          | BAN502       | PC       | Aerodynamics – II                   | 3 | 1 | 0 | 4 |
| 3          | BAN503       | PC       | Advanced Aerospace Propulsion       | 4 | 0 | 0 | 4 |
| 4          | BAN504       | PC       | Flight mechanics                    | 3 | 1 | 0 | 4 |
| 5          | BME505       | ES       | Manufacturing Engineering           | 3 | 0 | 0 | 3 |
| 6          | -            | CE       | Core Elective – I                   | 3 | 0 | 0 | 3 |
| PRACTICALS |              |          |                                     |   |   |   |   |
| 7          | BAN5V1       | PR       | Value Added Program I               | 0 | 0 | 2 | 1 |
| 8          | BAN5L1       | PC       | Aerodynamics Laboratory             | 0 | 0 | 4 | 2 |
| 9          | BAN5L2       | PC       | Aero Design and Modeling Laboratory | 0 | 0 | 2 | 1 |
| 10         | BAN5L3       | PC       | Computer Aided Analysis             | 0 | 0 | 2 | 1 |

**Total No. of Contact Hours: 32 Total No. of Credits: 27**

| SEMESTER VI |              |          |                                               |   |   |   |   |
|-------------|--------------|----------|-----------------------------------------------|---|---|---|---|
| SL. NO      | SUBJECT CODE | CATEGORY | COURSE TITLE                                  | L | T | P | C |
| THEORY      |              |          |                                               |   |   |   |   |
| 1           | BSS601       | HS       | Value Education and professional Ethics       | 3 | 0 | 0 | 3 |
| 2           | BAN601       | PC       | Aerospace Structural Materials and Composites | 3 | 0 | 0 | 3 |
| 3           | BAN602       | PC       | Finite Element Methods                        | 3 | 1 | 0 | 4 |
| 4           | BAN603       | PC       | Control Engineering                           | 3 | 0 | 0 | 3 |
| 5           | -            | CE       | Core Elective – II                            | 3 | 0 | 0 | 3 |
| 6           | -            | NE       | Non – Major Elective – I                      | 3 | 0 | 0 | 3 |
| PRACTICALS  |              |          |                                               |   |   |   |   |
| 7           | BAN6V1       | PR       | Value Added Program – II                      | 0 | 0 | 2 | 1 |
| 8           | BAN6L1       | PC       | Aircraft System Laboratory                    | 0 | 0 | 4 | 2 |
| 9           | BAN6L2       | PC       | Propulsion Laboratory                         | 0 | 0 | 4 | 2 |
| 10          | BAN6L3       | PC       | Aircraft Design Project – I                   | 0 | 0 | 4 | 2 |

**Total No. of Contact Hours: 33 Total No. of Credits: 26**

| SEMESTER VII |              |          |                                     |   |   |   |   |
|--------------|--------------|----------|-------------------------------------|---|---|---|---|
| SL. NO       | SUBJECT CODE | CATEGORY | COURSE TITLE                        | L | T | P | C |
| THEORY       |              |          |                                     |   |   |   |   |
| 1            | BAN701       | PC       | Computational Fluid Dynamics        | 3 | 0 | 0 | 3 |
| 2            | BAN702       | PC       | Avionics                            | 3 | 0 | 0 | 3 |
| 3            | BAN703       | PC       | Heat Transfer                       | 3 | 0 | 0 | 3 |
| 4            | -            | CE       | Core Elective – III                 | 3 | 0 | 0 | 3 |
| 5            | -            | NE       | Non – Major Elective – II           | 3 | 0 | 0 | 3 |
| 6            | -            | OE       | Open Elective – I                   | 3 | 0 | 0 | 3 |
| PRACTICALS   |              |          |                                     |   |   |   |   |
| 7            | BAN7L1       | PC       | Airframe and Aero Engine Repair Lab | 0 | 0 | 2 | 1 |
| 8            | BAN7L2       | PC       | Avionics Laboratory                 | 0 | 0 | 2 | 1 |
| 9            | BAN7L3       | PC       | Aircraft Design Project – II        | 0 | 0 | 4 | 2 |
| 10           | BAN7P1       | PR       | Project Phase 1                     | 0 | 0 | 4 | 2 |

**Total No. of Contact Hours: 30    Total No. of Credits: 24**

| SEMESTER VIII |              |          |                            |   |   |    |   |
|---------------|--------------|----------|----------------------------|---|---|----|---|
| SL. NO        | SUBJECT CODE | CATEGORY | COURSE TITLE               | L | T | P  | C |
| THEORY        |              |          |                            |   |   |    |   |
| 1             | -            | NE       | Non – Major Elective – III | 3 | 0 | 0  | 3 |
| 2             | -            | OE       | Open Elective – II         | 3 | 0 | 0  | 3 |
| PRACTICALS    |              |          |                            |   |   |    |   |
| 3             | BAN8P1       | PR       | Project Work               | 0 | 0 | 18 | 9 |
| 4             | BAN8C1       | PR       | Comprehension              | 0 | 0 | 0  | 1 |

**Total No. of Contact Hours: 24    Total No. of Credits: 16**

**TOTAL NO. OF CREDITS FOR THE PROGRAM        : 198**

**SUMMARY OF CURRICULUM STRUCTURE AND CREDIT & CONTACT  
HOUR DISTRIBUTION**

| S.No<br>. | Sub Area                                                 | Credit As per Semester |    |     |    |    |    |     |      | No. of<br>Credit | % of<br>credit |
|-----------|----------------------------------------------------------|------------------------|----|-----|----|----|----|-----|------|------------------|----------------|
|           |                                                          | I                      | II | III | IV | V  | VI | VII | VIII |                  |                |
| 1         | Humanities & Social Sciences (HS)                        | 6                      | 7  | -   | 3  | -  | 3  | -   | -    | 19               | 9.6            |
| 2         | Basic Sciences (BS)                                      | 11                     | 10 | 4   | 4  | -  | -  | -   | -    | 29               | 14.7           |
| 3         | Engineering Sciences (ES)                                | 10                     | 7  | 6   | 1  | 3  | -  | -   | -    | 27               | 13.7           |
| 4         | Professional Core (PC)                                   | -                      | -  | 18  | 18 | 20 | 16 | 13  | -    | 85               | 42.9           |
| 5         | Core Electives (CE)                                      | -                      | -  | -   | -  | 3  | 3  | 3   | -    | 9                | 4.5            |
| 6         | Non major Electives (NE)                                 | -                      | -  | -   | -  | -  | 3  | 3   | 3    | 9                | 4.5            |
| 7         | Open Electives (OE)                                      | -                      | -  | -   | -  | -  | -  | 3   | 3    | 6                | 3              |
| 8         | Project Work, Seminar, Internship, Term Paper, etc. (PR) | -                      | -  | -   | -  | 1  | 1  | 2   | 10   | 14               | 7              |
|           | <b>Total Credit</b>                                      | 27                     | 24 | 28  | 26 | 27 | 26 | 24  | 16   | 198              | 100            |
|           | <b>Total Contact Hour</b>                                | 27                     | 26 | 34  | 33 | 30 | 32 | 30  | 24   | 236 Hrs          |                |

## LIST OF ELECTIVES

### List of Core Elective (CE) I:

| Code No. | Course Title                              | L | T | P | C |
|----------|-------------------------------------------|---|---|---|---|
| BANE01   | Basics of Aircraft Maintenance and Repair | 3 | 0 | 0 | 3 |
| BANE02   | Rockets and Missiles                      | 3 | 0 | 0 | 3 |
| BANE03   | Experimental Stress Analysis              | 3 | 0 | 0 | 3 |
| BANE04   | Experimental Aerodynamics                 | 3 | 0 | 0 | 3 |

### List of Core Elective (CE) II:

| Code No. | Course Title            | L | T | P | C |
|----------|-------------------------|---|---|---|---|
| BANE05   | Helicopter Maintenance  | 3 | 0 | 0 | 3 |
| BANE06   | Space Mechanics         | 3 | 0 | 0 | 3 |
| BANE07   | Theory of Vibrations    | 3 | 0 | 0 | 3 |
| BANE08   | Helicopter Aerodynamics | 3 | 0 | 0 | 3 |

### List of Core Elective (CE) III:

| Code No. | Course Title                           | L | T | P | C |
|----------|----------------------------------------|---|---|---|---|
| BANE09   | Aircraft Engine Repair and Maintenance | 3 | 0 | 0 | 3 |
| BANE10   | Cryogenic Rocket Propulsion            | 3 | 0 | 0 | 3 |
| BANE11   | Theory of Plates and Shells            | 3 | 0 | 0 | 3 |
| BANE12   | Hypersonic Aerodynamics                | 3 | 0 | 0 | 3 |

### List of Non Major Elective (NE) I:

| Code No. | Course Title                                           | L | T | P | C |
|----------|--------------------------------------------------------|---|---|---|---|
| BANE13   | An Introduction to Combustion                          | 3 | 0 | 0 | 3 |
| BANE14   | Principles of Turbo machinery in Air breathing Engines | 3 | 0 | 0 | 3 |
| BANE15   | Nano Science and Technology                            | 3 | 0 | 0 | 3 |
| BANE16   | Unmanned Aerial Vehicle                                | 3 | 0 | 0 | 3 |

### List of Non Major Elective (NE) II:

| Code No. | Course Title                   | L | T | P | C |
|----------|--------------------------------|---|---|---|---|
| BANE17   | Boundary Layer Theory          | 3 | 0 | 0 | 3 |
| BANE18   | Fatigue and Fracture Mechanics | 3 | 0 | 0 | 3 |
| BANE19   | High Temperature Materials     | 3 | 0 | 0 | 3 |

**List of Non Major Elective (NE) III:**

| <b>Code No.</b> | <b>Course Title</b>                         | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|-----------------|---------------------------------------------|----------|----------|----------|----------|
| BANE20          | Wind Energy                                 | 3        | 0        | 0        | 3        |
| BANE21          | Satellite Technology                        | 3        | 0        | 0        | 3        |
| BANE22          | Aircraft Rules and Regulations CAR I and II | 3        | 0        | 0        | 3        |

**List of Open Elective (OE) I:**

| <b>Code No.</b> | <b>Course Title</b>                                  | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|-----------------|------------------------------------------------------|----------|----------|----------|----------|
| BBA001          | Principles of Management and Organizational Behavior | 3        | 0        | 0        | 3        |
| BANE23          | Airport Management                                   | 3        | 0        | 0        | 3        |
| BANE24          | Aerospace Bio – Medical and Life Support Engineering | 3        | 0        | 0        | 3        |

**List of Open Elective (OE) II:**

| <b>Code No.</b> | <b>Course Title</b>                  | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|-----------------|--------------------------------------|----------|----------|----------|----------|
| BBA008          | Total Quality Management             | 3        | 0        | 0        | 3        |
| BANE25          | Industrial Aerodynamics              | 3        | 0        | 0        | 3        |
| BANE26          | Mechanics of Heterogeneous Materials | 3        | 0        | 0        | 3        |



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                 |    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----|
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 37th Academic Council Meeting held in May 2015. |    |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                 |    |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | PARTIAL DIFFERENTIAL EQUATIONS                  | 12 |
| Formation of PDE by eliminating arbitrary constants, functions – Solutions of first order PDE – Standard types-homogeneous linear PDE of second order with constant coefficients - Lagrange’s Linear PDE – Method of grouping, multiplier methods.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                 |    |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | FOURIER SERIES                                  | 12 |
| Dirichlet’s conditions – General Fourier series – Half-range Sine and Cosine series – Parseval’s identity – Harmonic Analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                 |    |
| UNIT III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | BOUNDARY VALUE PROBLEMS                         | 12 |
| Classifications of second order linear partial differential equation – Solutions of one-dimensional wave equation and one-dimensional heat equation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                 |    |
| UNIT IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | LAPLACE TRANSFORMS                              | 12 |
| Laplace transform of simple functions – Transform of elementary functions – Basic properties – initial and final value theorem – Transform of derivatives and integrals – transform of periodic functions – inverse Laplace transforms –Convolution theorem (excluding proof) – Solution of linear ODE of second order with constant coefficients and solutions of simultaneous first order differential equations with constant coefficients using Laplace transformation techniques.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                 |    |
| UNIT V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | FOURIER TRANSFORMS                              | 12 |
| Fourier integral theorem – Fourier transform pair-Sine and Cosine transforms – Properties – Transform of simple function – Convolution theorem – Parseval’s identity.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                 |    |
| <b>Text Books:</b><br>1. Grewal, B.S., Higher Engineering Mathematics, Khanna Publications, 2007.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                 |    |
| <b>References:</b><br>1. Glyn James, Advance Modern Engineering Mathematics, Pearson Education, 2007.<br>2. Kreyszig. E, Advanced Engineering Mathematics, (8 <sup>th</sup> edition), John Wiley & Sons, Singapore, 2000.<br>3. Kandasamy P et al, Engineering Mathematics, Vol. II & III (4 <sup>th</sup> revised edition), S. Chand & Co., New Delhi, 2000.<br>4. Narayanan S., Manicavachagom Pillay T. K., Ramanaiah G., Advanced Mathematics for Engineering Students, Volume II & III (2 <sup>nd</sup> edition), S. Viswanathan Printers and Publishers, 1992.<br>5. Venkataraman M. K., Engineering Mathematics – Vol. III – A & B (13 <sup>th</sup> edition), National Publishing Co., Chennai, 1998.<br>6. Julius S. Bendat and Allan G BANE20. Piersol., Random Data: Analysis and Measurement Procedures (4 <sup>th</sup> edition), Wiley Series in Probability and Statistics, 2010.<br>7. <a href="https://www.wolfram.com/mathematica/">https://www.wolfram.com/mathematica/</a> |                                                 |    |



Early design  
of Aircrafts

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                       |    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Professional Core (PC)                                                                                                                                                                |    |
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 37th Academic Council Meeting held in May 2015.                                                                                                                                       |    |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                       |    |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | INTRODUCTION TO FLIGHT                                                                                                                                                                | 8  |
| Brief history of Aviation-Hot air balloon and heavier than air flying machines-early airplane configurations-Modern Airplanes-Components of airplane and their functions-Rotary wing aircrafts-Space vehicles.                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                       |    |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | FUNDAMENTALS OF AERONAUTICS                                                                                                                                                           | 11 |
| International Standard Atmosphere-Pressure, Temperature and Density altitude, Basic Aerodynamics - Continuity, Momentum and Energy equations, Bernoulli's equation-Mach number-subsonic, transonic, sonic and supersonic flow regimes, Measurement of pressure and airspeed- IAS,EAS and TAS. Airfoil geometry and nomenclature-infinite and finite wing sections-lift, drag and moment coefficients-angle of attack-aspect ratio-Reynolds number-induced drag and parasite drag-airfoil characteristics, Elements of Aircraft performance, stability and control. |                                                                                                                                                                                       |    |
| UNIT III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | AIRCRAFT STRUCTURE AND MATERIALS                                                                                                                                                      | 8  |
| Design<br>afts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Structural components of an airplane- monocoque and semi monocoque structure –materials for structural components – composite materials and their significance in Aviation Technology |    |
| UNIT IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | AIRCRAFT PROPULSION                                                                                                                                                                   | 10 |
| Propeller Engine – Gas Turbine Engine – Turbo prop, Turbo jet, Turbo fan Engines- specific fuel consumption-variation of thrust and power with speed and altitude – materials for engine components.                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                       |    |
| UNIT V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | SPACE VEHICLES & ASTRONAUTICS                                                                                                                                                         | 8  |
| Basics of Rocket Technology-escape velocity-reentry vehicles-heat transfer problems of space vehicles- ablative cooling-Satellite technology– Hypersonic vehicles, Elements of Astronautics.                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                       |    |
| Total Periods: 45                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                       |    |
| Text Books:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                       |    |
| 1. Anderson, J. D., Introduction to Flight,TataMcGraw-Hill Higher Education, 6 <sup>th</sup> edition 2010.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                       |    |
| 2. Kermode, A. C, Barnard, R. H and Philpott, D. R, Mechanics of Flight, Pearson education, 2012.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                       |    |
| References:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                       |    |
| 1. Shevell, R. C., Fundamentals of Flight., Prentice hall (2 <sup>nd</sup> edition), 1989.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                       |    |
| 2. Steven, A. Brandt, Randall J. Stiles, John J. Bertin and Ray Whitford, Introduction to Aeronautics: A Design Perspective, AIAA Education series (2 <sup>nd</sup> edition),2004.                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                       |    |
| 3. Torenbeek, E and Wittenberg, H, Flight Physics: Essentials of Aeronautical Disciplines and Technology, with Historical Notes, Springer, 2009.                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                       |    |
| 4. www.grc.nasa.gov/WWW/k-12/airplane/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                       |    |



|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                 |    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----|
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                    | 37th Academic Council Meeting held in May 2015. |    |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                 |    |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                                                                      | INTRODUCTION                                    | 10 |
| Fluid –definition-Fluid properties-Newton’s law of viscosity-Classification of fluids-fluid statics-Hydrostatic forces on submerged surfaces- Stability of floating bodies                                                                                                                                                                                                                                                                  |                                                 |    |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                                                                     | FLUID FLOW ANALYSIS AND FLOW MEASUREMENT        | 14 |
| Ideal and real flow-Concept of continuum-Eulerian and Lagrangian approaches-Velocity field-Pathline, Streakline, Streamline- Stream tube- Fluid acceleration-Continuity, momentum differential equations-Navier Stokes equation- Stream function – Vorticity –Irrotationality- Potential function-Potential flow-Laplace equation-Bernoulli’s equation and its applications-Venturi meter-Orificemeter, Flow Rate and Velocity Measurement. |                                                 |    |
| UNIT III                                                                                                                                                                                                                                                                                                                                                                                                                                    | DIMENSIONAL ANALYSIS                            | 10 |
| Buckingham Pi Theorem-Non dimensional numbers and their significance-Flow similarity and model studies. Significance of Dimensional analysis and its application                                                                                                                                                                                                                                                                            |                                                 |    |
| UNIT IV                                                                                                                                                                                                                                                                                                                                                                                                                                     | FLOW THROUGH PIPES                              | 12 |
| Laminar and turbulent flow- Boundary layer flow – Boundary layer thickness - Reynolds number and its significance-Laminar fully developed pipe flow-Hagen-Poiseuille flow-Coefficient of friction-Head loss – Darcy-Weisbach equation-Hydraulic gradient- Total energy lines-Moody’s diagram-Turbulent flow through pipes.                                                                                                                  |                                                 |    |
| UNIT V                                                                                                                                                                                                                                                                                                                                                                                                                                      | FLUID MACHINERY                                 | 14 |
| Classification of fluid machines-Reciprocating and centrifugal pumps-impulse and reaction turbines-Working principle of Pelton, Francis and Kaplan turbines-Velocity triangles-fans and blowers.                                                                                                                                                                                                                                            |                                                 |    |
| Total Periods: 60                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                 |    |
| Text Books:                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                 |    |
| 1. Frank M White, Fluid Mechanics, The McGraw Hill companies. (7 <sup>th</sup> edition), 2011.                                                                                                                                                                                                                                                                                                                                              |                                                 |    |
| 2. Rathakrishnan, E, Fundamentals of Fluid Mechanics, Prentice-Hall (3 <sup>rd</sup> edition), 2012.                                                                                                                                                                                                                                                                                                                                        |                                                 |    |
| References:                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                 |    |
| 1. Yunus A Cengel and John M Cimbala, Fluid mechanics: Fundamentals and Applications, Tata McGraw Hill (2 <sup>nd</sup> edition), 2010.                                                                                                                                                                                                                                                                                                     |                                                 |    |
| 2. Irving H Shames, Mechanics of Fluids, The McGraw Hill companies (4 <sup>th</sup> edition), 2003.                                                                                                                                                                                                                                                                                                                                         |                                                 |    |
| 3. Yuan, S.W, Foundations of Fluid Mechanics, Prentice-Hall, 1967.                                                                                                                                                                                                                                                                                                                                                                          |                                                 |    |
| 4. reu.eng.ua.edu › Programs                                                                                                                                                                                                                                                                                                                                                                                                                |                                                 |    |
| 5. www.fluidmechanics.co.uk/                                                                                                                                                                                                                                                                                                                                                                                                                |                                                 |    |

|                                                                                                                                                                                                                       |                                                                                                      |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN303                                                                                                                                                                                                                | FUNDAMENTALS OF AERO –<br>THERMODYNAMICS                                                             |                                                 |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                                                                                                                                                       | Total Contact Hours – 60                                                                             |                                                 |     |     |     |     | 3   | 1   | 0   | 4    |      |      |      |      |
|                                                                                                                                                                                                                       | Prerequisite – Physics, Basics of Mechanical Engineering                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                                                                       | Course Designed by – Department of Aeronautical Engineering                                          |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVE: To make the student understand about the basics of engineering thermodynamics, various laws and their applications, prediction of thermodynamic performance of various engines, and other thermal devices. |                                                                                                      |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                                                                                                                                       |                                                                                                      |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                                                                                                                                       |                                                                                                      |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                                                                                                                                  | Apply the fundamental laws of thermodynamics and its thermodynamic relations. (Apply)                |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                                                                                                                                  | Compute the air standard efficiencies using P-V and T-S diagram of various air power cycles. (Apply) |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                                                                                                                                  | Calculate the efficiency of various Vapor power cycles (Apply)                                       |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 4                                                                                                                                                                                                                  | Estimate the COP of refrigeration and air-conditioning systems. (Analyze)                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 5                                                                                                                                                                                                                  | Calculate the efficiency of jet propulsion cycles. (Apply)                                           |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                                                                                                                                       |                                                                                                      |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                                                                                                                                          |                                                                                                      |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                                                                                                                             | PO1                                                                                                  | PO2                                             | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                                                                                                                                  | H                                                                                                    |                                                 |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 2                                                                                                                                                                                                                  | H                                                                                                    |                                                 |     |     |     |     |     |     |     |      |      | M    | H    |      |
| CO 3                                                                                                                                                                                                                  | H                                                                                                    |                                                 |     |     |     |     |     |     |     | M    |      | M    | H    |      |
| CO 4                                                                                                                                                                                                                  | H                                                                                                    |                                                 |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 5                                                                                                                                                                                                                  | H                                                                                                    |                                                 |     |     |     |     |     |     |     | M    |      |      | H    |      |
|                                                                                                                                                                                                                       |                                                                                                      |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| Category                                                                                                                                                                                                              |                                                                                                      | Professional Core (PC)                          |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                                                                                                                                              |                                                                                                      | 37th Academic Council Meeting held in May 2015. |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE CONTENT                                                                                                                                                                                                        |                                                                                                      |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| UNIT I                                                                                                                                                                                                                |                                                                                                      | BASIC THERMODYNAMICS                            |     |     |     |     |     |     |     |      |      |      | 16   |      |

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| Systems, Zeroth law, First law - Steady flow energy equation - Heat and work transfer in flow and non-flow processes - Second law, Kelvin-Planck statement - Clausius statement – Reversibility and irreversibility - Concept of Entropy, Clausius inequality, Principle of increase of entropy – Absolute entropy – Availability - Entropy change in non-flow processes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                     |           |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>AIR POWER CYCLES</b>                             | <b>12</b> |
| Carnot, Otto, Diesel, Dual, Stirling and Ericsson cycle - Air standard efficiency – Mean effective pressure – Actual and theoretical PV diagram of two stroke and four stroke IC engines.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                     |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>VAPOUR POWER CYCLES</b>                          | <b>12</b> |
| Introduction – Rankine cycle – Means of increase of efficiency of the Rankin cycle – Ideal reheat and regenerative Rankine cycle – Second law analysis of vapour power cycles – Cogeneration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                     |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>REFRIGERATION AND AIR – CONDITIONING</b>         | <b>10</b> |
| Principles of refrigeration and Psychometric - Vapour compression - Vapour absorption types - Co-efficient of performance, Properties of refrigerants – Basic Principle and types of Air conditioning.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                     |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>THERMODYNAMICS OF AIRCRAFT PROPULSION CYCLES</b> | <b>10</b> |
| Isentropic flow through passages – Brayton cycle – Brayton cycle with intercooling, reheat and regeneration – Ideal jet propulsion cycles. Basics of heat transfer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                     |           |
| <b>Text Books:</b> <ol style="list-style-type: none"> <li>1. Rathakrishnan E., Fundamentals of Engineering Thermodynamics, Prentice-Hall India, 2012.</li> <li>2. Nag.P.K., Engineering Thermodynamics, Tata McGraw-Hill, New Delhi, 2007.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                     |           |
| <b>Reference Books:</b> <ol style="list-style-type: none"> <li>1. Yunus A Cengel and Michael A Boles., Thermodynamics- an Engineering approach, McGraw Hill Education (7<sup>th</sup> edition), 2012.</li> <li>2. Holman.J.P., Thermodynamics, McGraw-Hill (3<sup>rd</sup> edition), 2007.</li> <li>3. Gordon J. Van Wylen and Richard E. Sonntag and Claus Borgnakke., Fundamentals of Classical Thermodynamics – Vol 1, Wiley Eastern, 1994.</li> <li>4. Arora C.P., Thermodynamics, Tata McGraw-Hill, New Delhi, 2003.</li> <li>5. Merle C Potter and Craig W Somerton., Thermodynamics for Engineers, Schaum’s Outline Series, Tata McGraw-Hill (2<sup>nd</sup> edition), 2009.</li> <li>6. <a href="http://www.thermocalc.com/">www.thermocalc.com/</a></li> <li>7. <a href="http://www.grc.nasa.gov/WWW/cdtb/software/t-mats.html">www.grc.nasa.gov/WWW/cdtb/software/t-mats.html</a></li> </ol> |                                                     |           |



| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                       |           |
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| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>INTRODUCTION TO STRENGTH OF MATERIALS</b>          | <b>16</b> |
| Introduction to mechanics of deformable bodies - Material selection criteria – stress – strain – Stress and strain diagram – Hook’s law - Elastic constants – definition of engineering constants: elastic moduli – Young’s modulus, Bulk Modulus & Volumetric Strain, Poisson’s ratio, Shear Modulus, relation between three elastic moduli and Poisson’s ratio, Statically determinate and indeterminate problems in tension and compression – Thermal stress – Impact loading – Composite bars                                                                                                                                                                                                                                                                                                      |                                                       |           |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>STRESSES IN BEAMS</b>                              | <b>10</b> |
| Shear force and bending moment diagrams for simply supported, cantilever beams and overhanging beams– bending stress variation in beams of symmetric sections, neutral axis Euler–Bernoulli beam theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                       |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>DEFLECTION OF BEAMS</b>                            | <b>10</b> |
| Double integration, Macaulay’s method, moment area method, conjugate beam method, method of superposition, Maxwell’s reciprocal theorem. Governing ODE for beam bending, Boundary conditions for various types of beam end supports                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                       |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>TORSION</b>                                        | <b>10</b> |
| Torsion of solid and hollow circular shafts – Shear stress variation – Power transmission in shafts – Open and closed-coiled helical springs – Stresses in helical springs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                       |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>BI – AXIAL STRESSES AND ELEMENTS OF ELASTICITY</b> | <b>14</b> |
| Stresses in thin cylindrical and spherical shell under internal pressure and volumetric strain– Principle stresses and maximum shear stresses– Combined loading – Mohr’s circle and its construction – concept of theory of elasticity, basic assumptions, coordinate transformation, plane stress and plane strain conditions, stress tensor Introduction to Failure Theory and their importance                                                                                                                                                                                                                                                                                                                                                                                                      |                                                       |           |
| <b>Text Books:</b> <ol style="list-style-type: none"> <li>1. Gere &amp; Timoshenko, Mechanics of Materials, McGraw Hill, 1993</li> <li>2. William Nash, Strength of Materials, Tata McGraw Hill, 2004</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                       |           |
| <b>Reference Books:</b> <ol style="list-style-type: none"> <li>1. F. P. Beer, E.R. Johnston, and J.T. Dewolf, Mechanics of Materials, McGraw-Hill (4<sup>th</sup> edition), 2006</li> <li>2. Dym, C.L., and Shames, I.H., Solid Mechanics, McGraw Hill, Kogakusha, 1973.</li> <li>3. Stephen Timoshenko, Strength of Materials, Vol I &amp; II, CBS Publishers and Distributors, Third Edition.</li> <li>4. R.K. Rajput, Strength of Materials, S. Chand and Co., 1999.</li> <li>5. Timoshenko, S. and Young, D.H., Elements of Strength of Materials, T. VanNostrand Co. Inc., Princeton, N.J., 1977.</li> <li>6. <a href="http://www.mdsolids.com/">www.mdsolids.com/</a></li> <li>7. <a href="http://www.actuspotentia.com/MechMat.shtml">http://www.actuspotentia.com/MechMat.shtml</a></li> </ol> |                                                       |           |

|                                                                                                             |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN305                                                                                                      | MECHANICS OF MACHINES                                                                                                                 |     |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                                             | Total Contact Hours – 45                                                                                                              |     |     |     |     |     | 3   | 0   | 0   | 3    |      |      |      |      |
|                                                                                                             | Prerequisite – Engineering Mechanics                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                             | Course Designed by – Department of Aeronautical Engineering                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                                  |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To impart students with the knowledge about motion, masses and forces in machines.                       |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To enable students to apply fundamental of mechanics to machines which include engines, linkages etc.,   |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To impart students with the knowledge about various power transmitting devices such as gears, belts etc. |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To facilitate students to understand the concept of balancing of rotating and reciprocating masses.      |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. To give awareness to students on the phenomenon of vibration and its effects.                            |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                             |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                             |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                        | Describe the working of different mechanisms along with inversion and their corresponding velocity and acceleration diagrams. (Apply) |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                        | Determine the Power transmission in machine elements using fundamentals of friction. (Apply)                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                        | Sketch the Cam profile for various follower motions. (Apply)                                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 4                                                                                                        | Determine the unbalanced forces acting on rotating and reciprocating parts in engine. (Apply)                                         |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 5                                                                                                        | Classify the types of vibration and the frequencies of vibrating systems. (Understand)                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                             |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                                |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                   | PO1                                                                                                                                   | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                        | H                                                                                                                                     |     |     |     | H   |     |     |     |     | H    |      |      | H    |      |
| CO 2                                                                                                        | H                                                                                                                                     |     |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 3                                                                                                        | H                                                                                                                                     |     |     |     | H   |     |     |     |     | H    |      |      | H    |      |
| CO 4                                                                                                        | H                                                                                                                                     |     |     |     | H   |     |     |     |     | H    |      |      | H    |      |
| CO 5                                                                                                        | H                                                                                                                                     |     |     |     |     |     |     |     |     |      |      |      | H    |      |
| Category                                                                                                    | Professional Core (PC)                                                                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                                    | 37th Academic Council Meeting held in May 2015.                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE CONTENT                                                                                              |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |

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| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>MECHANISMS</b>                                                           | <b>8</b>  |
| Machine Structure – Kinematic link, pair and chain – Grueblers criteria – Constrained motion – Degrees of freedom –Kutzbach criterion - Slider crank and crank rocker mechanisms – <b>Inversions – Applications</b> –Kinematic analysis of simple mechanisms – Determination of velocity and acceleration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                             |           |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>FRICTION</b> Static and dynamic friction, Sliding and rolling friction   | <b>9</b>  |
| Friction in screw and nut – Pivot and collar – Thrust bearing – Plate and disc clutches – Belt (Flat and Vee) and rope drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                             |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>GEARING AND CAMS</b>                                                     | <b>9</b>  |
| Gear profile and geometry – Nomenclature of spur and helical gears – <b>Gear trains:</b> Simple, Compound gear trains and epicyclic gear trains - <b>Determination of</b> speed and torque - Cams – Types of cams and followers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                             |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>FORCE ANALYSIS AND BALANCING</b>                                         | <b>10</b> |
| Introduction to force analysis - Static and dynamic – <b>Inertia force and inertia torque</b> – D’Alembert’s principle -Static and dynamic balancing – Single and several masses in different planes –Balancing of reciprocating masses- primary <b>balancing and concepts of</b> secondary balancing – Single and multicylinder engines (Inline) – Balancing of radial V engine – direct and reverse crank method.                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                             |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>VIBRATION</b> Natural and damped frequency, critical damping coefficient | <b>9</b>  |
| Free, forced and damped vibrations of single degree of freedom systems – Force transmitted to supports – Vibration isolation – Vibration absorption – Torsional vibration of shaft – Single and multi rotor systems – Geared shafts – Critical speed of shaft.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                             |           |
| <b>Text Books:</b> <ol style="list-style-type: none"> <li>1. Rattan.S.S., Theory of Machines, Tata McGraw–Hill Publishing Co, New Delhi, 2004.</li> <li>2. Balaguru. S., Dynamics of Machinery, SciTech publication (2<sup>nd</sup> edition), 2009.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                             |           |
| <b>Reference Books:</b> <ol style="list-style-type: none"> <li>1. Rao, J.S and Dukkupati, R.V, “Mechanism and Machine Theory”, Second Edition, Wiley Eastern Ltd., 1992.</li> <li>2. Malhotra, D.R and Gupta, H.C., “The Theory of Machines”, SatyaPrakasam, Tech. India Publications, 1989.</li> <li>3. Gosh, A. and Mallick, A.K., “Theory of Machines and Mechanisms”, Affiliated East West Press,1989.</li> <li>4. Shigley, J.E. and Uicker, J.J., “Theory of Machines and Mechanisms”, McGraw-Hill, 1980.</li> <li>5. Burton Paul, “Kinematics and Dynamic of Planer Machinery”, Prentice Hall, 1979.</li> <li>6. <a href="http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5593596">ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5593596</a></li> <li>7. <a href="http://www.simplemachines.org/">www.simplemachines.org/</a></li> </ol> |                                                                             |           |

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| <b>BCE3L1</b> | <b>FLUID MECHANICS AND MACHINERIES<br/>LAB</b>       | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|               | Total Contact Hours – 30                             | 0        | 0        | 4        | 2        |
|               | Prerequisite – Engineering Mechanics                 |          |          |          |          |
|               | Course Designed by – Department of Civil Engineering |          |          |          |          |

### OBJECTIVES

1. To help the student to understand about pipe flow losses and flow through notches and weirs.
2. To accustom the student about buoyancy test and Bernoulli's principle
3. To introduce to the student about the various flow meters
4. To acquaint the student about the performance characteristics of various pumps
5. To introduce to the student about the performance characteristics of various turbines

### COURSE OUTCOMES

**At the end of Course, Students will be able to,**

|             |                                                                                                                               |
|-------------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>CO 1</b> | <b>Observe</b> the flow characteristics in a fluid flow system. <b>(Imitation)</b>                                            |
| <b>CO 2</b> | <b>Acquire</b> the pressure data with manometers/sensors for finding the efficiency of given system. <b>(Manipulation)</b>    |
| <b>CO 3</b> | <b>Perform</b> the basic calculations and plot graphs to infer fluid behaviour at various flow conditions. <b>(Precision)</b> |

### CO / PO MAPPING

**L –LOW, M – MEDIUM, H – HIGH**

| <b>COs / POs</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PO12</b> | <b>PSO1</b> | <b>PSO2</b> |
|------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>CO 1</b>      | H          |            |            |            |            |            |            |            | H          | H           |             |             | H           |             |
| <b>CO 2</b>      | H          |            |            |            |            |            |            |            | H          | H           |             |             | H           |             |
| <b>CO 3</b>      | H          |            |            |            |            |            |            |            | H          | H           |             |             | H           |             |

|                 |                                                        |
|-----------------|--------------------------------------------------------|
| <b>Category</b> | <b>Professional Core (PC)</b>                          |
| <b>Approval</b> | <b>37th Academic Council Meeting held in May 2015.</b> |

### LIST OF EXPERIMENTS

|   |                                                  |
|---|--------------------------------------------------|
| 1 | Determination of pipe flow losses.               |
| 2 | Calibration of orifice meter and venture meter.  |
| 3 | Flow through notches and weir.                   |
| 4 | Flow through open orifice.                       |
| 5 | Verification of Bernoulli's Equation.            |
| 6 | Performance characteristics of centrifugal pump. |

|                                                                                                          |                                                            |
|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| 7                                                                                                        | Performance characteristics of submergible pump.           |
| 8                                                                                                        | Performance characteristics of jet pump.                   |
| 9                                                                                                        | Characteristics of impulse turbine – Pelton wheel turbine. |
| 10                                                                                                       | Characteristics of reaction turbine – Francis turbine.     |
| <b>References:</b><br>1. Fluid Mechanics and Machinery Lab Manual, Department of Civil Engineering, 2015 |                                                            |

|               |                                                             |          |          |          |          |
|---------------|-------------------------------------------------------------|----------|----------|----------|----------|
| <b>BCE3L2</b> | <b>STRENGTH OF MATERIALS LAB</b>                            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|               | Total Contact Hours – 30                                    | 0        | 0        | 4        | 2        |
|               | Prerequisite – Engineering Mechanics                        |          |          |          |          |
|               | Course Designed by – Department of Aeronautical Engineering |          |          |          |          |

### OBJECTIVES

1. To enable the student to understand about the tensile test and stress – strain curves and also about the compression tests
2. To accustom the student about shear test, torsion test and hardness tests.
3. To introduce to the student about the impact test.
4. To acquaint the student about the open and closed coil spring tests.
5. To introduce to the student about fatigue test.

### COURSE OUTCOMES

At the end of Course, Students will be able to,

|             |                                                                                                                                                       |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO 1</b> | <b>Carry out</b> elementary mechanical coupon testing of materials as per the given procedure. <b>(Imitation)</b>                                     |
| <b>CO 2</b> | <b>Acquire</b> data using the available measuring devices. <b>(Manipulation)</b>                                                                      |
| <b>CO 3</b> | <b>Perform</b> basic mathematical calculation using the appropriate formulae and represent the results in form of graph and table. <b>(Precision)</b> |

### CO / PO MAPPING

L –LOW, M – MEDIUM, H – HIGH

| COs / POs   | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO 1</b> | H   |     |     |     |     |     |     |     | H   | H    |      |      | H    |      |
| <b>CO 2</b> | H   |     |     |     |     |     |     |     | H   | H    |      |      | H    |      |
| <b>CO 3</b> | H   |     |     |     |     |     |     |     | H   | H    |      |      | H    |      |

|                 |                                                        |
|-----------------|--------------------------------------------------------|
| <b>Category</b> | <b>Professional Core (PC)</b>                          |
| <b>Approval</b> | <b>37th Academic Council Meeting held in May 2015.</b> |

### LIST OF EXPERIMENTS

|   |                                                                                                        |
|---|--------------------------------------------------------------------------------------------------------|
| 1 | Tension test of a mild steel rod.                                                                      |
| 2 | Shear test on mild steel and aluminum rod. Estimation of Young's modulus using four point bending test |
| 3 | Torsion test on mild steel rod.                                                                        |
| 4 | Hardness test (a) Brinell& (b) Rockwell.                                                               |
| 5 | Impact tests (a) Izod (b) Charpy.                                                                      |

|                                                                                                         |                                                                                          |
|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| 6                                                                                                       | Deflection test on helical spring.                                                       |
| 7                                                                                                       | Deflection of beams with various end conditions.                                         |
| 8                                                                                                       | Flexural Test by 3-point Bending method.                                                 |
| 9                                                                                                       | Block compression test.                                                                  |
| 10                                                                                                      | Determination of fracture strength and fracture pattern of ductile and brittle material. |
| <b>References:</b><br>1. Strength of Materials Lab Manual, Department of Aeronautical Engineering, 2015 |                                                                                          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                     |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>BME3L1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>MACHINE DRAWING</b>                                                                              |                                                        |            |            |            |            | <b>L</b>   | <b>T</b>   | <b>P</b>   | <b>C</b>    |             |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Total Contact Hours – 30                                                                            |                                                        |            |            |            |            | 0          | 0          | 4          | 2           |             |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Prerequisite – Engineering Graphics                                                                 |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Course Designed by – Department of Mechanical Engineering                                           |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>OBJECTIVES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                     |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| 1. To give the students an idea of fundamental issues common to almost all areas of machine drawing.<br>2. To train the student to draw an assembled diagram of a machine part based on the details of individual parts.<br>3. To help the student to understand the machine drawing, nomenclature and various notations.<br>4. To train the students to prepare a working drawing of machines.<br>5. To enable the student to communicate his ideas through drawings.                                                                                                                                                               |                                                                                                     |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                     |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>At the end of Course, Students will be able to,</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                     |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Observe</b> basic representation of symbols used in Engineering drawings. <b>(Imitation)</b>     |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Acquire</b> attributes of Production Drawing and Limits, fits, tolerances. <b>(Manipulation)</b> |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Complete</b> the assembly of a given set of machine components. <b>(Manipulation)</b>            |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO / PO MAPPING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                     |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>L –LOW, M – MEDIUM, H – HIGH</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                     |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>COs / POs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>PO1</b>                                                                                          | <b>PO2</b>                                             | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PO12</b> | <b>PSO1</b> | <b>PSO2</b> |
| <b>CO 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | H                                                                                                   | H                                                      |            |            |            |            |            |            | H          | H           |             |             | H           |             |
| <b>CO 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | H                                                                                                   | H                                                      |            |            |            |            |            |            | H          | H           |             |             | H           |             |
| <b>CO 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | H                                                                                                   | H                                                      |            |            |            |            |            |            | H          | H           |             |             | H           |             |
| <b>Category</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                     | <b>Professional Core (PC)</b>                          |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>Approval</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                     | <b>37th Academic Council Meeting held in May 2015.</b> |            |            |            |            |            |            |            |             |             |             |             |             |
| Indian standard code (BIS) of practice for engineering drawing – general principle of presentation, conventional representation of threaded parts, springs, Gears and common features, Abbreviations and symbols used in technical drawings.<br>Tolerance – Types – Symbols used and representation on the drawing – fit types, selection for different application – Allowance, Interchangeability. Surface finish Relation to the manufacturing processes – Types of representation on the drawing welding symbols.<br>Preparation of working drawing for given machine components: Bolts, Screws, Studs, Nuts, Keys and Key-ways. |                                                                                                     |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |

Preparation of simple assembly drawings: Different types of cotter and knuckle joints.

Preparation of simple assembly drawing for following machine with part drawings given: Screw jack, Plummer block, connecting rod, machine vice, tail stock of lathe, fuel injection pump for single cylinder engine, stop valve.

List of Experiments:

1. Draw the various Types of representation on welding symbols.
2. Preparation of working drawing for given machine components Bolts and Nuts.
3. Preparation of working drawing for given machine components Screw.
4. Preparation of working drawing for given machine components Key and Key-ways.
5. Draw the sectional assembled view of Sleeve and cotter joint
6. Draw the sectional assembled view of Knuckle joint.
7. Draw the sectional assembled view of Screw Jack.
8. Draw the sectional assembled view of Plummer Block.
9. Draw the sectional assembled view of Connecting Rod.
10. Draw the sectional assembled view of Tail stock.

**Text Books:**

1. Narayanan. K. L. Machine Drawing, New age publisher, 2006.

**References:**

1. Bhatt, N. D., Machine Drawing, Charotar publishing house, 2000.
2. Gopala Krishnan, Machine Drawing, Subash publishers, 2001.
3. <https://www.smartdraw.com/software/mechanical-drawing-software.htm>
4. <https://www.machinedesignonline.com/>



|                                                                                                                                                                                                                                                                                                |                                                            |    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|----|
| Category                                                                                                                                                                                                                                                                                       | Basic Sciences (BS)                                        |    |
| Approval                                                                                                                                                                                                                                                                                       | 37th Academic Council Meeting held in May 2015.            |    |
| COURSE CONTENT                                                                                                                                                                                                                                                                                 |                                                            |    |
| UNIT I                                                                                                                                                                                                                                                                                         | INTERPOLATION (FINITE DIFFERENCES)                         | 12 |
| Iterative method, Newtown-Raphson method for single variable-solutions of linear system by Gaussian, Gauss-Jordan, Jacobian and Gauss-Siedel methods, Inverse of matrix by Gauss-Jordan method , Eigen value of a matrix power and Jacobian methods.                                           |                                                            |    |
| UNIT II                                                                                                                                                                                                                                                                                        | INTERPOLATION (FINITE DIFFERENCES)                         | 12 |
| Newton’s Divided difference formula, Lagrange’s interpolation-forward and backward difference formula-Stirling’s and Bessel’s central difference formula.                                                                                                                                      |                                                            |    |
| UNIT III                                                                                                                                                                                                                                                                                       | NUMERICAL DIFFERENTIATION AND INTEGRATION                  | 12 |
| Numerical differentiation with interpolation polynomials, Numerical integration by Trapezoidal Simpson’s 1/3” and 3/8” rule, Double integrals using Trapezoidal and Simpson’s rule.                                                                                                            |                                                            |    |
| UNIT IV                                                                                                                                                                                                                                                                                        | INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS | 12 |
| Single step methods, Taylor series, Euler and modified Euler, Runge kutta method of first and second order differential equations, multiple step methods, Milne and Adam’s – Bash forth predictor and corrector method.                                                                        |                                                            |    |
| UNIT V                                                                                                                                                                                                                                                                                         | BOUNDARY VALUE PROBLEMS FOR ODE AND PDE                    | 12 |
| Finite difference for the second order ordinary differential equations, finite difference solutions for one dimensional heat equations (both implicit and explicit), one dimensional wave equation, Two dimensional, Laplace and Poisson equation.                                             |                                                            |    |
| <b>Text Books:</b><br>1. Jain. M. K. Iyengar, S. R. K. And Jain, R K., Numerical Methods for Scientific and Engineering Computation, 3rd edition, New age international publication, company, 1993<br>2. Grewal, B.S., Higher Engineering Mathematics, Khanna Publications, 2007.              |                                                            |    |
| <b>References:</b><br>1. M. K. Venkatraman., Numerical Methods, NPC, Chennai.<br>2. Richard W. Hamming., Numerical Methods for Scientists and Engineers, Dover Publications (2nd edition), 1987.<br>3. <a href="https://www.wolfram.com/mathematica/">https://www.wolfram.com/mathematica/</a> |                                                            |    |

|                                                                                                                                                                                                                      |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN401                                                                                                                                                                                                               | AIRCRAFT STRUCTURES I                                                                                      |                                                     |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                                                                                                                                                      | Total Contact Hours – 60                                                                                   |                                                     |     |     |     |     | 3   | 1   | 0   | 4    |      |      |      |      |
|                                                                                                                                                                                                                      | Prerequisite – Engineering Mechanics, Fundamentals of Structural Mechanics                                 |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                                                                      | Course Designed by – Department of Aeronautical Engineering                                                |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                                                                                                                                           |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To acquaint students with the fundamentals of aircraft structures.                                                                                                                                                |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To acquaint students with statically determinate and indeterminate structures.                                                                                                                                    |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To introduce students to energy methods applied to simple aerospace structural elements.                                                                                                                          |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To introduce various structural analysis of various column type aerospace structural elements.                                                                                                                    |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. To introduce various failure theory of structural analysis.                                                                                                                                                       |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                                                                                                                                      |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                                                                                                                                      |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                                                                                                                                 | Determine the forces acting in the members of statically determinate truss and frames. (Apply)             |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                                                                                                                                 | Calculate the slope and deflection of statically indeterminate beams. (Apply)                              |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                                                                                                                                 | Calculate the deflection and strain energy of statically determinate and indeterminate structures. (Apply) |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 4                                                                                                                                                                                                                 | Compute the buckling load and crippling stress of columns with different end conditions. (Apply)           |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 5                                                                                                                                                                                                                 | Determine the safe stress of the structural component using failure theories. (Apply)                      |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                                                                                                                                      |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                                                                                                                                         |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                                                                                                                            | PO1                                                                                                        | PO2                                                 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                                                                                                                                 | H                                                                                                          |                                                     |     |     |     |     |     |     |     | M    |      |      | H    |      |
| CO 2                                                                                                                                                                                                                 | H                                                                                                          |                                                     |     |     |     |     |     |     |     |      |      | M    | H    |      |
| CO 3                                                                                                                                                                                                                 | H                                                                                                          |                                                     |     |     |     |     |     |     |     |      |      | M    | H    |      |
| CO 4                                                                                                                                                                                                                 | H                                                                                                          |                                                     |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 5                                                                                                                                                                                                                 | H                                                                                                          |                                                     |     |     |     |     |     |     |     | M    |      |      | H    |      |
| Category                                                                                                                                                                                                             |                                                                                                            | Professional Core (PC)                              |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                                                                                                                                             |                                                                                                            | 37th Academic Council Meeting held in May 2015.     |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE CONTENT                                                                                                                                                                                                       |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| UNIT I                                                                                                                                                                                                               |                                                                                                            | TRUSSES AND FRAMES                                  |     |     |     |     |     |     |     |      |      |      | 12   |      |
| Statically determinate frames - Analysis of plane Truss - Method of joints - 3 D Truss- Plane frames - Composite beam. Extension of Euler–Bernoulli beam theory for curved beams, Analysis of curved beams and rings |                                                                                                            |                                                     |     |     |     |     |     |     |     |      |      |      |      |      |
| UNIT II                                                                                                                                                                                                              |                                                                                                            | STATICALLY DETERMINATE AND INDETERMINATE STRUCTURES |     |     |     |     |     |     |     |      |      |      | 12   |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                       |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------|
| Propped Cantilever - Fixed-Fixed beams - Clapeyron's Three Moment Equation – slope deflection and energy distribution method. Continuous beam, Beams on elastic supports                                                                                                                                                                                                                                                                                                                                                                                                                                         |                       |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>ENERGY METHODS</b> | <b>12</b> |
| Strain energy evaluation in structural members – energy theorems – dummy load & unit load methods – Maxwell's reciprocal theorem – energy methods applied to statically determinate and indeterminate beams, frames, rings & trusses                                                                                                                                                                                                                                                                                                                                                                             |                       |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>COLUMNS</b>        | <b>12</b> |
| Ideal column, Governing ODE for Column buckling, Slenderness ratio<br>Euler's column curve – inelastic buckling – effect of initial curvature – the Southwell plot – columns with eccentricity – use of energy methods – theory of beam columns – beam columns with different end conditions – stresses in beam columns.                                                                                                                                                                                                                                                                                         |                       |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>FAILURE THEORY</b> | <b>12</b> |
| Fail safe and safe life structures, factor of safety, Brief introduction of yield material, brittle vs. ductile behavior, Creep and creep rupture, viscoelastic materials - environmental stress, stress potentials, effect of time and temperature - Fatigue and Fracture - Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.                                                                                                                                                       |                       |           |
| <b>Text Books:</b> <ol style="list-style-type: none"> <li>1. Donaldson, B.K., Analysis of Aircraft Structures – An Introduction, McGraw-Hill, 1993.</li> <li>2. Megson T M G, Aircraft Structures for Engineering Students, Edward Arnold Publishers</li> <li>3. C.T.Sun, Mechanics of aircraft structures, John Wiley &amp; sons, inc.</li> </ol>                                                                                                                                                                                                                                                               |                       |           |
| <b>References:</b> <ol style="list-style-type: none"> <li>1. Timoshenko, S., Strength of Materials, Vol. I and II, Princeton D. Von Nostrand Co, 1990.</li> <li>2. Peer, D. J., and Azar J. J., Aircraft Structures, McGraw – Hill (2nd edition), 1999.</li> <li>3. Bruhn.E.F., Analysis and design of flight vehicle structures, Tri set of offset company, 1973.</li> <li>4. Michael C.Y.Niu ,Airframe structural design (ISBN No.962-7128-04-X), 1998</li> <li>5. Rivello, Theory and Analysis of Flight Structures, McGraw-Hill, 1969.</li> <li>6. Perry, Aircraft Structures, McGraw-Hill, 1950.</li> </ol> |                       |           |

|                                                                                                                                                                           |                                                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>BAN402</b>                                                                                                                                                             | <b>AERODYNAMICS I</b>                                                                                                                   |                                                        |            |            |            |            | <b>L</b>   | <b>T</b>   | <b>P</b>   | <b>C</b>    |             |             |             |             |
|                                                                                                                                                                           | Total Contact Hours – 60                                                                                                                |                                                        |            |            |            |            | 3          | 1          | 0          | 4           |             |             |             |             |
|                                                                                                                                                                           | Prerequisite – Fundamentals of Fluid Mechanics                                                                                          |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
|                                                                                                                                                                           | Course Designed by – Department of Aeronautical Engineering                                                                             |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>OBJECTIVES</b>                                                                                                                                                         |                                                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| 1. To introduce student about basic concepts of mathematical formulation of air flow.                                                                                     |                                                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| 2. To impart theoretical knowledge about the elementary flow and their combination to analysis flow over real object.                                                     |                                                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| 3. To Study the distribution of pressure around airfoil for incompressible inviscid flow. To study transformation of flow over circle cylinder into flow over the airfoil |                                                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| 4. To study flow around wing and measure lift generated.                                                                                                                  |                                                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| 5. To introduce the students about viscous flow theory for flow over flat plate and solution for incompressible boundary layer                                            |                                                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>COURSE OUTCOMES</b>                                                                                                                                                    |                                                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>At the end of Course, Students will be able to,</b>                                                                                                                    |                                                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 1</b>                                                                                                                                                               | <b>Identify</b> the concepts of various types of flow based on mathematical equations. ( <b>Understand</b> )                            |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 2</b>                                                                                                                                                               | <b>Apply</b> the concept of inviscid flow theory to solve flow over basic aerodynamic shapes. ( <b>Apply</b> )                          |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 3</b>                                                                                                                                                               | <b>Practice</b> the construction of airfoils numerically with the help of mathematical transformations. ( <b>Apply</b> )                |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 4</b>                                                                                                                                                               | <b>Describe</b> the concept of lift generation and will be able to analyze the factors for efficient wing design. ( <b>Understand</b> ) |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 5</b>                                                                                                                                                               | <b>Determine</b> the skin friction drag over surfaces. ( <b>Apply</b> )                                                                 |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO / PO MAPPING</b>                                                                                                                                                    |                                                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>L –LOW, M – MEDIUM, H – HIGH</b>                                                                                                                                       |                                                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>COs / POs</b>                                                                                                                                                          | <b>PO1</b>                                                                                                                              | <b>PO2</b>                                             | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PO12</b> | <b>PSO1</b> | <b>PSO2</b> |
| <b>CO 1</b>                                                                                                                                                               | H                                                                                                                                       |                                                        |            |            |            |            |            |            |            | M           |             |             | H           |             |
| <b>CO 2</b>                                                                                                                                                               | H                                                                                                                                       |                                                        |            |            |            |            |            |            |            |             |             |             | H           |             |
| <b>CO 3</b>                                                                                                                                                               | H                                                                                                                                       |                                                        |            |            | L          |            |            |            |            |             |             | H           | H           |             |
| <b>CO 4</b>                                                                                                                                                               | H                                                                                                                                       |                                                        |            |            |            |            |            |            |            |             |             | H           | H           |             |
| <b>CO 5</b>                                                                                                                                                               | H                                                                                                                                       |                                                        |            |            |            |            |            |            |            | M           |             |             | H           |             |
| <b>Category</b>                                                                                                                                                           |                                                                                                                                         | <b>Professional Core (PC)</b>                          |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>Approval</b>                                                                                                                                                           |                                                                                                                                         | <b>37th Academic Council Meeting held in May 2015.</b> |            |            |            |            |            |            |            |             |             |             |             |             |

| <b>COURSE CONTENT</b>                                                                                                                                                                                                                                                                                                     |                                       |           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|-----------|
| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                             | <b>BASIC AERODYNAMIC PRINCIPLES</b>   | <b>10</b> |
| Models of fluid - System and Control volume approach, substantial, local and convective derivative, Continuity, momentum and energy equations, Inviscid flow, Euler equation, incompressible Bernoulli's Equation. Circulation and Vorticity                                                                              |                                       |           |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                            | <b>FUNDAMENTALS OF INVISCID FLOWS</b> | <b>13</b> |
| Elementary Flows and their combinations – Ideal Flow over a circular cylinder, D'Alembert's Paradox, Magnus effect, KuttaJoukowski Theorem, Starting Vortex, Kutta condition, Real flow over smooth and rough cylinder                                                                                                    |                                       |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                           | <b>AIRFOIL THEORY</b>                 | <b>15</b> |
| Complex Potential, Methodology of Conformal Transformation, Kutta-Joukowski transformation and its applications, Karman Trefftz Profiles, Thin Airfoil theory and its applications.                                                                                                                                       |                                       |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                            | <b>FINITE WING THEORY</b>             | <b>11</b> |
| Vortex Filament, Biot and Savart Law, Bound Vortex and trailing Vortex, Horse Shoe Vortex, Lifting Line Theory and its limitations, induced drag coefficient, elliptic and general lift distribution, Oswald's wing efficiency factor, effect of plan form and aspect ratio.                                              |                                       |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                             | <b>VISCOUS FLOW THEORY</b>            | <b>11</b> |
| Laminar Boundary layer and its thickness, displacement thickness, momentum thickness, Energy thickness, Shape parameter, Boundary layer equations for a steady two-dimensional incompressible flow, Boundary Layer growth over a Flat plate, Critical Reynolds Number, Blasius solution, Basics of Turbulent flow         |                                       |           |
| <b>Text Books:</b><br>1. Anderson, J.D., Fundamentals of Aerodynamics, McGraw Hill Book Co., 1999, Indian Edition                                                                                                                                                                                                         |                                       |           |
| <b>References:</b><br>1. Rathakrishnan, E., Theoretical Aerodynamics, John Wiley & Sons, Inc., 2013<br>2. Milne Thomson, L.H., Theoretical Aerodynamics, Macmillan, 1985.<br>3. John J Bertin., Aerodynamics for Engineers, Pearson Education Inc, 5th Edition.<br>4. Clancy L J., Aerodynamics, John Wiley & sons, 1991. |                                       |           |

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|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN403                                                                                                   | AIRCRAFT PROPULSION                                                                                                              |                        |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                                          | Total Contact Hours – 60                                                                                                         |                        |     |     |     |     | 4   | 0   | 0   | 4    |      |      |      |      |
|                                                                                                          | Prerequisite – Engineering Mechanics, Fundamentals of Aero – Thermodynamics                                                      |                        |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                          | Course Designed by – Department of Aeronautical Engineering                                                                      |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                               |                                                                                                                                  |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To provide students with an overview of various aerospace propulsion systems.                         |                                                                                                                                  |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To provide students with a sound foundation in the fundamentals of thermodynamics of aircraft engines |                                                                                                                                  |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To teach students the elementary principles of inlets and nozzle                                      |                                                                                                                                  |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To teach students basic principles of compressors and turbines used in aircraft propulsion            |                                                                                                                                  |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. To teach students about the various type of combustion chamber and combustion process                 |                                                                                                                                  |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                          |                                                                                                                                  |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                          |                                                                                                                                  |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                     | Compare the performance characteristics of turbojet, turbofan, turboprop and propeller engines. (Understand)                     |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                     | Identify the engine starting problems associated with inlets. (Understand)                                                       |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                     | Discuss the types of nozzles and the losses in nozzles. (Understand)                                                             |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 4                                                                                                     | Explain the working principle of axial and centrifugal flow compressors. (Understand)                                            |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 5                                                                                                     | Discuss important factors affecting combustion chamber design and the problems associated with flame stabilization. (Understand) |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 6                                                                                                     | Analyze the working principle of axial and radial flow turbines and their overall performance. (Analyze)                         |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                          |                                                                                                                                  |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                             |                                                                                                                                  |                        |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                | PO1                                                                                                                              | PO2                    | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                     | H                                                                                                                                |                        |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 2                                                                                                     | H                                                                                                                                |                        |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 3                                                                                                     | H                                                                                                                                |                        |     |     |     |     |     |     |     |      |      | H    | H    |      |
| CO 4                                                                                                     | H                                                                                                                                |                        |     |     |     |     |     |     |     | M    |      | H    | H    |      |
| CO 5                                                                                                     | H                                                                                                                                |                        |     |     |     |     |     |     |     |      |      | H    | H    |      |
| CO 6                                                                                                     | H                                                                                                                                |                        |     |     |     |     |     |     |     | M    |      |      | H    |      |
| Category                                                                                                 |                                                                                                                                  | Professional Core (PC) |     |     |     |     |     |     |     |      |      |      |      |      |

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----|
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 37th Academic Council Meeting held in May 2015. |    |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                 |    |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | FUNDAMENTALS OF ENGINES                         | 10 |
| History and classifications of Aero engines, working of gas turbine engine – Thrust equation – Factors affecting thrust – Engine performance parameters – Efficiency, Specific fuel consumption, Methods of thrust augmentation – Characteristics of propeller, turboprop, turbofan and turbojet engines.                                                                                                                                                                                                 |                                                 |    |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | INLETS AND NOZZLES                              | 14 |
| Subsonic inlets– External and internal flow pattern – inlet performance criterion –Boundary layer separation – Supersonic inlets – the starting problem – shock boundary layer problem – external deceleration – flow stability problem – Exhaust nozzles –Theory of flow in isentropic nozzles – Losses in nozzles –Nozzle efficiency—nozzle choking –Over expanded and under expanded nozzles – Ejector and variable area nozzles – Interaction of nozzle flow with adjacent surfaces – Thrust reversal |                                                 |    |
| UNIT III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | COMPRESSORS                                     | 14 |
| Principle of operation of centrifugal compressor – Work done and pressure rise – Velocity diagrams – Diffuser vane design considerations – Concept of pre whirl – Rotation stall – Elementary theory of axial flow compressor – Velocity triangles – degree of reaction – Three dimensional – Air angle distributions for free vortex and constant reaction designs – Compressor blade design – Centrifugal and Axial compressor performance characteristics.                                             |                                                 |    |
| UNIT IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | COMBUSTION CHAMBERS                             | 12 |
| Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling – Flame stabilization – flame holders.                                                                                                                                                                                                                                            |                                                 |    |
| UNIT V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | TURBINES                                        | 10 |
| Elementary theory of axial flow turbine – Vortex theory – Stator and rotor blades – losses in the blade – choice of blade profile, chord and pitch – stage and overall performance – blade cooling – radial flow turbine.                                                                                                                                                                                                                                                                                 |                                                 |    |
| <b>Text Books:</b><br>1. Hill, P.G. & Peterson, C.R, Mechanics & Thermodynamics of Propulsion, Addison – Wesley Longman INC, 1999.<br>2. Cohen, H. Rogers, G.F.C. and Saravana Muttou, H.I.H., Gas Turbine Theory, Longman, 1989.                                                                                                                                                                                                                                                                         |                                                 |    |
| <b>References:</b><br>1. Ahmed F. El-Sayed, Aircraft Propulsion and Gas turbine engines, CRS Press, 2008<br>2. Saeed Farokhi, Aircraft Propulsion, John Wiley & Sons, Inc., 2009<br>3. Rolls Royce Jet Engine – 5thEdition – 1996.<br>4. Oates, G.C., Aero thermodynamics of Aircraft Engine Components, AIAA Education Series.                                                                                                                                                                           |                                                 |    |



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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----|
| Category                                                                                                                                                                                                                                                                                         | Professional Core (PC)                          |    |
| Approval                                                                                                                                                                                                                                                                                         | 37th Academic Council Meeting held in May 2015. |    |
| COURSE CONTENT                                                                                                                                                                                                                                                                                   |                                                 |    |
| UNIT I                                                                                                                                                                                                                                                                                           | AIRCRAFT SYSTEMS                                | 12 |
| Hydraulic systems - Study of typical workable system - components –Hydraulic systems controllers – Pneumatic systems - Advantages - Working principles - Typical Air pressure system – Brake system- Typical Pneumatic power system - Components, Landing Gear systems – Classification.         |                                                 |    |
| UNIT II                                                                                                                                                                                                                                                                                          | AIRPLANE CONTROL SYSTEMS                        | 10 |
| Conventional Systems - fully powered flight controls - Power actuated systems – Modern control systems - Digital fly by wire systems - Auto pilot system active control Technology.                                                                                                              |                                                 |    |
| UNIT III                                                                                                                                                                                                                                                                                         | ENGINE SYSTEMS                                  | 8  |
| Fuel systems for Piston and jet engines, - Components of multi engines. Lubricating systems for piston and jet engines - Starting and Ignition systems - Typical examples for piston and jet engines.                                                                                            |                                                 |    |
| UNIT IV                                                                                                                                                                                                                                                                                          | AUXILIARY SYSTEMS                               | 8  |
| Basic Air cycle systems - Vapour Cycle systems, Evaporative vapour cycle systems -Evaporative air cycle systems –Oxygen systems - Fire protection systems, Deicing and anti icing systems.                                                                                                       |                                                 |    |
| UNIT V                                                                                                                                                                                                                                                                                           | AIRCRAFT INSTRUMENTS                            | 7  |
| Flight Instruments and Navigation Instruments – Gyroscope - Accelerometers, Air speed Indicators – TAS, EAS- Mach Meters - Altimeters - Principles and operation - Study of various types of engine instruments - Tachometers - Temperature gauges – Pressure gauges - Operation and Principles. |                                                 |    |
| <b>Text Books:</b><br>1. McKinley, J.L., and Bent, R.D., Aircraft Maintenance & Repair, McGraw-Hill,1993.<br>2. General Hand Books of Airframe and Powerplant Mechanics, U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, NewDelhi1995.                    |                                                 |    |
| <b>References:</b><br>1. Mekinley, J.L. and Bent, R.D., Aircraft Power Plants, McGraw-Hill, 1993.<br>2. Pallet, E.H.J., Aircraft Instruments & Principles, Pitman & Co., 1993.<br>3. Treager, S., Gas Turbine Technology, McGraw-Hill, 1997.                                                     |                                                 |    |

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|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>BCE407</b>                                                                                                                               | <b>ENVIRONMENTAL STUDIES</b>                                                                                                            |            |            |            |            | <b>L</b>   | <b>T</b>   | <b>P</b>   | <b>C</b>   |             |             |             |             |             |
|                                                                                                                                             | Total Contact Hours – 45                                                                                                                |            |            |            |            | 3          | 0          | 0          | 3          |             |             |             |             |             |
|                                                                                                                                             | Prerequisite – Engineering Chemistry, Biology for Engineers                                                                             |            |            |            |            |            |            |            |            |             |             |             |             |             |
|                                                                                                                                             | Course Designed by – Department of Humanities and Sciences                                                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>OBJECTIVES</b>                                                                                                                           |                                                                                                                                         |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 1. To acquaint the student about the various natural resources and their associated problems                                                |                                                                                                                                         |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 2. To accustom the student about ecosystem and the different types of ecosystems and their importance                                       |                                                                                                                                         |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 3. To introduce to the student about the values of bio diversity and the importance of its conservation and also on environmental pollution |                                                                                                                                         |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 4. To familiarize the student on the social issues that have a direct effect on the environment                                             |                                                                                                                                         |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 5. To help the student understand about the effects of human population on the environment and remedial measures                            |                                                                                                                                         |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>COURSE OUTCOMES</b>                                                                                                                      |                                                                                                                                         |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>At the end of Course, Students will be able to,</b>                                                                                      |                                                                                                                                         |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 1</b>                                                                                                                                 | <b>Summarize</b> the types of natural resources and identify the role of an individual in conservation of nature. ( <b>Understand</b> ) |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 2</b>                                                                                                                                 | <b>Describe</b> different eco systems and energy flow in a defined ecosystem. ( <b>Understand</b> )                                     |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 3</b>                                                                                                                                 | <b>Define</b> ecosystem bio-diversity and the threats to biodiversity. ( <b>Remember</b> )                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 4</b>                                                                                                                                 | <b>Define</b> types of pollution, effects and control measures of pollution. ( <b>Remember</b> )                                        |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 5</b>                                                                                                                                 | <b>Explain</b> the need for sustainable development and water conservation. ( <b>Understand</b> )                                       |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 6</b>                                                                                                                                 | <b>Express</b> the need for population control and the impact of population growth in economy. ( <b>Understand</b> )                    |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO / PO MAPPING</b>                                                                                                                      |                                                                                                                                         |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>L –LOW, M – MEDIUM, H – HIGH</b>                                                                                                         |                                                                                                                                         |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>COs / Pos</b>                                                                                                                            | <b>PO1</b>                                                                                                                              | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PO12</b> | <b>PSO1</b> | <b>PSO2</b> |
| <b>CO 1</b>                                                                                                                                 | H                                                                                                                                       |            |            |            |            | H          | H          |            |            |             |             |             |             |             |
| <b>CO 2</b>                                                                                                                                 | H                                                                                                                                       |            |            |            |            | H          | H          |            |            | M           |             |             |             |             |
| <b>CO 3</b>                                                                                                                                 | H                                                                                                                                       |            |            |            |            | H          | H          |            |            | M           |             |             |             |             |
| <b>CO 4</b>                                                                                                                                 | H                                                                                                                                       |            |            |            |            | H          | H          |            |            |             |             |             |             |             |
| <b>CO 5</b>                                                                                                                                 | H                                                                                                                                       |            |            |            |            | H          | H          |            | L          |             |             |             |             |             |
| <b>CO 6</b>                                                                                                                                 | H                                                                                                                                       |            |            | L          |            | H          | H          |            |            |             |             |             |             |             |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                 |  |  |  |  |  |  |  |  |  |  |  |    |  |
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| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                 |  |  |  |  |  |  |  |  |  |  |  |    |  |
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Professional Core (PC)                          |  |  |  |  |  |  |  |  |  |  |  |    |  |
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 37th Academic Council Meeting held in May 2015. |  |  |  |  |  |  |  |  |  |  |  |    |  |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                 |  |  |  |  |  |  |  |  |  |  |  |    |  |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | NATURAL RESOURCES AND ASSOCIATED PROBLEMS       |  |  |  |  |  |  |  |  |  |  |  | 6  |  |
| The multidisciplinary nature of environmental studies definition, scope and importance – need for public awareness – Natural Resources – Forest Resources – Water Resources - Mineral Resources –Energy resources – Land Resources – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.                                                                                                                                                                                                              |                                                 |  |  |  |  |  |  |  |  |  |  |  |    |  |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ECOSYSTEMS                                      |  |  |  |  |  |  |  |  |  |  |  | 9  |  |
| Concept of an ecosystem structure and function of an ecosystem, produces consumers and decomposes, energy flow in the ecosystem, Ecological succession food chains, food webs and ecological pyramids, introduction, types, characteristics features, structure and function of different ecosystem                                                                                                                                                                                                                                                                   |                                                 |  |  |  |  |  |  |  |  |  |  |  |    |  |
| UNIT III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | BIODIVERSITY AND ENVIRONMENTAL POLLUTION        |  |  |  |  |  |  |  |  |  |  |  | 12 |  |
| <b>BIODIVERSITY</b><br>Introduction – definition ;genetic, species and ecosystem diversity, biogeographically classification of India, value of biodiversity; consumptive use productive use social, ethical aesthetic and option values, biodiversity at global, national and local levels India as a mega-diversity nation, hot spots of biodiversity, threats to biodiversity habitual loss poaching of wild life man, wildlife conflicts, endangered and endemic species of India, conservation of biodiversity in-situ and ex-situ conservation of biodiversity. |                                                 |  |  |  |  |  |  |  |  |  |  |  |    |  |
| <b>ENVIRONMENTAL POLLUTION</b><br>Definition,causes, effects and control measure of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards, solid waste management – causes, effects and its control measure – role of an individual in presentation of pollution and case studies.                                                                                                                                                                                                                    |                                                 |  |  |  |  |  |  |  |  |  |  |  |    |  |
| UNIT IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | SOCIAL ISSUES AND THE ENVIRONMENT               |  |  |  |  |  |  |  |  |  |  |  | 9  |  |
| From unsustainable to sustainable development, urban problems related to energy, water conservation, rain water harvesting, watershed management, resettlement and rehabilitation of people its problems and concerns , case studies environmental ethics, issues and possible solution climate change global warming add rain, ozone layer depletion nuclear accident and holocaust case studies waste land reclamation, various environment protection act , issues involved enforcement of environmental legislation public awareness.                             |                                                 |  |  |  |  |  |  |  |  |  |  |  |    |  |
| UNIT V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | HUMAN POPULATION AND THE ENVIRONMENT            |  |  |  |  |  |  |  |  |  |  |  | 9  |  |
| Population growth variation among nations, population explosion family welfare program environment and human health, human right, value education, HIV/AIDS, women and child welfare role of information technology in environment and human health case studies.                                                                                                                                                                                                                                                                                                     |                                                 |  |  |  |  |  |  |  |  |  |  |  |    |  |
| <b>FIELDWORK</b><br>Visit to a local area to document assets river forest/ grass land/ hill mountain, visit to local polluted site rural/industrial / agricultural, study of common plants, insects, birds, study of simple ecosystems = ponds,                                                                                                                                                                                                                                                                                                                       |                                                 |  |  |  |  |  |  |  |  |  |  |  |    |  |

river hill slopes etc(field work equal to 5 lecture hours)

**Text Books:**

1. Sharma.B.K. andKaur, Environmental Chemistry, Goel Publishing House, Meerut, 1994.
2. De.A.K., Environmental Chemistry, New Age International (p) lt., New Delhi, 1996.
3. Kurian Joseph and Nagendran.R, Essential of Environmental Studies, Pearson Education, 2004.

**References:**

1. Dara S.S., A Text Book of Environmental Chemistry and Pollution Control, S.Chand and company Ltd., New Delhi, 2004.
2. Jeyalakshmi.R, Principles of Environmental Science, First Edition, Devi Publications, Chennai, 2006.
3. Kamaraj.P and Arthanareeswari.M, Environmental Science - Challenges and Changes, first Edition, Sudhandhir Publications, 2007.

|                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN4L1                                                                                                                                                                                                                                                                                                                                                                                                                                     | AIRCRAFT STRUCTURES LABORATORY                                                                         |                                                 |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                            | Total Contact Hours – 30                                                                               |                                                 |     |     |     |     | 0   | 0   | 4   | 2    |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                            | Prerequisite – Fundamentals of Structural Mechanics                                                    |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                            | Course Designed by – Department of Aeronautical Engineering                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To acquaint the student to the various experimental processes to carry out structural analysis.<br>2. To familiarize to the student about the analysis of beams.<br>3. To enable the student to understand about the analysis of columns.<br>4. To help the student to understand about the effect of complex loading on aircraft structures.<br>5. To introduce to the student about the shear flow estimation in aircraft structures. |                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                                                                                                                                                                                                                                                                                                                                                       | Demonstrate structural mechanics principles/phenomenon using simple experiments. (Manipulation)        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                                                                                                                                                                                                                                                                                                                                                       | Observe deformation of structural members or/and failure of materials under given loads. (Imitation)   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                                                                                                                                                                                                                                                                                                                                                       | Perform comparative study between the obtained experimental results and theoretical values.(Precision) |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                                                                                                                                                                                                                                                                                                                                                  | PO1                                                                                                    | PO2                                             | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                                                                                                                                                                                                                                                                                                                                                       | H                                                                                                      |                                                 |     |     |     |     |     |     | H   | H    |      |      | H    |      |
| CO 2                                                                                                                                                                                                                                                                                                                                                                                                                                       | H                                                                                                      |                                                 |     |     |     |     |     |     | H   | H    |      |      | H    |      |
| CO 3                                                                                                                                                                                                                                                                                                                                                                                                                                       | H                                                                                                      |                                                 |     |     |     |     |     |     | H   | H    |      |      | H    |      |
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                        | Professional Core (PC)                          |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                        | 37th Academic Council Meeting held in May 2015. |     |     |     |     |     |     |     |      |      |      |      |      |
| LIST OF EXPERIMENTS                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                          | Verification of Maxwell’s theorem and principle of superposition.                                      |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                          | Column – Testing.                                                                                      |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                          | Testing of riveted joints.                                                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                          | Unsymmetrical Bending of a Beam.                                                                       |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                          | Determination of Shear Centre in open Section.                                                         |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                          | Determination of Shear Centre in closed Section.                                                       |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                                          | Combined bending and Torsion of a Hollow Circular Tube.                                                |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 8                                                                                                                                                                                                                                                                                                                                                                                                                                          | Constant Strength Beams.                                                                               |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |

|                                                                                                       |                                                 |
|-------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| 9                                                                                                     | Wagner beam – Tension field beam.               |
| 10                                                                                                    | Material properties test of composite laminate. |
| <b>References:</b><br>1. Aircraft Structures Lab Manual, Department of Aeronautical Engineering, 2015 |                                                 |

|                                                                                   |                                                                       |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------|----------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BME4L1                                                                            | MANUFACTURING ENGINEERING<br>LABORATORY                               |                                                                      |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                   | Total Contact Hours – 15                                              |                                                                      |     |     |     |     | 0   | 0   | 2   | 1    |      |      |      |      |
|                                                                                   | Prerequisite – Manufacturing Engineering                              |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                   | Course Designed by – Department of Aeronautical Engineering           |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                        |                                                                       |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To introduce student to various machine cutting operation                      |                                                                       |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To train the student for using the lathe                                       |                                                                       |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To train the student for performing various operation using lathe              |                                                                       |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To train the student for performing drilling operations and boring operation   |                                                                       |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| 5.To train the student for using the surface grinding machine and milling machine |                                                                       |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                   |                                                                       |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                   |                                                                       |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                              | Carry out different machining operations on center lathe (Imitation)  |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                              | Perform drilling, reaming and boring processes. (Precision)           |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                              | Observe the working of Planner shaper miller and grinder. (Imitation) |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                   |                                                                       |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                      |                                                                       |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                         | PO1                                                                   | PO2                                                                  | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                              | H                                                                     |                                                                      |     |     |     |     |     |     | H   |      |      | H    |      |      |
| CO 2                                                                              | H                                                                     |                                                                      |     |     |     |     |     |     | H   | M    |      | H    |      |      |
| CO 3                                                                              | H                                                                     |                                                                      |     |     |     |     |     |     | H   |      |      | H    |      |      |
| Category                                                                          |                                                                       | Professional Core (PC)                                               |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                          |                                                                       | 37th Academic Council Meeting held in May 2015.                      |     |     |     |     |     |     |     |      |      |      |      |      |
| LIST OF EXPERIMENTS                                                               |                                                                       |                                                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                 |                                                                       | Study of centre, capstan and automatic lathes and their accessories. |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                 |                                                                       | Exercise on setting the work piece and the tool in the lathe.        |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                 |                                                                       | Plane turning and step turning.                                      |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                 |                                                                       | Taper turning and knurling.                                          |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                 |                                                                       | Eccentric Turning.                                                   |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                                 |                                                                       | Thread cutting and grooving.                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                                 |                                                                       | Exercise on Drilling and reaming.                                    |     |     |     |     |     |     |     |      |      |      |      |      |
| 8                                                                                 |                                                                       | Drilling and boring.                                                 |     |     |     |     |     |     |     |      |      |      |      |      |

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| 9                                                                                            | Surface grinding                        |
| 10                                                                                           | Study of milling and grinding machines. |
| <b>References:</b><br>1. Machine Shop Lab Manual, Department of Mechanical Engineering, 2015 |                                         |



|                                                                                        |                                           |
|----------------------------------------------------------------------------------------|-------------------------------------------|
| 6                                                                                      | Exercise on threading, bores and tapings. |
| 7                                                                                      | Exercise on part assembly.                |
| 8                                                                                      | Exercise on drafting.                     |
| 9                                                                                      | Exercise on surface modeling.             |
| 10                                                                                     | Exercise on kinematics.                   |
| <b>References:</b><br>1. CADD Lab Manual, Department of Aeronautical Engineering, 2015 |                                           |

|                                                                                |                                                                                                                               |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|-------|------|------|
| BAN501                                                                         | AIRCRAFT STRUCTURES - II                                                                                                      |                                                 |     |     |     | L   | T   | P   | C    |      |      |       |      |      |
|                                                                                | Total Contact Hours – 60                                                                                                      |                                                 |     |     |     | 3   | 1   | 0   | 4    |      |      |       |      |      |
|                                                                                | Prerequisite – Fundamentals of Structural Mechanics, Aircraft Structures I                                                    |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
|                                                                                | Course Designed by – Department of Aeronautical Engineering                                                                   |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| OBJECTIVES                                                                     |                                                                                                                               |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| 1. To Understand the basics concept of unsymmetrical bending.                  |                                                                                                                               |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| 2. To Understand the basic concept of shear flow in open and closed sections.  |                                                                                                                               |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| 3. To Understand the buckling of plates and to solve the sheet panel problems. |                                                                                                                               |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| 4. To carry-out stress analysis in wing and fuselage.                          |                                                                                                                               |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| COURSE OUTCOMES                                                                |                                                                                                                               |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| At the end of Course, Students will be able to,                                |                                                                                                                               |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| CO 1                                                                           | Compute the bending stress distribution in beams of symmetric and unsymmetrical sections. (Apply)                             |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| CO 2                                                                           | Calculate the shear flow distribution in symmetrical and unsymmetrical thin-walled open section and its shear center. (Apply) |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| CO 3                                                                           | Calculate the shear flow distribution in thin walled single and multi-cell structures subjected to combined loading. (Apply)  |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| CO 4                                                                           | Compute the crippling strength of thin plates and effective width of sheet stiffener panels. (Apply)                          |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| CO 5                                                                           | Analyze the stress developed in aircraft wings and fuselage. (Analyze)                                                        |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| CO / PO MAPPING                                                                |                                                                                                                               |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                   |                                                                                                                               |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| COs / POs                                                                      | PO1                                                                                                                           | PO2                                             | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO 9 | PO10 | PO11 | PO1 2 | PSO1 | PSO2 |
| CO 1                                                                           | H                                                                                                                             |                                                 |     |     |     |     |     |     |      | H    |      |       | H    |      |
| CO 2                                                                           | H                                                                                                                             |                                                 |     |     |     |     |     |     |      | H    |      |       | H    |      |
| CO 3                                                                           | H                                                                                                                             |                                                 |     |     |     |     |     |     |      | H    |      |       | H    |      |
| CO 4                                                                           | H                                                                                                                             |                                                 |     |     |     |     |     |     |      |      |      |       | H    |      |
| CO 5                                                                           | H                                                                                                                             |                                                 |     |     |     |     |     |     |      |      |      |       | H    |      |
| Category                                                                       |                                                                                                                               | Professional Core (PC)                          |     |     |     |     |     |     |      |      |      |       |      |      |
| Approval                                                                       |                                                                                                                               | 37th Academic Council Meeting held in May 2015. |     |     |     |     |     |     |      |      |      |       |      |      |
| COURSE CONTENT                                                                 |                                                                                                                               |                                                 |     |     |     |     |     |     |      |      |      |       |      |      |
| UNIT I                                                                         |                                                                                                                               | UNSYMMETRICAL BENDING                           |     |     |     |     |     |     |      |      |      |       | 12   |      |

**Generalised theory of beam bending, curvature, neutral plane**

Bending of symmetric beams subject to skew loads - bending stresses in beams of unsymmetrical sections – generalized ‘k’ method, neutral axis method, principal axis method- advantages and disadvantages.

|                |                                    |           |
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| <b>UNIT II</b> | <b>SHEAR FLOW IN OPEN SECTIONS</b> | <b>12</b> |
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Thin walled beams – concept of shear flow – the shear centre and its determination – shear flow distribution in **symmetrical and unsymmetrical** thin-walled sections – **structural idealization – shear flow variation in idealized sections.**

|                 |                                      |           |
|-----------------|--------------------------------------|-----------|
| <b>UNIT III</b> | <b>SHEAR FLOW IN CLOSED SECTIONS</b> | <b>12</b> |
|-----------------|--------------------------------------|-----------|

Bredt - Batho theory – single-cell and multi-cell tubes subject to torsion – shear flow distribution in thin-walled **single & multi-cell** structures subject to combined bending torsion – with walls effective and ineffective in bending – shear center of closed sections.

|                |                           |                                                              |           |
|----------------|---------------------------|--------------------------------------------------------------|-----------|
| <b>UNIT IV</b> | <b>BUCKLING OF PLATES</b> | <b>Classical plate theory- assumptions and displacements</b> | <b>12</b> |
|----------------|---------------------------|--------------------------------------------------------------|-----------|

Bending of thin plates – rectangular sheets under compression - local buckling stress of thin walled sections – crippling strength by Needham’s and Gerard’s methods – **thin-walled column strength** – load carrying capacity of sheet stiffener panels – effective width – inter-rivet and sheet wrinkling failures - **short panel failing strength.**

|               |                                             |           |
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| <b>UNIT V</b> | <b>STRESS ANALYSIS OF WING AND FUSELAGE</b> | <b>12</b> |
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Wing structural arrangements – **factors influencing** - wing stress analysis methods – determination of shear force and bending moment distribution over fuselage – **Numerical problems** – Tension field beam – general Wagner equation - Semi-tension field beams.

**TEXTBOOKS:**  
 1. Megson T M G, ‘Aircraft Structures for Engineering Students’, Fifth Edition, Elsevier Aerospace Engineering Series, 2007. (Units 1, 2, 3 & 5)  
 2. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999 (Unit 4)

**REFERENCES:**  
 1. Rivello, R.M., Theory and Analysis of Flight Structures, McGraw Hill, 1993.  
 2. Howard D Curtis, ‘Fundamentals of Aircraft Structural Analysis’, WCB-McGraw Hill, 1997  
 3. Bruhn. E.H., ‘Analysis and Design of Flight Vehicles Structures’, Tri-state off-set company, USA, 1985

**WEBLINKS:**  
<http://nptel.ac.in/courses/105106049/63>  
<https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-21-techniques-for-structural-analysis-and-design-spring-2005/>

|                                                                                                                                                                                 |                                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN502                                                                                                                                                                          | AERODYNAMICS II                                                                                                        |                                                 |     |     |     |     |     | L   | T   | P    | C    |      |      |      |
|                                                                                                                                                                                 | Total Contact Hours – 60                                                                                               |                                                 |     |     |     |     |     | 3   | 1   | 0    | 4    |      |      |      |
|                                                                                                                                                                                 | Prerequisite – Fundamentals of Fluid Mechanics, Aerodynamics I                                                         |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                                 | Course Designed by – Department of Aeronautical Engineering                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                                                                                                      |                                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To make the student understand concepts and 1-d equations used for compressible flows.                                                                                       |                                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To acquaint the student with the estimation of flow properties across normal shock, oblique shock and expansion waves.                                                       |                                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To familiarize the student to the governing equations in compressible flows.                                                                                                 |                                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To educate the student on problems faced by high speed flow airfoils, wings and airplane configuration and to understand design modifications required to overcome problems. |                                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. To create awareness among the students about various experimental methods and measurement techniques.                                                                        |                                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                                                                                                 |                                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                                                                                                 |                                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                                                                                            | Apply the concepts of isentropic flow for problems related to variable area ducts. (Apply)                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                                                                                            | Calculate the properties of flow through shock and expansion waves. (Apply)                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                                                                                            | Determine the aerodynamic coefficients of compressible flows based on linearized flow theory. (Apply)                  |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 4                                                                                                                                                                            | Categorize various aircrafts intended for subsonic and supersonic regimes based on wing and fuselage design. (Analyze) |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 5                                                                                                                                                                            | Describe flow measurement and visualization techniques for high-speed flows. (Understand)                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                                                                                                 |                                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                                                                                                    |                                                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                                                                                       | PO1                                                                                                                    | PO2                                             | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                                                                                            | H                                                                                                                      |                                                 |     |     |     |     |     |     |     |      |      | H    | H    |      |
| CO 2                                                                                                                                                                            | H                                                                                                                      |                                                 |     |     |     |     |     |     |     |      |      | H    | H    |      |
| CO 3                                                                                                                                                                            | H                                                                                                                      |                                                 | L   |     |     |     |     |     |     |      |      | H    | H    |      |
| CO 4                                                                                                                                                                            | H                                                                                                                      |                                                 |     |     | M   |     |     |     |     | L    |      | H    | H    |      |
| CO 5                                                                                                                                                                            | H                                                                                                                      |                                                 |     |     | M   |     |     |     |     |      |      | H    | H    |      |
| Category                                                                                                                                                                        |                                                                                                                        | Professional Core (PC)                          |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                                                                                                        |                                                                                                                        | 37th Academic Council Meeting held in May 2015. |     |     |     |     |     |     |     |      |      |      |      |      |

| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |           |
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| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW</b>                        | <b>12</b> |
| Compressibility, Continuity, Momentum and Energy equation for steady one-dimensional flow, Compressible Bernoulli's equation, Area – Mach number – Velocity relation, Mach cone, Mach angle, One dimensional Isentropic flow through variable area duct, Isentropic relations - Critical conditions, Characteristic Mach number, Maximum discharge velocity.                                                                                                                                                     |                                                                        |           |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>SHOCKS AND EXPANSION WAVES</b>                                      | <b>14</b> |
| Normal shock relations, Prandtl's relation, Hugoniot equation, Raleigh Supersonic Pitot tube equation, Moving normal shock waves, Oblique shocks, $\theta\beta M$ relation, Shock Polar, Reflection of oblique shocks, Left running and Right running waves, Interaction of oblique shock waves, slip line, Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Maximum turning angle, Simple and non-simple regions, Operating characteristics of convergent and convergent-divergent nozzles. |                                                                        |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>TWO-DIMENSIONAL COMPRESSIBLE FLOW</b>                               | <b>14</b> |
| Potential equation for 2-dimensional compressible flow, Linearization of potential equation, Small perturbation theory, Linearised Pressure Coefficient, Linearised subsonic flow, Prandtl-Glauert rule, Linearised supersonic flow, Method of characteristics, Wave drag coefficient.                                                                                                                                                                                                                           |                                                                        |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE CONFIGURATION</b> | <b>10</b> |
| Critical Mach number, Drag divergence Mach number, Shock Stall, Shock- Boundary layer interaction, Supercritical Airfoil Sections, Transonic area rule, Swept wing, Airfoils for supersonic flows, Lift, drag, Pitching moment and Centre of pressure for supersonic profiles, Shock-expansion theory, wave drag, supersonic wings, Design considerations for supersonic aircrafts, Introduction to Hypersonic Flows, Numerical Analysis of one Dimensional flow.                                                |                                                                        |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>EXPERIMENTAL METHODS</b>                                            | <b>10</b> |
| Wind tunnels for Subsonic, transonic, Supersonic and hypersonic flows, Various Measurement techniques, Power requirement, Force and moment measurement, Wind tunnel balance, Wind tunnel corrections, Flow visualization techniques, Hot wire technique, Optical methods, Shock tube, Gun tunnels                                                                                                                                                                                                                |                                                                        |           |
| <b>Text Books:</b> <ol style="list-style-type: none"> <li>1. Anderson, J. D, Modern Compressible Flow, Third Edition, Tata McGraw-Hill &amp; Co., 2012.</li> <li>2. Rathakrishnan., E, Gas Dynamics, Prentice Hall of India, 2004.</li> <li>3. Yahya S.M., Fundamentals of Compressible Flows, Third Edition, New Age International Publishers, 2003.</li> </ol>                                                                                                                                                 |                                                                        |           |
| <b>References:</b> <ol style="list-style-type: none"> <li>1. Shapiro, A. H., Dynamics and Thermodynamics of Compressible Fluid Flow, Ronald Press, 1982.</li> <li>2. Zucrow, M. J. and Anderson, J. D., Elements of Gas Dynamics, McGraw- Hill &amp; Co., 1989.</li> <li>3. Oosthuizen, P.H., &amp; Carscallen, W.E., Compressible Fluid Flow, McGraw- Hill &amp; Co., 19976. Perry, Aircraft Structures, McGraw-Hill, 1950.</li> </ol>                                                                          |                                                                        |           |

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|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN503                                                                                                           | ADVANCED AEROSPACE PROPULSION                                                                               |                                                 |     |     |     | L   | T   | P   | C   |      |      |      |      |      |
|                                                                                                                  | Total Contact Hours – 60                                                                                    |                                                 |     |     |     | 4   | 0   | 0   | 4   |      |      |      |      |      |
|                                                                                                                  | Prerequisite – Fundamentals of Aero – Thermodynamics, Aircraft Propulsion                                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                  | Course Designed by – Department of Aeronautical Engineering                                                 |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                                       |                                                                                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To acquaint the student about the various scramjet and ramjet engine propulsion.                              |                                                                                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To accustom the student about pulsejet propulsion and the different types of jet propulsion their importance. |                                                                                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To introduce to the student about the importance of solid propellant rockets.                                 |                                                                                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To introduce to the student about the importance of liquid propellant rockets.                                |                                                                                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. To help the student understand about the non-conventional propulsion techniques.                              |                                                                                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                                  |                                                                                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                                  |                                                                                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                             | Explain the working principle, modes of operation and performance parameters of Ramjet engine. (Understand) |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                             | Discuss supersonic combustion and the challenges involved in scramjet design. (Understand)                  |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                             | Explain the operating principle of solid propellant rockets and selection of propellant grain. (Understand) |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 4                                                                                                             | Describe various feed systems, cooling methods in liquid propellant rockets. (Understand)                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 5                                                                                                             | Explain the working principle and the practical limitations of hybrid rockets. (Understand)                 |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                                  |                                                                                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                                     |                                                                                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                        | PO1                                                                                                         | PO2                                             | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                             | H                                                                                                           |                                                 |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 2                                                                                                             | H                                                                                                           |                                                 |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 3                                                                                                             | H                                                                                                           |                                                 |     |     |     |     |     |     |     | M    |      |      | H    |      |
| CO 4                                                                                                             | H                                                                                                           |                                                 |     |     |     |     |     |     |     | M    |      |      | H    |      |
| CO 5                                                                                                             | H                                                                                                           |                                                 |     |     |     |     |     |     |     |      |      |      | H    |      |
| Category                                                                                                         |                                                                                                             | Professional Core (PC)                          |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                                         |                                                                                                             | 37th Academic Council Meeting held in May 2015. |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE CONTENT                                                                                                   |                                                                                                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |

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| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                                                                                                             | <b>RAMJET PROPULSION</b>                        | <b>14</b> |
| Operating principle of ramjet engine – Components of ramjet engines and their efficiencies – Combustion in ramjet engine – Critical, subcritical and supercritical modes of operation -Ramjet engine and its performance characteristics – Ramjet design calculations – Flame stability problems in ramjet combustors –Integral ram rockets.                                                              |                                                 |           |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                            | <b>SCRAMJET PROPULSION</b>                      | <b>10</b> |
| Introduction to hypersonic vehicles, design challenges and supersonic combustion - problems associated with supersonic combustion– Types of scramjet combustors – Fuel injection schemes in scramjet combustors – Flame Stabilization                                                                                                                                                                     |                                                 |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                           | <b>SOLID PROPELLANT ROCKETS</b>                 | <b>12</b> |
| Operating principle – Specific impulse of a rocket – Internal ballistics – Selection criteria of solid propellants – propellant grain design considerations – Progressive, Regressive and neutral burning in solid rockets.                                                                                                                                                                               |                                                 |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                            | <b>LIQUID PROPELLANT ROCKETS</b>                | <b>12</b> |
| Liquid propellant rockets – selection of liquid propellants – various feed systems for liquid rockets –basics of cryogenic techniques – Cooling in liquid rockets and the associated heat transfer problems – advantages of liquid rockets over solid rockets - introduction to hybrid propulsion – advantages and limitations of hybrid propulsion - static testing of rockets and safety considerations |                                                 |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                             | <b>NON - CONVENTIONAL PROPULSION TECHNIQUES</b> | <b>12</b> |
| Pulse propulsion – combustion process in pulsejet engines – inlet charging process – Introduction to nozzleless propulsion and basic concepts - Electric rocket propulsion - Ion propulsion – Nuclear rocket – Types – Solar Sail - comparison of performance of these propulsion systems with chemical rocket propulsion systems.                                                                        |                                                 |           |
| <b>Text Books:</b><br>1. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 8th Edition, 2010.<br>2. Thomas A Ward, “Aerospace Propulsion Systems”, John Wiley & Sons Inc., New York,2010.                                                                                                                                                                                     |                                                 |           |
| <b>References:</b><br>1. J D Mattingly, “Elements of Propulsion - Gas Turbines and Rockets “, AIAA Education Series, 2006.<br>2. David H. Heiser and David T. Pratt., “Hypersonic Air -breathing Propulsion”, AIAA Education Series, 1999.<br>3. DanM.Goebel, Ira Katz, ‘Fundamentals of Electric Propulsion’, John Wiley & Sons Inc, New York, 2003.                                                     |                                                 |           |

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| <b>BAN504</b> | <b>FLIGHT MECHANICS</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|---------------|-------------------------|----------|----------|----------|----------|

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|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
|                                                                                                        | Total Contact Hours – 60                                                                                          |                                                 |     |     |     | 3   | 1   | 0   | 4   |      |      |      |      |      |
|                                                                                                        | Prerequisite – Fundamentals of Aeronautics and Astronautics, Aerodynamics I                                       |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                        | Course Designed by – Department of Aeronautical Engineering                                                       |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| <b>OBJECTIVES</b>                                                                                      |                                                                                                                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To understand aircraft performance relating to steady level                                         |                                                                                                                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To understand aircraft performance relating to Range, Endurance, climb & Glide                      |                                                                                                                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To acquire knowledge about Takeoff, Landing and Turning performance                                 |                                                                                                                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To understand the principles of stability and control relating to longitudinal stability            |                                                                                                                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. To understand the principles of stability and control relating to directional and lateral stability |                                                                                                                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| <b>COURSE OUTCOMES</b>                                                                                 |                                                                                                                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| <b>At the end of Course, Students will be able to,</b>                                                 |                                                                                                                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>1                                                                                                | Calculate thrust and power required for propeller driven and jet powered aircraft at steady level flight. (Apply) |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>2                                                                                                | Evaluate the Range, Endurance, glide and climb performances. (Evaluate)                                           |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>3                                                                                                | Estimate the take-off, landing, turning performance using V-n diagram. (Evaluate)                                 |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>4                                                                                                | Describe the characteristics of longitudinal stability. (Understand)                                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>5                                                                                                | Evaluate the lateral and directional stability characteristics. (Evaluate)                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| <b>CO / PO MAPPING</b>                                                                                 |                                                                                                                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| <b>L –LOW, M – MEDIUM, H – HIGH</b>                                                                    |                                                                                                                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COs<br>/<br>POs                                                                                        | PO1                                                                                                               | PO2                                             | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO<br>1                                                                                                | H                                                                                                                 |                                                 |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO<br>2                                                                                                | H                                                                                                                 |                                                 |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO<br>3                                                                                                | H                                                                                                                 |                                                 |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO<br>4                                                                                                | H                                                                                                                 |                                                 |     |     |     |     |     |     |     | H    |      |      | H    |      |
| CO<br>5                                                                                                | H                                                                                                                 |                                                 |     |     |     |     |     |     |     | H    |      |      | H    |      |
| Category                                                                                               |                                                                                                                   | Professional Core (PC)                          |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                               |                                                                                                                   | 37th Academic Council Meeting held in May 2015. |     |     |     |     |     |     |     |      |      |      |      |      |
| <b>COURSE CONTENT</b>                                                                                  |                                                                                                                   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| UNIT I                                                                                                 |                                                                                                                   | STEADY LEVEL FLIGHT                             |     |     |     |     |     |     |     |      |      |      | 12   |      |

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| <b>International Standard Atmosphere, TAS, IAS and EAS</b> , Streamlined and Bluff body – Skin friction Drag, Pressure Drag and Induced Drag – Drag Polar – Various drags of an airplane – <b>Methods of Drag Reduction - Effect on Drag Polar</b> . Steady level flight, Thrust required and Power required, Thrust available and Power available for propeller driven and jet powered aircraft, <b>Effect of altitude</b> , conditions for minimum drag and minimum power required                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                      |  |  |  |          |           |          |          |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>RANGE, ENDURANCE, CLIMB AND GLIDE PERFORMANCE</b> |  |  |  |          | <b>12</b> |          |          |
| Range and Endurance of Propeller and Jet aircrafts, Shallow and steep angles of climb, Rate of climb, Climb hodograph, Maximum Climb angle and Maximum Rate of climb- <b>Effect of design parameters for propeller and jet aircrafts</b> , Absolute and service ceiling, Cruise climb, Gliding flight, Glide hodograph                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                      |  |  |  |          |           |          |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>TAKE OFF, LANDING AND TURNING PERFORMANCE</b>     |  |  |  |          | <b>10</b> |          |          |
| Take-off and landing performance, Turning performance, bank angle and load factor, Constraints on load factor, Pull up and pull down maneuvers, maximum turn rate, V-n diagram.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                      |  |  |  |          |           |          |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>LONGITUDINAL STABILITY</b>                        |  |  |  |          | <b>14</b> |          |          |
| <b>General concepts</b> , Static and dynamic stability, Stability and Controllability, Requirements of control surfaces, criteria for longitudinal static stability, contribution to stability by wing, tail, fuselage, wing fuselage combination, <b>Total longitudinal stability</b> , Neutral point-Stick fixed and Stick free aspects, Free elevator factor, static margin, Hinge moment, <b>Power effects on stability-propeller and jet aircrafts</b> , longitudinal control, Movement of centre of gravity, elevator control power, elevator angle to trim, elevator angle per g, maneuver point, Stick force gradient and stick force per g, Aerodynamic balancing Aircraft Equations of motion, small disturbance theory, Estimation of longitudinal stability derivatives Routh’s discriminant, <b>solving the stability quartic</b> , Phugoid motion, <b>Factors affecting the period and damping</b> . |                                                      |  |  |  |          |           |          |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>LATERAL AND DIRECTIONAL STABILITY</b>             |  |  |  |          | <b>12</b> |          |          |
| Directional stability-yaw and sideslip, contribution to static directional stability by wing, fuselage, vertical tail, <b>Power effects on directional stability-propeller and jet aircrafts</b> , Rudder lock and Dorsal fin, Directional control, rudder control power, rudder requirements, adverse yaw, asymmetric power condition, spin recovery, Lateral stability-Dihedral effect, <b>contribution of various components</b> , lateral control, aileron control power, <b>strip theory</b> , <b>roll control by spoilers</b> , aileron reversal, aileron reversal speed                                                                                                                                                                                                                                                                                                                                     |                                                      |  |  |  |          |           |          |          |
| <b>Text Books:</b><br>1. Anderson, Jr., J.D. Aircraft Performance and Design, McGraw-Hill International Edition, 2012.<br>2. Houghton,E.L. and Carruthers, N.B. Aerodynamics for engineering students, Edward Arnold Publishers, 2000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                      |  |  |  |          |           |          |          |
| <b>References:</b><br>1. Nelson, R.C.” Flight Stability & Automatic Control”, McGraw Hill, 2005.<br>2.Pamadi, B.N. Performance, Stability, Dynamics, and Control of Airplanes, AIAA Education Series, 2004<br>3. McCormick, B.W. “Aerodynamics, Aeronautics & Flight Mechanics”, John Wiley, 1995.<br>4. Babister, A.W. “Aircraft Stability and response”, Pergamon Press, 1996.<br>5. Etkin, B., “Dynamics of Flight Stability and Control”, John Wiley, New York, 1982.<br>6. Perkins C.D. & Hage R.E. “Airplane performance, stability and control”, John Wiley & Sons 1976.                                                                                                                                                                                                                                                                                                                                    |                                                      |  |  |  |          |           |          |          |
| <b>BME505</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>MANUFACTURING ENGINEERING</b>                     |  |  |  | <b>L</b> | <b>T</b>  | <b>P</b> | <b>C</b> |



| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                   |           |
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| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>METAL WORKING PROCESS</b>                                                      | <b>8</b>  |
| Mechanical working of metals –hot and cold working –rolling, extrusion, spinning, wire-drawing, press working. Welding – different types of gas and arc welding process, soldering and brazing. Casting – different types, furnaces, casting defects and inspection                                                                                                                                                                                                                                                                                                                                            |                                                                                   |           |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>THEORY OF METAL CUTTING AND MACHINING PROCESSES</b>                            | <b>12</b> |
| Introduction, mechanics of metal cutting-chip formation, Merchant's circle theory cutting force calculations, tool materials. Influence of tool angles, tool life, cutting fluids, machining time calculations, Metal cutting economics, problem in merchant circle, tool life, machining time and economics. Lathe – introduction, types, construction, mechanisms and attachments for various operations, nomenclature of single point cutting tool. Capstan and turret lathes various mechanisms, tool and loading arrangement. Automatic lathes - single spindle and multi spindle mechanisms, CNC lathes. |                                                                                   |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>SHAPER, PLANER AND MILLING PROCESS</b>                                         | <b>8</b>  |
| Shaper, planer and slotter: types, specifications, mechanisms, holding devices, difference between shaper and planer. Milling machine – types and specification, mechanisms, holding devices, milling operations. Milling tool nomenclature, indexing types-simple, compound and differential                                                                                                                                                                                                                                                                                                                  |                                                                                   |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>DRILLING, BORING, BROACHING, SURFACE FINISHING PROCESS</b>                     | <b>8</b>  |
| Drilling, Boring- Specification, Nomenclature of drilling and reaming tool and its specification. Broaching: Specification, types, mechanisms, nomenclature of broaching tool. Grinding process, Types of grinding machines, Grinding Wheels, Honing, Super finishing, Polishing, Metal spraying, Galvanizing, Electroplating.                                                                                                                                                                                                                                                                                 |                                                                                   |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>NON-TRADITIONAL MACHINING PROCESSES AND HIGH ENERGY RATE FORMING PROCESSES</b> | <b>9</b>  |
| Non-traditional machining techniques, classification, Abrasive jet machining, Electrical Discharge Machining, E. D wire cutting, Electro chemical machining, Electron Beam Machining, Laser Beam Machining, Ultrasonic Machining. Explosive forming, Electro hydraulic, Electromagnetic forming, Dynapack machine.                                                                                                                                                                                                                                                                                             |                                                                                   |           |
| <b>Text Books:</b><br>1. P.C. Sharma., A text book of Production Technology, S.Chand& Company ltd, 2007.<br>2. P.N.Rao. Manufacturing Technology-Foundry Forging and Welding, TMH publishing co, 2009.                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                   |           |
| <b>References:</b><br>1. W.A.J. Chapman., Workshop Technology. Vol I, II& III, 1975, ELBS.<br>2. Roy A Lindberg, Process and Material Manufacture, PHI, 1995.<br>3. Kalpakjan, Manufacturing Engineering and Technology, Addison Wesley, 2005.<br>4. Hajra Chowdary S.K, The fundamentals of work shop technology Vol. I & II, Media publishers, 1997.                                                                                                                                                                                                                                                         |                                                                                   |           |

|               |                              |          |          |          |          |
|---------------|------------------------------|----------|----------|----------|----------|
| <b>BAN5V1</b> | <b>VALUE ADDED PROGRAM I</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|---------------|------------------------------|----------|----------|----------|----------|

|  |                                                             |   |   |   |   |
|--|-------------------------------------------------------------|---|---|---|---|
|  | Total Contact Hours – 30                                    | 0 | 0 | 2 | 1 |
|  | Prerequisite – Nil                                          |   |   |   |   |
|  | Course Designed by – Department of Aeronautical Engineering |   |   |   |   |

### OBJECTIVES

1. To acquaint the student about personal value, responsibility in the society and about self-confidence and self esteem
2. To introduce about goal setting, time management and planning
3. To boost the creativity, lateral thinking of the students
4. To familiarize the student on teamwork, interpersonal skills, leadership skills and ability to manage stressed situations
5. To help the student understand about decision making and self-assessment

### COURSE OUTCOMES

**At the end of Course, Students will be able to,**

**CO 1 Demonstrate**Team work and leadership quality. (**Manipulation**)

**CO 2 Demonstrate**communication and interpersonal skills. (**Manipulation**)

**CO 3 Express**the need of social responsibilities. (**Articulation**)

### CO / PO MAPPING

**L –LOW, M – MEDIUM, H – HIGH**

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO 1      |     |     |     |     |     | H   |     | H   | H   |      |      |      |      |      |
| CO 2      |     |     |     |     |     | H   |     | H   | H   |      |      |      |      |      |
| CO 3      |     |     |     |     |     | H   | L   | H   | H   |      |      |      |      |      |

**Category**

**Professional Core (PC)**

**Approval**

**37th Academic Council Meeting held in May 2015.**

### LIST OF EXPERIMENTS

|   |                                                         |
|---|---------------------------------------------------------|
| 1 | An activity to make a goal setting..                    |
| 2 | An activity to describe the importance of team work.    |
| 3 | An activity to make a time management chart.            |
| 4 | An activity for personal grooming.                      |
| 5 | An activity to enhance self-confidence and self-esteem. |
| 6 | An activity to make SWOT analysis.                      |
| 7 | An activity to describe the planning process.           |
| 8 | An activity to create environmental awareness.          |

|                                                                                                    |                                                                      |
|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| 9                                                                                                  | An activity to describe the responsibilities of students in society. |
| 10                                                                                                 | An activity to showcase the impact of engineers on society.          |
| <b>References:</b><br>1. Value Added Program Booklet, Department of Aeronautical Engineering, 2015 |                                                                      |

|                                                                                                    |                                                                                                    |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|---------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN5L1                                                                                             | AERODYNAMICS LABORATORY                                                                            |                                                         |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                                    | Total Contact Hours – 30                                                                           |                                                         |     |     |     |     | 0   | 0   | 4   | 2    |      |      |      |      |
|                                                                                                    | Prerequisite – Fundamentals of Fluid Mechanics, Aerodynamics                                       |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                    | Course Designed by – Department of Aeronautical Engineering                                        |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                         |                                                                                                    |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To acquaint the student to the various experimental processes to carry out structural analysis. |                                                                                                    |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To familiarize to the student about the analysis of beams.                                      |                                                                                                    |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To enable the student to understand about the analysis of columns.                              |                                                                                                    |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To help the student to understand about the effect of complex loading on aircraft structures.   |                                                                                                    |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. To introduce to the student about the shear flow estimation in aircraft structures.             |                                                                                                    |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                    |                                                                                                    |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                    |                                                                                                    |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                               | Carryout flow analysis over various aerodynamic models. ( Imitation)                               |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                               | Demonstrate the usage of mechanical and electronic instruments in data acquisition. (Manipulation) |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                               | Conduct experiments at various orientation of models to characterize the flow. (Articulation)      |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                    |                                                                                                    |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                       |                                                                                                    |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                          | PO1                                                                                                | PO2                                                     | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                               | H                                                                                                  |                                                         |     |     |     |     |     |     | H   | H    |      |      | H    |      |
| CO 2                                                                                               | H                                                                                                  |                                                         |     |     |     |     |     |     | H   | H    |      |      | H    |      |
| CO 3                                                                                               | H                                                                                                  |                                                         |     |     |     |     |     |     | H   | H    |      | M    | H    |      |
| Category                                                                                           |                                                                                                    | Professional Core (PC)                                  |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                           |                                                                                                    | 37th Academic Council Meeting held in May 2015.         |     |     |     |     |     |     |     |      |      |      |      |      |
| LIST OF EXPERIMENTS                                                                                |                                                                                                    |                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                  |                                                                                                    | Calibration of subsonic wind tunnel.                    |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                  |                                                                                                    | Pressure distribution over smooth cylinder              |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                  |                                                                                                    | Pressure distribution over rough cylinder.              |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                  |                                                                                                    | Pressure distribution over symmetric airfoil.           |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                  |                                                                                                    | Pressure distribution over cambered airfoil.            |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                                                  |                                                                                                    | Pressure distribution over a wing.                      |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                                                  |                                                                                                    | Force measurement on Airfoil using wind tunnel balance. |     |     |     |     |     |     |     |      |      |      |      |      |
| 8                                                                                                  |                                                                                                    | Pressure distribution over a building model.            |     |     |     |     |     |     |     |      |      |      |      |      |

|                                                                                                |                                                                 |
|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| 9                                                                                              | Aerodynamic studies of automotive models.                       |
| 10                                                                                             | Flow visualization at subsonic velocity using (a) Smoke (b) Oil |
| <b>References:</b><br>1. Aerodynamics Lab Manual, Department of Aeronautical Engineering, 2015 |                                                                 |

|               |                                                             |          |          |          |          |
|---------------|-------------------------------------------------------------|----------|----------|----------|----------|
| <b>BAN5L2</b> | <b>AERO DESIGN AND MODELING<br/>LABORATORY</b>              | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|               | Total Contact Hours – 15                                    | 0        | 0        | 2        | 1        |
|               | Prerequisite – Fundamentals of Aeronautics and Astronautics |          |          |          |          |
|               | Course Designed by – Department of Aeronautical Engineering |          |          |          |          |

### OBJECTIVES

1. To design and fabricate gliders, catapult and power gliders.
2. To design and fabricate single, double and pivoted double crank flapping wing mechanism.
3. To design and fabricate wing, vertical and horizontal stabilizer using balsa wood.
4. To design and fabricate fuselage and control surfaces using polystyrene and glass fibers.
5. To estimate discharge rate of Li-Po battery, propeller thrust and assembling Remote Control Aircraft.

### COURSE OUTCOMES

**At the end of Course, Students will be able to,**

|             |                                                                                                                      |
|-------------|----------------------------------------------------------------------------------------------------------------------|
| <b>CO 1</b> | <b>Design</b> and fabricate the Aircraft Structural components with appropriate materials. ( <b>Naturalization</b> ) |
| <b>CO 2</b> | <b>Conduct</b> flight testing of powered glider and RC plane. ( <b>Precision</b> )                                   |
| <b>CO 3</b> | <b>Observe</b> Performance characteristics of Glider and RC plane. ( <b>Imitation</b> )                              |

### CO / PO MAPPING

**L –LOW, M – MEDIUM, H – HIGH**

| <b>COs / POs</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PO12</b> | <b>PSO1</b> | <b>PSO2</b> |
|------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>CO 1</b>      | H          |            | H          |            |            |            |            |            | H          | H           |             |             | H           |             |
| <b>CO 2</b>      | H          |            | H          |            |            |            |            |            | H          | H           |             |             | H           |             |
| <b>CO 3</b>      | H          |            |            |            |            |            | M          |            | H          | H           |             | M           | H           |             |

|                 |                                                        |
|-----------------|--------------------------------------------------------|
| <b>Category</b> | <b>Professional Core (PC)</b>                          |
| <b>Approval</b> | <b>37th Academic Council Meeting held in May 2015.</b> |

### LIST OF EXPERIMENTS

|   |                                                                                |
|---|--------------------------------------------------------------------------------|
| 1 | Design and fabrication of gliders using balsa wood.                            |
| 2 | Design and fabrication of power gliders.                                       |
| 3 | Design and fabrication of single crank flapping wing mechanism.                |
| 4 | Design and fabrication of double crank flapping wing mechanism.                |
| 5 | Design and fabrication of pivoted double crank flapping wing mechanism.        |
| 6 | Design and fabrication of wing using balsa wood.                               |
| 7 | Design and fabrication of horizontal and vertical stabilizer using balsa wood. |
| 8 | Estimation the discharge rate of Li-Po battery for different thrust setting.   |

|                                                                                                          |                                                                |
|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| 9                                                                                                        | Estimating the propeller thrust for different voltage setting. |
| 10                                                                                                       | Assembling of Remote-Control Aircraft.                         |
| <b>References:</b><br>1. Aero Design and Modeling Lab Manual, Department of Mechanical Engineering, 2015 |                                                                |

|                                                                                                                              |                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN5L3                                                                                                                       | COMPUTER AIDED ANALYSIS                                                           |     |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                                                              | Total Contact Hours – 15                                                          |     |     |     |     |     | 0   | 0   | 2   | 1    |      |      |      |      |
|                                                                                                                              | Prerequisite – Aircraft Structures, Aerodynamics                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                              | Course Designed by – Department of Aeronautical Engineering                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                                                   |                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To acquaint the student with various computer software for engineering analysis                                           |                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To familiarize the student with to the various options and types of analysis that can be carried out using ANSYS software |                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To train the student on basic structural analysis                                                                         |                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To train the student on basic thermal analysis                                                                            |                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. To train the student on basic fluid flow analysis                                                                         |                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                                              |                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                                              |                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                                         | Design the structural components under static and dynamic loading. (Precision)    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO2                                                                                                                          | Observe temperature distribution for structure under thermal loading. (Imitation) |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                                         | Carry out the flow analysis over aerodynamic shapes. (Imitation)                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                                              |                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                                                 |                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                                    | PO1                                                                               | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                                         | H                                                                                 |     |     |     | H   |     |     |     | H   | H    |      | H    | H    |      |
| CO 2                                                                                                                         | H                                                                                 |     |     |     | H   |     |     |     | H   | H    |      | H    | H    |      |
| CO 3                                                                                                                         | H                                                                                 | M   |     |     | H   |     |     |     | H   | H    |      | H    | H    |      |
| Category                                                                                                                     | Professional Core (PC)                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                                                     | 37th Academic Council Meeting held in May 2015.                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| LIST OF EXPERIMENTS                                                                                                          |                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                            | Study of ANSYS and its tools                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                            | Stress analysis of beams with different loading conditions.                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                            | Stress analysis of a plate with circular hole.                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                            | Stress analysis of an axisymmetric component.                                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                            | Vibration analysis of cantilever beam.                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                                                                            | Simple conduction example.                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                                                                            | Thermal mixed boundary example.                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |

|                                                                                       |                                        |
|---------------------------------------------------------------------------------------|----------------------------------------|
| 8                                                                                     | Flow field analysis of jets.           |
| 9                                                                                     | Flow field simulation over an airfoil. |
| 10                                                                                    | Fluid – Structure interaction.         |
| <b>References:</b><br>1. CAA Lab Manual, Department of Aeronautical Engineering, 2015 |                                        |

|               |                                         |          |          |          |          |
|---------------|-----------------------------------------|----------|----------|----------|----------|
| <b>BSS601</b> | <b>VALUE EDUCATION AND PROFESSIONAL</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|---------------|-----------------------------------------|----------|----------|----------|----------|

|                                                                                                                                                                                                                                                                                                                                   |                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
|                                                                                                                                                                                                                                                                                                                                   | ETHICS                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                   | Total Contact Hours – 45                                                                               |     |     |     |     | 3   | 0   | 0   | 3   |      |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                   | Prerequisite – Nil                                                                                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                   | Course Designed by – Department of Humanities and Social Sciences                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                                                                                                                                                                                                                                                        |                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To teach the philosophy of Life, personal value, social value, mind cultural value and personal health                                                                                                                                                                                                                         |                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To teach professional ethical values, codes of ethics, responsibilities, safety, rights and related global issues.                                                                                                                                                                                                             |                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                                   |                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                                   |                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                                                                                                                                                                                                                                              | Describe the meaning and philosophy of life and the qualities an individual must possess. (Understand) |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                                                                                                                                                                                                                                              | Explain the individual responsibility towards family and society. (Understand)                         |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                                                                                                                                                                                                                                              | Discuss the methods to maintain proper physical and mental health. (Understand)                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 4                                                                                                                                                                                                                                                                                                                              | Summarize the importance of safety during social experimentation. (Understand)                         |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 5                                                                                                                                                                                                                                                                                                                              | Express the rights and responsibilities of engineer on global issues. (Understand)                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                                                                                                                                                                                                                                                   |                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                                                                                                                                                                                                                                                      |                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                                                                                                                                                                                                                                         | PO1                                                                                                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                                                                                                                                                                                                                                              |                                                                                                        |     |     |     |     |     |     | H   |     |      |      |      |      |      |
| CO 2                                                                                                                                                                                                                                                                                                                              |                                                                                                        |     |     |     |     |     |     | H   | H   |      | L    | M    |      |      |
| CO 3                                                                                                                                                                                                                                                                                                                              |                                                                                                        |     |     |     |     |     |     | H   |     |      |      | M    |      |      |
| CO 4                                                                                                                                                                                                                                                                                                                              |                                                                                                        |     |     |     |     |     | M   | H   | H   |      |      |      |      |      |
| CO 5                                                                                                                                                                                                                                                                                                                              |                                                                                                        |     |     |     |     |     | M   | H   | H   | L    |      |      |      |      |
| Category                                                                                                                                                                                                                                                                                                                          | Professional Elective (PE)                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                                                                                                                                                                                                                                                          | 37th Academic Council Meeting held in May 2015.                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                    |                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| UNIT I                                                                                                                                                                                                                                                                                                                            | PHILOSOPHY OF LIFE AND INDIVIDUAL QUALITIES                                                            |     |     |     |     |     |     |     |     |      |      |      | 9    |      |
| Human Life on Earth - Purpose of Life, Meaning and Philosophy of Life. The Law of Nature – Protecting Nature /Universe. Basic Culture - Thought Analysis - Regulating desire - Guarding against anger - To get rid of Anxiety – The Rewards of Blessing - Benevolence of Friendship - Love and Charity - Self – tranquility/Peace |                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                          |          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|----------|
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>SOCIAL VALUES (INDIVIDUAL AND SOCIAL WELFARE)</b>                                     | <b>9</b> |
| Family - Peace in Family, Society, The Law of Life Brotherhood - The Pride of Womanhood – Five responsibilities/duties of Man: - a) to himself, b) to his family, c) to his environment, d) to his society, e) to the Universe in his lives, Thriftiness (Thrift)/Economics. Health - Education - Governance - People's Responsibility / duties of the community, World peace.                                                                                                                                                                                                |                                                                                          |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>MIND CULTURE &amp; TENDING PERSONAL HEALTH</b>                                        | <b>9</b> |
| Mind Culture - Life and Mind - Bio - magnetism, Universal Magnetism (God –Realization and Self Realization) - Genetic Centre – Thought Action – Short term Memory – Expansiveness – Thought – Waves, Channelizing the Mind, Stages - Meditation, Spiritual Value. Structure of the body - the three forces of the body- life body relation, natural causes and unnatural causes for diseases, Methods in Curing diseases                                                                                                                                                      |                                                                                          |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>ENGINEERING AS SOCIAL EXPERIMENTATION AND ENGINEERS'S RESPONSIBILITIES FOR SAFETY</b> | <b>9</b> |
| Engineering as Experimentation – Engineer as Responsible Experimenters – Codes of Ethics – The Challenger, case study, Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – The Three Mile Island and Chernobyl case studies.                                                                                                                                                                                                                                                                                                                            |                                                                                          |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>ENGINEER'S RESPONSIBILITIES FOR RIGHTS AND GLOBAL ISSUES</b>                          | <b>9</b> |
| Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Whistle Blowing – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.<br>Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Eye Witnesses and Advisors – Moral Leadership                                                                                                      |                                                                                          |          |
| <b>Text Books:</b><br>1.Value Education for Health, Happiness and Harmony, The World Community Service, Centre Vethathiri Publications (Unit 1 – III).<br>2.Mike W Martin and Roland Schinzinger, Ethics In Engineering, Tata Mcgraw Hill, Newyork 2005 (Units IV & V)                                                                                                                                                                                                                                                                                                        |                                                                                          |          |
| <b>References:</b><br>1. Philosophy of Universal Magnetism (Bio - magnetism, Universal Magnetism) The World Community Service Centre Vethathiri Publications (for Unit III)<br>2. Thirukkural with English Translation of Rev. Dr. G.U. Pope, Uma Publication, 156, Serfoji Nagar, Medical College Road,Thanjavur 613 004 (for Units I - III)<br>3. R S Nagaarazan, Textbook on Professional Ethics and Human Values, New Age International Publishers, 2006 (for Units IV-V)<br>4. Charles D Fledderman, Engineering Ethics, Prentice Hall, New Mexico, 2004(for Units IV-V) |                                                                                          |          |

|               |                                                             |          |          |          |          |
|---------------|-------------------------------------------------------------|----------|----------|----------|----------|
| <b>BAN601</b> | <b>AEROSPACE STRUCTURAL MATERIALS<br/>AND COMPOSITES</b>    | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|               | Total Contact Hours – 45                                    | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |
|               | Prerequisite – Aircraft Structures – I                      |          |          |          |          |
|               | Course Designed by – Department of Aeronautical Engineering |          |          |          |          |

## OBJECTIVES

1. To acquaint the student with various types of aerospace composite materials.
2. To develop the understanding of composite mechanics.
3. To learn different theory of laminate design.
4. To learn different theory of failure analysis.
5. To have a clear understanding of composite fabrication process.

## COURSE OUTCOMES

**At the end of Course, Students will be able to,**

|      |                                                                                                                                     |
|------|-------------------------------------------------------------------------------------------------------------------------------------|
| CO 1 | <b>Discuss</b> various materials used in aerospace applications. ( <b>Understand</b> )                                              |
| CO 2 | <b>Compute</b> the properties of isotropic, anisotropic and orthotropic materials. ( <b>Apply</b> )                                 |
| CO 3 | <b>Calculate</b> the properties of laminated composites along natural and arbitrary axis. ( <b>Apply</b> )                          |
| CO 4 | <b>Determine</b> the stiffness matrix, stress and strain of laminated composite plate with different orientations. ( <b>Apply</b> ) |
| CO 5 | <b>Interpret</b> the properties and failure modes in composite plates and sandwich panels. ( <b>Apply</b> )                         |
| CO 6 | <b>Describe</b> the manufacturing process of fibers and fabrication methods of composites. ( <b>Understand</b> )                    |

## CO / PO MAPPING

**L – LOW, M – MEDIUM, H – HIGH**

| COs<br>/<br>POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO 1            | H   |     |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 2            | H   |     |     |     |     |     |     |     |     |      |      | M    | H    |      |
| CO 3            | H   |     |     |     |     |     |     |     |     | M    |      | M    | H    |      |
| CO 4            | H   |     |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 5            | H   |     |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 6            | H   |     |     |     |     |     |     |     |     | M    |      |      | H    |      |

| Category | Professional Core (PC) |
|----------|------------------------|
|----------|------------------------|

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                 |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---|
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 37th Academic Council Meeting held in May 2015. |   |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                 |   |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | INTRODUCTION TO AEROSPACE MATERIALS             | 9 |
| Introduction – Monocoque and semi monocoque structure – Wrought Aluminum Alloys – Cast Aluminum Alloy – Plastics and Rubber – Introduction to FRP, Glass and Carbon Composites– Fibers and Resins – Thermoplastics and Thermoset– Super Alloys. Emerging Trends in Aerospace Materials.                                                                                                                                                                                                                                                                            |                                                 |   |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | MICROMECHANICS                                  | 9 |
| Micro mechanics – Mechanics of materials approach, elasticity approach to determine material properties – Fiber Volume ratio – Mass fraction – Density of composites-Generalized Hooke’s Law - Elastic constants for anisotropic, orthotropic and isotropic materials. Numerical problems.                                                                                                                                                                                                                                                                         |                                                 |   |
| UNIT III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | MACROMECHANICS                                  | 9 |
| Macro Mechanics – Stress-strain relations with respect to natural axis, arbitrary axis – Determination of material properties - Experimental characterization of lamina. Numerical problems.                                                                                                                                                                                                                                                                                                                                                                       |                                                 |   |
| UNIT IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | LAMINATION THEORY AND FAILURE ANALYSIS          | 9 |
| Governing differential equation for a unidirectional lamina and general laminate, angle ply and cross ply laminate, Failure criteria for composites-Failure modes of sandwich panels – Numerical problems.                                                                                                                                                                                                                                                                                                                                                         |                                                 |   |
| UNIT V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | FABRICATION METHODS                             | 9 |
| Various open and closed mould processes, Manufacture of fibers, Types of resins, properties and applications, Netting analysis-Basic design concepts of sandwich construction - Materials used for sandwich construction.                                                                                                                                                                                                                                                                                                                                          |                                                 |   |
| <b>Text Books:</b><br>1. Jones, R.M., "Mechanics of Composite Materials", Taylor & Francis, II Edition, 2000.<br>2. Madhuji Mukhapadhyay, “Mechanics of Composite Materials and Structures”, University Press, 2004                                                                                                                                                                                                                                                                                                                                                |                                                 |   |
| <b>References:</b><br>1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites”, John Wiley and sons. Inc., New York, 1995.<br>2. Lubin, G., “Handbook on Advanced Plastics and Fibre Glass”, Von Nostrand Reinhold Co., New York, 1989.<br>3. Autar K Kaw, “Mechanics of Composite Materials”, CRC Press, 1997.<br>4. Calcote, L R. “The Analysis of laminated Composite Structures”, Von – Nostrand Reinhold Co., New York 1998.<br>5. Allen Baker, “Composite Materials for Aircraft Structures”, AIAA Series, Second Edition, 1999. |                                                 |   |

|                                                                                                     |                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN602                                                                                              | FINITE ELEMENT METHODS                                                                     |                                                 |     |     |     | L   | T   | P   | C   |      |      |      |      |      |
|                                                                                                     | Total Contact Hours – 60                                                                   |                                                 |     |     |     | 3   | 1   | 0   | 4   |      |      |      |      |      |
|                                                                                                     | Prerequisite – Fundamentals of Fluid Mechanics, Structural Mechanics, Aerothermodynamics   |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                     | Course Designed by – Department of Aeronautical Engineering                                |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                          |                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To acquaint the student with basic numerical methods for analyzing structural components.        |                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To develop the understanding of finite element modeling and analysis of one-dimensional system.  |                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To develop the understanding of finite element modeling and analysis of two-dimensional system.  |                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To develop the understanding of finite element modeling and analysis of three-dimensional system |                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. To acquaint with the application of finite element method to aerospace structures.               |                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                     |                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                     |                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>1                                                                                             | Compare various functional approximation methods for structural problems. (Analyze)        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>2                                                                                             | Calculate the nodal field variables for one dimensional structure. (Apply)                 |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>3                                                                                             | Determine the stiffness matrix and stress developed in two dimensional structures. (Apply) |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>4                                                                                             | Calculate the nodal displacements and stress for axi-symmetric structures. (Apply)         |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>5                                                                                             | Analyze the static and dynamic behavior of structures. (Analyze)                           |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                     |                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                        |                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COs<br>/<br>POs                                                                                     | PO1                                                                                        | PO2                                             | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO<br>1                                                                                             | H                                                                                          |                                                 |     |     |     |     |     |     |     | M    |      |      | H    |      |
| CO<br>2                                                                                             | H                                                                                          |                                                 |     |     |     |     |     |     |     |      |      | M    | H    |      |
| CO<br>3                                                                                             | H                                                                                          |                                                 |     |     |     |     |     |     |     |      |      | M    | H    |      |
| CO<br>4                                                                                             | H                                                                                          |                                                 |     |     |     |     |     |     |     | M    |      |      | H    |      |
| CO<br>5                                                                                             | H                                                                                          |                                                 |     |     | L   |     |     |     |     |      |      |      | H    |      |
| Category                                                                                            |                                                                                            | Professional Core (PC)                          |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                            |                                                                                            | 37th Academic Council Meeting held in May 2015. |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE CONTENT                                                                                      |                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| UNIT I                                                                                              |                                                                                            | INTRODUCTION                                    |     |     |     |     |     |     |     |      |      |      |      | 12   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                    |           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|-----------|
| Introduction to FEA - historical background - Review of various approximate methods – Rayleigh Ritz method, Weighted residual methods - Convergence criteria - Fundamentals of Finite Element Modeling – Element Division - Numbering Scheme - Examples of Finite Element Modeling                                                                                                                                                                                                                                                                       |                                                    |           |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>ONE DIMENSIONAL SYSTEMS</b>                     | <b>12</b> |
| Direct stiffness method – spring element- Derivation of the stiffness matrix- Example of a spring assemblage- Assembly of global stiffness matrix-Types of boundary conditions- The Potential energy approach –Examples - bar element – Coordinate systems and Shape Functions- The Potential Energy Approach- Assembly of Global Stiffness Matrix and Load Vector - Boundary Conditions- Temperature Effects – Heat transfer problems in 1D bar and wall                                                                                                |                                                    |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>TWO DIMENSIONAL SYSTEMS</b>                     | <b>12</b> |
| Beam element – element stiffness – load vector – global stiffness matrix – boundary conditions – solution, Plane truss structure - Coordinate Transformation – Local & Global Coordinate- The Element Stiffness Matrix- Stress Calculations- Temperature Effects –Examples. Plane stress & strain – Constant Strain Triangle (CST)- Potential Energy Approach - Element Stiffness; Force Terms, Stress Calculations- Temperature Effects- Examples                                                                                                       |                                                    |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>THREE DIMENSIONAL SYSTEMS</b>                   | <b>12</b> |
| Axisymmetric formulation – Element stiffness matrix and force vector – Body forces and temperature effects – Stress calculations – Boundary conditions and Nodal Solution; Mapping and Numerical Integration— Applications to cylinders under internal or external pressures – Rotating discs - Isoparametric Representation- Four noded quadrilateral for axisymmetric problems                                                                                                                                                                         |                                                    |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>APPLICATIONS OF FEM TO AEROSPACE STRUCTURES</b> | <b>12</b> |
| Linear static analysis - nonlinear static analysis – dynamic analysis-simple harmonic motion-damping consideration-forced vibration - Case studies and problems using software packages and programming.                                                                                                                                                                                                                                                                                                                                                 |                                                    |           |
| <b>TEXTBOOKS:</b><br>1. Tirupathi. R. Chandrapatha and Ashok D. Belegundu”, Introduction to Finite Elements in Engineering”, Prentice Hall India, Fourth Edition, 2011.                                                                                                                                                                                                                                                                                                                                                                                  |                                                    |           |
| <b>REFERENCES:</b><br>1. Reddy J.N.,”An Introduction to Finite Element Method “,McGraw Hill , 3rd edition, 2005.<br>2. Krishnamurthy, C.S., “Finite Element Analysis”, Tata McGraw Hill, 2nd 2001.<br>3. Bathe, K.J. and Wilson, E.L., “Numerical Methods in Finite Elements Analysis”, Prentice Hall of India, 1985.<br>4. Rao. S.S., “Finite Element Methods in Engineering”, Butterworth and Heinemann, Fourth Edition, 2005.<br>5. Daryl L. Logan, “A First Course in the Finite Element Method”, 5th Edition, PWS Publishing Company, Boston, 2010. |                                                    |           |
| <b>WEBLINKS:</b><br><a href="https://nptel.ac.in/courses/112104116/">https://nptel.ac.in/courses/112104116/</a>                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                    |           |

|               |                                                             |          |          |          |          |
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| <b>BAN603</b> | <b>CONTROL ENGINEERING</b>                                  | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|               | Total Contact Hours – 45                                    | 3        | 0        | 0        | 3        |
|               | Prerequisite – Basic Electrical and Electronics             |          |          |          |          |
|               | Course Designed by – Department of Aeronautical Engineering |          |          |          |          |

### OBJECTIVES

1. To provide students an understanding on various physical systems, development of flight control system and their important. Also Introduce students the concept of electrical analogies to mechanical system
2. Introduce students the concept of feedback control system, Block diagram reduction technique and signal flow graph
3. To impart knowledge on various signals, system response on respective signals and time response of first order and second order system. Also, to provide knowledge on steady state errors
4. To provide knowledge on concept of stability, Routh Hurwitz criteria for stability. Make student to develop Stability analysis using Bode plot, Root locus technique
5. To provide students brief knowledge on digital control system, Digital controllers. To introduce z- plane and z- transform techniques.

### COURSE OUTCOMES

**At the end of Course, Students will be able to,**

|             |                                                                                                                            |
|-------------|----------------------------------------------------------------------------------------------------------------------------|
| <b>CO 1</b> | <b>Analyze</b> mathematical model for mechanical and Electrical systems. <b>(Analyze)</b>                                  |
| <b>CO 2</b> | <b>Analyze</b> time response of the system with various test inputs and steady state errors. <b>(Analyze)</b>              |
| <b>CO 3</b> | <b>Analyze</b> the frequency response of the system and Correlate frequency - time domain specifications. <b>(Analyze)</b> |
| <b>CO 4</b> | <b>Predict</b> the stability of the system using Root Locus and Routh Hurwitz stability criterion. <b>(Evaluate)</b>       |
| <b>CO 5</b> | <b>Discuss</b> the basic components of Digital Control System. <b>(Understand)</b>                                         |

### CO / PO MAPPING

**L –LOW, M – MEDIUM, H – HIGH**

| <b>COs / POs</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PO12</b> | <b>PSO1</b> | <b>PSO2</b> |
|------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>CO 1</b>      | H          |            |            |            |            |            |            |            |            |             |             |             | H           |             |
| <b>CO 2</b>      | H          |            |            |            |            |            |            |            |            | M           |             |             | H           |             |
| <b>CO 3</b>      | H          |            |            |            |            |            |            |            |            |             |             |             | H           |             |
| <b>CO 4</b>      | H          |            |            |            |            |            |            |            |            | M           |             |             | H           |             |

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN6V1                                                                                                                                                                                                                                                                                                            | VALUE ADDED PROGRAM II                                                                                                                                 |                                                       |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                   | Total Contact Hours – 15                                                                                                                               |                                                       |     |     |     |     | 0   | 0   | 2   | 1    |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                   | Prerequisite – Nil                                                                                                                                     |                                                       |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                   | Course Designed by – Department of Aeronautical Engineering                                                                                            |                                                       |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                                                                                                                                                                                                                                        |                                                                                                                                                        |                                                       |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To boost up the technical writing skills of the student<br>2. To enhance the presentation skills of the student<br>3. To familiarize the student on attractive resume writing<br>4. To familiarize the student on Interviews and Group Discussions<br>5. To advance the problem-solving ability of the student |                                                                                                                                                        |                                                       |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                   |                                                                                                                                                        |                                                       |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                   |                                                                                                                                                        |                                                       |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                                                                                                                                                                                                                              | Acquire written communication & its importance in current scenario. (Understand)                                                                       |                                                       |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                                                                                                                                                                                                                              | Develop Individual or in-group class presentations skills pertaining to the applications of concepts, theories or issues in human development. (Apply) |                                                       |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                                                                                                                                                                                                                              | Develop analytical problem-solving skills. (Apply)                                                                                                     |                                                       |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                                                                                                                                                                                                                                   |                                                                                                                                                        |                                                       |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                                                                                                                                                                                                                                      |                                                                                                                                                        |                                                       |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                                                                                                                                                                                                                         | PO1                                                                                                                                                    | PO2                                                   | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                                                                                                                                                                                                                              |                                                                                                                                                        |                                                       |     |     |     |     |     | H   | H   | H    |      |      |      |      |
| CO 2                                                                                                                                                                                                                                                                                                              |                                                                                                                                                        |                                                       |     |     |     |     |     | H   | H   | H    |      |      |      |      |
| CO 3                                                                                                                                                                                                                                                                                                              |                                                                                                                                                        |                                                       |     |     |     |     |     | H   | H   | H    |      |      |      |      |
| Category                                                                                                                                                                                                                                                                                                          |                                                                                                                                                        | Professional Core (PC)                                |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                                                                                                                                                                                                                                          |                                                                                                                                                        | 37th Academic Council Meeting held in May 2015.       |     |     |     |     |     |     |     |      |      |      |      |      |
| LIST OF EXPERIMENTS                                                                                                                                                                                                                                                                                               |                                                                                                                                                        |                                                       |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                        | A business letter to a company asking for Quotation.  |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                        | A cover letter, resume, CV for applying a Job.        |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                        | A sample Email communication for the given situation. |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                        | A model Technical report writing.                     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                        | Group discussion on technical topics.                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                        | Group discussion on social awareness.                 |     |     |     |     |     |     |     |      |      |      |      |      |

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| 7                                                                                                                  | Group discussion on current affairs.      |
| 8                                                                                                                  | An activity to develop reasoning skills.. |
| 9                                                                                                                  | An activity to develop analytical skills. |
| 10                                                                                                                 | An activity to develop critical thinking. |
| <b>References:</b><br>1. Value Added Program II Preparatory Material, Department of Aeronautical Engineering, 2015 |                                           |



|                                                                                                    |                                                              |
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| 6                                                                                                  | “Brake Torque Load Test” on wheel brake units.               |
| 7                                                                                                  | Maintenance and rectification of snags in hydraulic systems. |
| 8                                                                                                  | Rectification of snags in aircraft fuel systems.             |
| 9                                                                                                  | Tyre pressure checking and Oleo leg pressure procedure.      |
| <b>References:</b><br>1. Aircraft Systems Lab Manual, Department of Aeronautical Engineering, 2015 |                                                              |

|                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN6L2                                                                                                                                                                                                                                                                                                                                                                                       | PROPULSION LABORATORY                                                                  |                                                 |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                                                                              | Total Contact Hours – 30                                                               |                                                 |     |     |     |     | 0   | 0   | 4   | 2    |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                                                                              | Prerequisite – Aerodynamics I & II, Aircraft Propulsion                                |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                                                                              | Course Designed by – Department of Aeronautical Engineering                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. Understand the need of various incompressible circular and non-circular jets.<br>2. Understand the importance of velocity in supersonic circular and noncircular jets.<br>3. Understand the determination of wall jet velocity profile in the aircraft.<br>4. Understand the need of operation of a ramjet engine.<br>5. Develop the studies of liquid fuel atomizer and pre-mixed flame. |                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                                                                                              |                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                                                                                              |                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                                                                                                                                                                                                                                                                                                         | Demonstrate the various procedures and techniques for the experiments. (Manipulation)  |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                                                                                                                                                                                                                                                                                                         | Observe the data using the different measuring devices and techniques. (Imitation)     |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                                                                                                                                                                                                                                                                                                         | Follow the mathematical concepts/equations to obtain quantitative results. (Imitation) |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                                                                                                                                                                                                                                                                                                              |                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                                                                                                                                                                                                                                                                                                                 |                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                                                                                                                                                                                                                                                                                                    | PO1                                                                                    | PO2                                             | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                                                                                                                                                                                                                                                                                                         | H                                                                                      |                                                 |     |     |     |     |     |     | H   | H    |      | H    | H    |      |
| CO 2                                                                                                                                                                                                                                                                                                                                                                                         | H                                                                                      |                                                 |     |     |     |     |     |     | H   | H    |      | H    | H    |      |
| CO 3                                                                                                                                                                                                                                                                                                                                                                                         | H                                                                                      |                                                 |     |     |     |     |     |     | H   | H    |      |      | H    |      |
| Category                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                        | Professional Core (PC)                          |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                        | 37th Academic Council Meeting held in May 2015. |     |     |     |     |     |     |     |      |      |      |      |      |
| LIST OF EXPERIMENTS                                                                                                                                                                                                                                                                                                                                                                          |                                                                                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                                                                                                                                                                                                                                            | Estimation of spread rate in incompressible circular jets.                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                                                                                                                                                                                                                                            | Estimation of spread rate in incompressible non- circular jets.                        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                                                                                                                                                                                                                                            | Estimation of centre line velocity decay in supersonic circular jets.                  |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                                                                                                                                                                                                                                            | Estimation of centre line velocity decay in supersonic non-circular jets.              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                                                                                                                                                                                                                                            | Determination of Wall jet velocity profile.                                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                                                                                                                                                                                                                                                                                                                                            | Supersonic Jet Pattern Analysis using Schlieren Technique.                             |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                                                                                                                                                                                                                                                                                                                                            | Study of free convective heat transfer over a flat plate.                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 8                                                                                                                                                                                                                                                                                                                                                                                            | Study of forced convective heat transfer over a flat plate.                            |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |

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| 9                                                                                            | Operation of a subsonic Ramjet engine.                        |
| 10                                                                                           | Determine the calorific value of Fuel using Bomb Calorimeter. |
| <b>References:</b><br>1. Propulsion Lab Manual, Department of Aeronautical Engineering, 2015 |                                                               |

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| BAN6L3                                                                                                                                                                                                                | AIRCRAFT DESIGN PROJECT I                                                                                        |                                                                         |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                                                                                                                                                       | Total Contact Hours – 30                                                                                         |                                                                         |     |     |     |     | 0   | 0   | 4   | 2    |      |      |      |      |
|                                                                                                                                                                                                                       | Prerequisite – Fundamentals of Aeronautics and Astronautics, Flight Mechanics                                    |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                                                                       | Course Designed by – Department of Aeronautical Engineering                                                      |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                                                                                                                                            |                                                                                                                  |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To familiarize the student to the different configurations of airplanes and on the comparison of the parameters of different airplanes to arrive at a proper selection of main parameters to design a new aircraft |                                                                                                                  |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To enable the student to be able to estimate the weight of the aircraft according to the main parameters selected                                                                                                  |                                                                                                                  |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To enable the student to select an appropriate powerplant and estimate the wing geometry according to the results of weight estimation                                                                             |                                                                                                                  |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To enable the student to calculate tail dimensions and to estimate the total drag of the airplane and also to perform a stability analysis of the airplane                                                         |                                                                                                                  |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. To make the student able to draft a three-view diagram of the designed airplane.                                                                                                                                   |                                                                                                                  |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                                                                                                                                       |                                                                                                                  |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                                                                                                                                       |                                                                                                                  |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                                                                                                                                  | Acquire the design parameters of various aircrafts necessary for the suitable preliminary design. (Manipulation) |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                                                                                                                                  | Acquire aerodynamic and geometric parameters for detailed aircraft design. (Manipulation)                        |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                                                                                                                                  | Integrate performance and stability parameters for different phases of flight. (Precision)                       |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                                                                                                                                       |                                                                                                                  |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                                                                                                                                          |                                                                                                                  |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                                                                                                                             | PO1                                                                                                              | PO2                                                                     | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                                                                                                                                  | H                                                                                                                |                                                                         |     |     |     |     |     |     | H   | H    |      | H    | H    |      |
| CO 2                                                                                                                                                                                                                  | H                                                                                                                |                                                                         |     |     |     |     |     |     | H   | H    |      | H    | H    |      |
| CO 3                                                                                                                                                                                                                  | H                                                                                                                |                                                                         |     |     |     |     |     |     | H   | H    |      | H    | H    |      |
| Category                                                                                                                                                                                                              |                                                                                                                  | Professional Core (PC)                                                  |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                                                                                                                                              |                                                                                                                  | 37th Academic Council Meeting held in May 2015.                         |     |     |     |     |     |     |     |      |      |      |      |      |
| LIST OF EXPERIMENTS                                                                                                                                                                                                   |                                                                                                                  |                                                                         |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                                                                     |                                                                                                                  | Comparative configuration study of different types of airplanes.        |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                                                                     |                                                                                                                  | Comparative study on specification and performance details of aircraft. |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                                                                     |                                                                                                                  | Preparation of comparative data sheets.                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                                                                     |                                                                                                                  | Work sheet layout procedures.                                           |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                                                                     |                                                                                                                  | Comparative graphs preparation.                                         |     |     |     |     |     |     |     |      |      |      |      |      |

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| 6                                                                                                                                                                                                                                                                                                                    | Selection of main parameters for the design.                       |
| 7                                                                                                                                                                                                                                                                                                                    | Preliminary weight estimations.                                    |
| 8                                                                                                                                                                                                                                                                                                                    | Selection of main parameters.                                      |
| 9                                                                                                                                                                                                                                                                                                                    | Power plant selection.                                             |
| 10                                                                                                                                                                                                                                                                                                                   | Aerofoil selection.                                                |
| 11                                                                                                                                                                                                                                                                                                                   | Wing and stabilizers selection.                                    |
| 12                                                                                                                                                                                                                                                                                                                   | Control surfaces designing.                                        |
| 13                                                                                                                                                                                                                                                                                                                   | Drag estimation.                                                   |
| 14                                                                                                                                                                                                                                                                                                                   | Detailed performance calculations and stability estimates.         |
| 15                                                                                                                                                                                                                                                                                                                   | Preparation of layouts of balance diagram and three view drawings. |
| <b>References:</b> <ol style="list-style-type: none"> <li>1. Aircraft Performance and Design, “John D Anderson”, Tata McGraw Hill Publications</li> <li>2. Analysis and Design of Flight Vehicle Structures, E F Bruhn</li> <li>3. CADD and CAA Lab Manuals, Department of Aeronautical Engineering, 2015</li> </ol> |                                                                    |

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| BAN701                                                                                   | COMPUTATIONAL FLUID DYNAMICS                                                                 |                                                 |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                          | Total Contact Hours – 45                                                                     |                                                 |     |     |     |     | 3   | 0   | 0   | 3    |      |      |      |      |
|                                                                                          | Prerequisite – Numerical methods, Fundamentals of Fluid Dynamics, Aerodynamics I & II        |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                          | Course Designed by – Department of Aeronautical Engineering                                  |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                               |                                                                                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To make the student be familiar with the various fluid flow analysis technique.       |                                                                                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To give insight of various computational technique for fluid flow analysis.           |                                                                                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To acquaint the student with various challenges involved in computational techniques. |                                                                                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To get exposure regarding its applications and recent developments.                   |                                                                                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. To learn advanced computing techniques like parallel computing, vector computing etc. |                                                                                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                          |                                                                                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                          |                                                                                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>1                                                                                  | Solve the well posed and ill posed problems. (Apply)                                         |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>2                                                                                  | Apply appropriate Finite Difference schemes for solving PDE. (Apply)                         |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>3                                                                                  | Analyze various explicit and implicit methods for a converging solution. (Analyze)           |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>4                                                                                  | Solve the steady state diffusion and convection problems using finite volume method. (Apply) |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO<br>5                                                                                  | Identify suitable turbulence model for fluid flow problems. (Understand)                     |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                          |                                                                                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                             |                                                                                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |
| COs<br>/<br>POs                                                                          | PO1                                                                                          | PO2                                             | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO<br>1                                                                                  | H                                                                                            |                                                 |     |     |     |     |     |     |     | H    |      |      | H    |      |
| CO<br>2                                                                                  | H                                                                                            |                                                 |     |     |     |     |     |     |     |      |      | H    | H    |      |
| CO<br>3                                                                                  | H                                                                                            |                                                 |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO<br>4                                                                                  | H                                                                                            |                                                 |     |     |     |     |     |     |     | H    |      | H    | H    |      |
| CO<br>5                                                                                  | H                                                                                            |                                                 |     |     |     |     |     |     |     |      |      | H    | H    |      |
| Category                                                                                 |                                                                                              | Professional Core (PC)                          |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                 |                                                                                              | 37th Academic Council Meeting held in May 2015. |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE CONTENT                                                                           |                                                                                              |                                                 |     |     |     |     |     |     |     |      |      |      |      |      |

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| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>FUNDAMENTAL CONCEPTS</b>                               | <b>10</b> |
| Basics of computational fluid dynamics – Governing equations of fluid dynamics – Substantial Derivative- Non conservative and conservative form of Continuity, Momentum and Energy equations -Well posed and ill posed problems.                                                                                                                                                                                                              |                                                           |           |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>INTRODUCTION TO FINITE DIFFERENCE METHOD EQUATIONS</b> | <b>9</b>  |
| Classification of PDEs-Reduction of system of second order PDEs-Boundary Conditions-Mathematical behavior of PDEs on CFD-Elliptic, Parabolic, Hyperbolic Equations. Derivation of Finite Difference Equations- Use of Finite Difference method.                                                                                                                                                                                               |                                                           |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>FINITE DIFFERENCE METHOD FOR DIFFUSION</b>             | <b>8</b>  |
| Explicit Methods-The FTCS method, Richardson method, DuFort& Frankel method-Implicit methods-Laasonen method, Crank Nicolson method, Beta formulation. Terminologies in Finite difference equations-Types of error-Error analysis-Consistency analysis-Von-Neuman stability analysis.                                                                                                                                                         |                                                           |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>FINITE VOLUME METHOD FOR DIFFUSION AND CONVECTION</b>  | <b>10</b> |
| Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems -Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness.                                                                                                                                                                 |                                                           |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>TURBULENCE MODELLING</b>                               | <b>8</b>  |
| Turbulence models, mixing length model, Two equation (k- $\epsilon$ ) models – High and low Reynolds number models. Large eddy simulation- Direct numerical simulation.                                                                                                                                                                                                                                                                       |                                                           |           |
| <b>Text Books:</b> <ol style="list-style-type: none"> <li>1. Jiyuan Tu, Guan,HengYeoh, Chaoqun Liu, “Computational Fluid Dynamics A Practical Approach” Springer Verlag,2012.</li> <li>2. J. D.Anderson, “Computational Fluid Dynamics”, McGraw Hill International, 2012.</li> </ol>                                                                                                                                                          |                                                           |           |
| <b>References:</b> <ol style="list-style-type: none"> <li>1. H.K. Versteeg and W. Malalsekera “An Introduction to Computational Fluid Dynamics, The Finite Volume Method”, Longman Scientific &amp; Technical, 2007.</li> <li>2. T. J. Chung, “Computational Fluid Dynamics”, Cambridge University Press, 2002.</li> <li>3. C. Hirsch, “Numerical Computation of Internal and External Flows” Volume-2, John Wiley and Sons, 1994.</li> </ol> |                                                           |           |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|--------------------------------------------------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>BAN702</b>                                                                                                                                                                                      | <b>AVIONICS</b>                                                                                         |                                                        |            |            |            |            | <b>L</b>   | <b>T</b>   | <b>P</b>   | <b>C</b>    |             |             |             |             |
|                                                                                                                                                                                                    | Total Contact Hours – 45                                                                                |                                                        |            |            |            |            | 3          | 0          | 0          | 3           |             |             |             |             |
|                                                                                                                                                                                                    | Prerequisite – Basic Electricals and Electronics, Aircraft Systems and Instrumentation.                 |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
|                                                                                                                                                                                                    | Course Designed by – Department of Aeronautical Engineering.                                            |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>OBJECTIVES</b>                                                                                                                                                                                  |                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| 1. To provide the students an understanding on need for avionics in civil and military industry, avionics subsystems, integrated systems and design approaches                                     |                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| 2. Introduce students about digital computer, digital numbering, digital arithmetic, logic gates, combinational logic circuits, microprocessor & memories and interface to it with analogue system |                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| 3. To introduce avionics system architecture- Data buses, MIL,ARINC standards                                                                                                                      |                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| 4. To provide idea of different cockpits, cockpit displays, panels, I/O technologies                                                                                                               |                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| 5. To impart brief knowledge on various avionics systems. Reliability, maintainability and certification                                                                                           |                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                             |                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>At the end of Course, Students will be able to,</b>                                                                                                                                             |                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 1</b>                                                                                                                                                                                        | <b>Describe</b> the needs for avionics in different fields of aviation. <b>(Understand)</b>             |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 2</b>                                                                                                                                                                                        | <b>Explain</b> the architecture of microprocessor and combinational logic circuits. <b>(Understand)</b> |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 3</b>                                                                                                                                                                                        | <b>Discuss</b> Avionics system architecture and various data-buses. <b>(Understand)</b>                 |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 4</b>                                                                                                                                                                                        | <b>Compare</b> various display technologies used in civil and military cockpits. <b>(Understand)</b>    |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 5</b>                                                                                                                                                                                        | <b>Discuss</b> the working principles of various avionic sub-systems. <b>(Understand)</b>               |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO / PO MAPPING</b>                                                                                                                                                                             |                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>L –LOW, M – MEDIUM, H – HIGH</b>                                                                                                                                                                |                                                                                                         |                                                        |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>COs / POs</b>                                                                                                                                                                                   | <b>PO1</b>                                                                                              | <b>PO2</b>                                             | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PO12</b> | <b>PSO1</b> | <b>PSO2</b> |
| <b>CO 1</b>                                                                                                                                                                                        | H                                                                                                       |                                                        |            |            |            |            |            |            |            |             |             |             |             | H           |
| <b>CO 2</b>                                                                                                                                                                                        | H                                                                                                       |                                                        |            |            |            |            |            |            |            | M           |             |             |             | H           |
| <b>CO 3</b>                                                                                                                                                                                        | H                                                                                                       |                                                        |            |            |            |            |            |            |            |             |             |             |             | H           |
| <b>CO 4</b>                                                                                                                                                                                        | H                                                                                                       |                                                        |            |            |            |            |            |            |            |             |             |             |             | H           |
| <b>CO 5</b>                                                                                                                                                                                        | H                                                                                                       |                                                        |            |            |            |            |            |            |            | M           |             |             |             | H           |
| <b>Category</b>                                                                                                                                                                                    |                                                                                                         | <b>Professional Core (PC)</b>                          |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>Approval</b>                                                                                                                                                                                    |                                                                                                         | <b>37th Academic Council Meeting held in May 2015.</b> |            |            |            |            |            |            |            |             |             |             |             |             |

| <b>COURSE CONTENT</b>                                                                                                                                                                                                                      |                                         |          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|----------|
| <b>UNIT I</b>                                                                                                                                                                                                                              | <b>INTRODUCTION TO AVIONICS</b>         | <b>9</b> |
| Need for avionics in civil and military aircraft and space systems – Integrated avionics and weapon systems – Typical avionics subsystems - Design approaches and recent advances - Application Technologies.                              |                                         |          |
| <b>UNIT II</b>                                                                                                                                                                                                                             | <b>PRINCIPLE OF DIGITAL SYSTEMS</b>     | <b>9</b> |
| Digital computer – Digital number system- number systems and codes-Fundamentals of logic and combinational logic circuits –Digital arithmetic – interfacing with analogue systems - Microprocessors – Memories.                            |                                         |          |
| <b>UNIT III</b>                                                                                                                                                                                                                            | <b>DIGITAL AVIONICS ARCHITECTURE</b>    | <b>9</b> |
| Avionics system architecture – Databuses – MIL-STD-1553B – ARINC – 420 – ARINC – 629.                                                                                                                                                      |                                         |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                             | <b>FLIGHT DECKS AND COCKPITS</b>        | <b>9</b> |
| Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.                                                                       |                                         |          |
| <b>UNIT V</b>                                                                                                                                                                                                                              | <b>INTRODUCTION TO AVIONICS SYSTEMS</b> | <b>9</b> |
| Communications systems- Navigation systems – Flight control systems – Radar – Electronic Warfare – Utility systems Reliability and maintainability – Certification.                                                                        |                                         |          |
| <b>Text Books:</b><br>1. Middleton, D.H., Ed., Avionics systems, Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.<br>2. Spitzer, C.R. Digital Avionics Systems, Prentice-Hall, Englewood Cliffs, N.J., U.S.A. 1987. |                                         |          |
| <b>References:</b><br>1. Malvino, A.P. and Leach, D.P. Digital Principles and Applications, Tata McGraw Hill, 1990.<br>2. Gaokar, R.S. Microprocessors Architecture-Programming and Applications,Prentice Hall, 2002..                     |                                         |          |

|                                                                                                           |                                                                                             |                            |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN703                                                                                                    | HEAT TRANSFER                                                                               |                            |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                                           | Total Contact Hours – 45                                                                    |                            |     |     |     |     | 3   | 0   | 0   | 3    |      |      |      |      |
|                                                                                                           | Prerequisite – Fundamentals of Aero – Thermodynamics, Fluid Mechanics                       |                            |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                           | Course Designed by – Department of Aeronautical Engineering                                 |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                                |                                                                                             |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To acquaint the student about the fundamentals of heat transfer.                                       |                                                                                             |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. To introduce to the student about the heat transfer analysis of conduction problems.                   |                                                                                             |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. To introduce to the student about the heat transfer analysis of convection problems.                   |                                                                                             |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. To introduce to the student about the heat transfer analysis of radiation problems.                    |                                                                                             |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. To help the student understand about the various heat transfer problems in the aerospace applications. |                                                                                             |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                           |                                                                                             |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                           |                                                                                             |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                      | Solve one dimensional steady state heat conduction problems. (Apply)                        |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                      | Estimate heat transfer rate of semi-infinite and infinite solids. (Evaluate)                |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                      | Estimate heat transfer coefficient for flow over a flat plate and circular pipe. (Evaluate) |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 4                                                                                                      | Calculate radiative heat transfer of black and gray surfaces. (Apply)                       |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 5                                                                                                      | Compare different types of heat exchangers and Evaluate their performance. (Analyze)        |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 6                                                                                                      | Solve heat transfer problems related to aerospace applications. (Apply)                     |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                           |                                                                                             |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| L – LOW, M – MEDIUM, H – HIGH                                                                             |                                                                                             |                            |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                 | PO1                                                                                         | PO2                        | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                      | H                                                                                           |                            |     |     |     |     |     |     |     | M    |      |      | H    |      |
| CO 2                                                                                                      | H                                                                                           |                            |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 3                                                                                                      | H                                                                                           |                            |     |     |     |     |     |     |     | M    |      |      | H    |      |
| CO 4                                                                                                      | H                                                                                           |                            |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 5                                                                                                      | H                                                                                           |                            |     |     |     |     |     |     |     |      |      |      | H    |      |
| CO 6                                                                                                      | H                                                                                           |                            |     |     | L   |     |     |     |     |      |      |      | H    |      |
| Category                                                                                                  |                                                                                             | Professional Elective (PE) |     |     |     |     |     |     |     |      |      |      |      |      |

|                                                                                                                                                                                                                                                                                                                                                                          |                                                 |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---|
| Approval                                                                                                                                                                                                                                                                                                                                                                 | 37th Academic Council Meeting held in May 2015. |   |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                           |                                                 |   |
| (Use of Heat and Mass Transfer Data Book is permitted)                                                                                                                                                                                                                                                                                                                   |                                                 |   |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                   | FUNDAMENTALS OF HEAT TRANSFER                   | 9 |
| Modes of heat transfer: Conduction – Convection – Radiation – One dimensional steady state heat conduction: Composite Medium – Critical thickness – Effect of variation of thermal Conductivity – Extended Surfaces.                                                                                                                                                     |                                                 |   |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                  | CONDUCTION HEAT TRANSFER                        | 9 |
| Unsteady state. Heat Conduction: Lumped System Analysis – Heat Transfer in Semi-infinite and infinite solids – Use of Transient – Temperature charts – Application of numerical techniques.                                                                                                                                                                              |                                                 |   |
| UNIT III                                                                                                                                                                                                                                                                                                                                                                 | CONVECTIVE HEAT TRANSFER                        | 9 |
| Introduction – Free convection in atmosphere - free convection on a vertical flat plate – Empirical relation in free convection – Forced convection – Laminar and turbulent - convective heat transfer analysis in flows between parallel plates, over a flat plate and in a circular pipe. Empirical relations, application of numerical techniques in problem solving. |                                                 |   |
| UNIT IV                                                                                                                                                                                                                                                                                                                                                                  | RADIATIVE HEAT TRANSFER AND HEAT EXCHANGERS     | 9 |
| RADIATIVE HEAT TRANSFER: Concept of black body-Intensity of radiation-Laws of Black body Radiation-Radiation from nonblack surfaces- real surfaces – Radiation between surfaces-Radiation shape factors-Radiation shields.<br>HEAT EXCHANGERS: Types-overall heat transfer coefficient- LMTD- NTU method of heat exchanger Analysis.                                     |                                                 |   |
| UNIT V                                                                                                                                                                                                                                                                                                                                                                   | HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING | 9 |
| Heat transfer problems in gas turbine, rocket thrust chambers and Re-entry vehicles –numerical problems using MATLAB.                                                                                                                                                                                                                                                    |                                                 |   |
| <b>Text Books:</b><br>1. Sachdeva, S.C. “Fundamentals of Engineering, Heat and Mass Transfer, Wiley Eastern Ltd. Fourth Edition, New Delhi, 2012.<br>2. Holman, J.P., "Heat Transfer ", McGraw Hill Book Co., Inc., New York, TenthEdition.,2009.                                                                                                                        |                                                 |   |
| <b>References:</b><br>1. Sutton, G.P., "Rocket Propulsion Elements ", John Wiley and Sons, 8th Edition.2010.<br>2. Lienhard J. H., “A Heat Transfer Text Book”, Phlogiston Press, U.S.A., 2008.<br>3. Ozisik M.N.,”Heat Transfer A Basic Approach”, The McGraw-Hill Company, reprint 1995.                                                                               |                                                 |   |

|               |                                                             |          |          |          |          |
|---------------|-------------------------------------------------------------|----------|----------|----------|----------|
| <b>BAN7L1</b> | <b>AIRFRAME AND AERO ENGINE REPAIR<br/>LAB</b>              | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|               | Total Contact Hours – 15                                    | 0        | 0        | 2        | 1        |
|               | Prerequisite – Nil                                          |          |          |          |          |
|               | Course Designed by – Department of Aeronautical Engineering |          |          |          |          |

### OBJECTIVES

1. To know the basic concepts of the maintenance and repair of both piston and jet aero engines and the procedures followed for overhaul of aero engines.
2. To practice the procedures of dismantling of piston engine and jet engine, study of components, accessories of both engines and handling safety precautions.
3. To demonstrate the various inspection methods such as visual inspection dimensional checks and testing methods especially NDT have studied clearly and
4. Ability to inspect surface defects, internal defects, by using dye penetrant method and identification of defects on jet engine components.
5. To know about the reassembly procedure of piston engines, jet engines and starting procedure of piston engines.

### COURSE OUTCOMES

**At the end of Course, Students will be able to,**

|             |                                                                                                               |
|-------------|---------------------------------------------------------------------------------------------------------------|
| <b>CO 1</b> | <b>Demonstrate</b> the various procedures and techniques for the Airframe repair ( <b>Manipulation</b> )      |
| <b>CO 2</b> | <b>Demonstrate</b> the procedures and techniques followed in Aero Engine inspection . ( <b>Manipulation</b> ) |
| <b>CO 3</b> | <b>Perform</b> engine dismantling and Assembling ( <b>Precision</b> )                                         |

### CO / PO MAPPING

**L –LOW, M – MEDIUM, H – HIGH**

| <b>COs / POs</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PO12</b> | <b>PSO1</b> | <b>PSO2</b> |
|------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>CO 1</b>      | H          |            |            |            |            |            | H          |            | H          | H           |             |             |             | H           |
| <b>CO 2</b>      | H          |            |            |            |            |            | H          |            | H          | H           |             |             |             | H           |
| <b>CO 3</b>      | H          |            |            |            |            |            | H          |            | H          | H           |             |             |             | H           |

|                 |                                                        |
|-----------------|--------------------------------------------------------|
| <b>Category</b> | <b>Professional Core (PC)</b>                          |
| <b>Approval</b> | <b>37th Academic Council Meeting held in May 2015.</b> |

### LIST OF EXPERIMENTS

|   |                                                                 |
|---|-----------------------------------------------------------------|
| 1 | Dismantling and reassembling a piston engine.                   |
| 2 | Piston Engine - cleaning, visual inspection, NDT checks.        |
| 3 | Piston Engine Components - dimensional checks.                  |
| 4 | Study of carburetor, fuel pump, spark plug and ignition system. |

|    |                                                                    |
|----|--------------------------------------------------------------------|
| 5  | Jet Engine – identification of components & defects.               |
| 6  | Engine starting procedures.                                        |
| 7  | Aircraft wood gluing by single scarf and double scarf joint point. |
| 8  | Fabric and Riveted patch repairs.                                  |
| 9  | Tube bending and flaring.                                          |
| 10 | Sheet metal forming.                                               |

**References:**

1. Airframe and Aero Engine Repair Lab Manual, Department of Aeronautical Engineering, 2015

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                     |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| BAN7L2                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | AVIONICS LABORATORY                                                                 |                                                              |     |     |     |     | L   | T   | P   | C    |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Total Contact Hours – 15                                                            |                                                              |     |     |     |     | 0   | 0   | 2   | 1    |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Prerequisite – Basic Electricals and Electronics                                    |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Course Designed by – Department of Aeronautical Engineering                         |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
| OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                     |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. To learn and practice about basic digital electronic circuits like Adder, subtractor, multiplexer, demultiplexer, encoder, decoder etc.<br>2. To learn about timer, shift register and comparator circuits.<br>3. To understand the 8-bit and 16-bit operation and to learn mnemonic’s coding for 8-bit and 16-bit circuit.<br>4. To understand the concept of interface programming and analog to digital conversion.<br>5. To learn stability analysis and design using MATLAB. |                                                                                     |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                     |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                     |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Demonstrate decoding and encoding operations in digital electronics. (Manipulation) |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Perform logical operation and storing the data in microprocessor. (Precision)       |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
| CO 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Design avionics control system using MATLAB. (Articulation)                         |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
| CO / PO MAPPING                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                     |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
| L –LOW, M – MEDIUM, H – HIGH                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                     |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
| COs / POs                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | PO1                                                                                 | PO2                                                          | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | H                                                                                   |                                                              |     |     |     |     |     |     | H   | H    |      |      |      | H    |
| CO 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | H                                                                                   |                                                              |     |     |     |     |     |     | H   | H    |      |      |      | H    |
| CO 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | H                                                                                   | M                                                            |     |     | M   |     |     |     | H   | H    |      | M    |      | H    |
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                     | Professional Core (PC)                                       |     |     |     |     |     |     |     |      |      |      |      |      |
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                     | 37th Academic Council Meeting held in May 2015.              |     |     |     |     |     |     |     |      |      |      |      |      |
| LIST OF EXPERIMENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                     |                                                              |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                     | Addition/Subtraction of binary numbers.                      |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                     | Multiplexer/Demultiplexer Circuits.                          |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                     | Encoder/Decoder Circuits.                                    |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                     | Timer Circuits, Shift Registers, Binary Comparator Circuits. |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                     | Addition and Subtraction of 8-bit and 16-bit numbers.        |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                     | Sorting of Data in Ascending & Descending order.             |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                     | Sum of a given series with and without carry.                |     |     |     |     |     |     |     |      |      |      |      |      |

|                                                                                            |                                                                       |
|--------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| 8                                                                                          | Greatest in a given series & Multi-byte addition in BCD mode.         |
| 9                                                                                          | Stability analysis using Root locus, Bode Plot techniques.            |
| 10                                                                                         | Design of lead, lag and lead – lag compensator for aircraft dynamics. |
| <b>References:</b><br>1. Avionics Lab Manual, Department of Aeronautical Engineering, 2015 |                                                                       |



|                                                                                                                                                                                                                                                                                                                      |                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| 8                                                                                                                                                                                                                                                                                                                    | Detailed structural layouts.                               |
| 9                                                                                                                                                                                                                                                                                                                    | Design of various components of wings, fuselage.           |
| 10                                                                                                                                                                                                                                                                                                                   | Preparation of a detailed design report with drawings.     |
| 11                                                                                                                                                                                                                                                                                                                   | Preparation of model using computer aided design packages. |
| 12                                                                                                                                                                                                                                                                                                                   | Preparation of structural analysis report for wing.        |
| 13                                                                                                                                                                                                                                                                                                                   | Preparation of structural analysis report for Fuselage.    |
| 14                                                                                                                                                                                                                                                                                                                   | Preparation of flow analysis report for wing.              |
| 15                                                                                                                                                                                                                                                                                                                   | Preparation of flow analysis report for fuselage.          |
| <b>References:</b> <ol style="list-style-type: none"> <li>1. Aircraft Performance and Design, “John D Anderson”, Tata McGraw Hill Publications</li> <li>2. Analysis and Design of Flight Vehicle Structures, E F Bruhn</li> <li>3. CADD and CAA Lab Manuals, Department of Aeronautical Engineering, 2015</li> </ol> |                                                            |

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| <b>BAN7P1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Project Phase 1                                                                                              |            |            |            |            |            |            | <b>L</b>   | <b>T</b>   | <b>P</b>    | <b>C</b>    |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Total Contact Hours – 30                                                                                     |            |            |            |            |            |            | 0          | 0          | 4           | 2           |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Prerequisite – Nil                                                                                           |            |            |            |            |            |            |            |            |             |             |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Course Designed by – Department of Aeronautical Engineering                                                  |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>OBJECTIVES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 1. To acquaint the student with theoretical and experimental studies related to aeronautical science.<br>2. To enable the student to get involved in key area of research in the branch of study.<br>3. To perform the literature studies and survey that will help in formulating the problem statement.<br>4. To enable the student to understand the concept of the acquired statement to get the idea about the work.<br>5. To work according to the acquired idea and to develop report in the form as specified in the guidelines. |                                                                                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>At the end of Course, Students will be able to,</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Observe</b> the current market scenario to develop new or modify the existing product. <b>(Imitation)</b> |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Complete</b> the concept design of the project. <b>(Manipulation)</b>                                     |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Point out</b> the methodology for implementation of design. <b>(Manipulation)</b>                         |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO / PO MAPPING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>L –LOW, M – MEDIUM, H – HIGH</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>COs / POs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>PO1</b>                                                                                                   | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PO12</b> | <b>PSO1</b> | <b>PSO2</b> |
| <b>CO 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | H                                                                                                            |            |            |            |            |            |            | H          | H          | H           | H           | H           | H           | H           |
| <b>CO 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | H                                                                                                            | H          | H          | H          | H          | H          |            | H          | H          | H           | H           | H           | H           | H           |
| <b>CO 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | H                                                                                                            | H          | H          | H          | H          | H          |            | H          | H          | H           | H           | H           | H           | H           |
| <b>Category</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Professional Core (PC)</b>                                                                                |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>Approval</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>37th Academic Council Meeting held in May 2015.</b>                                                       |            |            |            |            |            |            |            |            |             |             |             |             |             |
| The objective of the Project Phase 1 is to enable the students in convenient groups of not more than 4 members on a project involving theoretical and experimental studies related to the branch of study. Every project work shall have a guide who is the member of the faculty of the institution. Each student shall finally produce a comprehensive report covering background information, literature survey and problem statement. This final report shall be in typewritten form as specified in the guidelines.                 |                                                                                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |
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| <b>BAN8P1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>PROJECT WORK</b>                                                                                                                          |            |            |            |            |            | <b>L</b>   | <b>T</b>   | <b>P</b>   | <b>C</b>    |             |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Total Contact Hours – 60                                                                                                                     |            |            |            |            |            | 0          | 0          | 18         | 9           |             |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Prerequisite – Basic Subjects, Aerodynamics, Aircraft Structures, Aircraft Propulsion, Flight Mechanics, Engineering Mathematics             |            |            |            |            |            |            |            |            |             |             |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Course Designed by – Department of Aeronautical Engineering                                                                                  |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>OBJECTIVE :</b><br>The objective of the project work is to enable the students in convenient groups of not more than 4 members on a project involving theoretical and experimental studies related to the branch of study. Every project work shall have a guide who is the member of the faculty of the institution. Six periods per week shall be allotted in the time table and this time shall be utilized by the students to receive the directions from the guide, on library reading, laboratory work, computer analysis or field work as assigned by the guide and also to present in periodical seminars on the progress made in the project. Each student shall finally produce a comprehensive report covering background information, literature survey, problem statement, project work details and conclusion. This final report shall be in typewritten form as specified in the guidelines. |                                                                                                                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>COURSE OUTCOMES</b><br><b>At the end of Course, Students will be able to,</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Tell</b> the value of achieving perfection in projects implementation & completion. <b>(Imitation)</b>                                    |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Build</b> the skills, competencies and point of view of designed concepts. <b>(Naturalization)</b>                                        |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Replicate</b> professional skills in Presentation, Technical report writing, critical thinking and decision making. <b>(Manipulation)</b> |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO / PO MAPPING</b><br><b>L –LOW, M – MEDIUM, H – HIGH</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                              |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>COs / POs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>PO1</b>                                                                                                                                   | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PO12</b> | <b>PSO1</b> | <b>PSO2</b> |
| <b>CO 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | H                                                                                                                                            |            |            |            |            |            |            | H          | H          | H           | H           | H           | H           | H           |
| <b>CO 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | H                                                                                                                                            | H          | H          | H          | H          | H          |            | H          | H          | H           | H           | H           | H           | H           |
| <b>CO 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | H                                                                                                                                            | H          | H          | H          | H          | H          |            | H          | H          | H           | H           | H           | H           | H           |

|               |                                                                         |          |          |          |          |
|---------------|-------------------------------------------------------------------------|----------|----------|----------|----------|
| <b>BAN8C1</b> | <b>COMPREHENSION</b>                                                    | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|               | Total Contact Hours – Test will be conducted at the end of the semester | 0        | 0        | 0        | 1        |
|               | Prerequisite – All the courses up to eighth semester                    |          |          |          |          |
|               | Course Designed by – Department of Aeronautical Engineering             |          |          |          |          |

### OBJECTIVES

1. To provide a complete review of Aeronautical/Aerospace Engineering topics covered up to eighth semesters, so that a comprehensive understanding is achieved.
2. It will also help students to face job interviews, competitive examination and also to enhance the employment potential.
3. To provide overview of all topics covered and to assess the overall knowledge level up to eighth semester.

### COURSE OUTCOMES

**At the end of Course, Students will be able to,**

|                 |                                                                             |
|-----------------|-----------------------------------------------------------------------------|
| <b>CO<br/>1</b> | <b>Recollect</b> the core engineering concepts. <b>(Remember)</b>           |
| <b>CO<br/>2</b> | <b>Acquire</b> Presentation Skills to face job interviews. <b>(Apply)</b>   |
| <b>CO<br/>3</b> | <b>Write</b> competitive examinations for successful career. <b>(Apply)</b> |

### CO / PO MAPPING

**L –LOW, M – MEDIUM, H – HIGH**

| <b>COs<br/>/<br/>POs</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PO12</b> | <b>PSO1</b> | <b>PSO2</b> |
|--------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>CO<br/>1</b>          | H          |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO<br/>2</b>          | H          |            |            |            |            |            |            |            | H          | M           |             |             |             |             |
| <b>CO<br/>3</b>          | H          |            |            |            |            |            |            |            | H          |             |             |             |             |             |



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| <b>UNIT IV</b>                                                                                                                                                                                    | <b>MAINTENANCE OF ENGINE AND FUEL SYSTEM</b>           | <b>9</b> |
| Aircraft engine maintenance – Fuel system inspection – Inspection and repair of fuel tank – Trouble shooting.                                                                                     |                                                        |          |
| <b>UNIT V</b>                                                                                                                                                                                     | <b>MAINTENANCE OF AUXILIARY SYSTEM AND INSTRUMENTS</b> | <b>9</b> |
| Oxygen system, service and maintenance – Installation and maintenance of instruments – Testing instruments and systems – checking of a typical vacuum system.                                     |                                                        |          |
| <b>Text Books:</b><br>1. Kroes Watkins Delp,” Aircraft Maintenance and Repair”, McGraw Hill, 7th edition, New York, 2013.                                                                         |                                                        |          |
| <b>References:</b><br>1. A&P Mechanics, “Aircraft Hand Book”, F A A Himalayan Book House, New Delhi, 1996.<br>2. A&P Mechanics, “General Hand Book”, F A A Himalayan Book House, New Delhi, 1996. |                                                        |          |

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| <b>BANE02</b>                                                                                                                                                                                                                                                                                                                                                                              | <b>ROCKETS AND MISSILES</b>                                                                                          |                                                        | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|                                                                                                                                                                                                                                                                                                                                                                                            | Total Contact Hours – 45                                                                                             |                                                        | 3        | 0        | 0        | 3        |
|                                                                                                                                                                                                                                                                                                                                                                                            | Prerequisite – Aerodynamics, Aircraft Stability and Control, Avionics, Aircraft Structural Materials and Composites  |                                                        |          |          |          |          |
|                                                                                                                                                                                                                                                                                                                                                                                            | Course Designed by – Department of Aeronautical Engineering                                                          |                                                        |          |          |          |          |
| <b>OBJECTIVE:</b> To learn about the aerodynamics and stability of Rockets and Missiles.                                                                                                                                                                                                                                                                                                   |                                                                                                                      |                                                        |          |          |          |          |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                      |                                                        |          |          |          |          |
| <b>At the end of Course, Students will be able to,</b>                                                                                                                                                                                                                                                                                                                                     |                                                                                                                      |                                                        |          |          |          |          |
| <b>CO 1</b>                                                                                                                                                                                                                                                                                                                                                                                | <b>Describe</b> combustion mechanisms in solid and liquid propellant rockets. <b>(Understand)</b>                    |                                                        |          |          |          |          |
| <b>CO 2</b>                                                                                                                                                                                                                                                                                                                                                                                | <b>Compute</b> the forces and moments acting on rockets and missile while passing through atmosphere. <b>(Apply)</b> |                                                        |          |          |          |          |
| <b>CO 3</b>                                                                                                                                                                                                                                                                                                                                                                                | <b>Analyze</b> the trajectory of rockets and missiles in free space and gravitational field. <b>(Analyze)</b>        |                                                        |          |          |          |          |
| <b>CO 4</b>                                                                                                                                                                                                                                                                                                                                                                                | <b>Summarize</b> different thrust vector control techniques and stage separation in rockets. <b>(Understand)</b>     |                                                        |          |          |          |          |
| <b>CO 5</b>                                                                                                                                                                                                                                                                                                                                                                                | <b>Apply</b> suitable materials used for their construction. <b>(Apply)</b>                                          |                                                        |          |          |          |          |
| <b>Category</b>                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                      | <b>Professional Elective (PE)</b>                      |          |          |          |          |
| <b>Approval</b>                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                      | <b>37th Academic Council Meeting held in May 2015.</b> |          |          |          |          |
| <b>COURSE CONTENT</b>                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                      |                                                        |          |          |          |          |
| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                                                                                              | <b>ROCKET SYSTEMS</b>                                                                                                |                                                        |          |          |          | <b>9</b> |
| Ignition system in rockets – types of igniters and igniter design considerations – injection system and propellant feed systems of liquid rockets and their design considerations – design considerations of liquid rocket thrust chambers – combustion mechanisms of liquid and solid propellants.                                                                                        |                                                                                                                      |                                                        |          |          |          |          |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                             | <b>AERODYNAMICS OF ROCKETS AND MISSILES</b>                                                                          |                                                        |          |          |          | <b>9</b> |
| Airframe components of rockets and missiles – forces acting on a missile while passing through atmosphere – classification of missiles – slender body aerodynamics – method of describing forces and moments – lift force and lateral moment – lateral aerodynamic damping moment – longitudinal moment – drag estimation – body upwash and body downwash in missiles – rocket dispersion. |                                                                                                                      |                                                        |          |          |          |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                            | <b>ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD</b>                                                           |                                                        |          |          |          | <b>9</b> |
| One dimensional and two-dimensional rocket motions in free space and homogeneous gravitational fields – description of vertical, inclined and gravity turn trajectories – determination of range and altitude – simple approximations to burn out velocity and altitude – estimation of culmination time and altitude.                                                                     |                                                                                                                      |                                                        |          |          |          |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                             | <b>STAGING AND CONTROL OF ROCKETS AND MISSILES</b>                                                                   |                                                        |          |          |          | <b>9</b> |
| Design philosophy behind multistaging of launch vehicles and ballistic missiles – multistage vehicle optimization – stage separation techniques in atmosphere and in space – stage separation dynamics and lateral separation characteristics – various types of thrust vector control methods including secondary                                                                         |                                                                                                                      |                                                        |          |          |          |          |

|                                                                                                                                                                                                                                                                                           |                                           |          |
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| injection thrust vector control – numerical problems on stage separation and multistaging.                                                                                                                                                                                                |                                           |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                             | <b>MATERIALS FOR ROCKETS AND MISSILES</b> | <b>9</b> |
| Selection criteria of materials for rockets and missiles – materials for various airframe components and engine parts – materials for thrust control devices – various adverse conditions faced by aerospace vehicles and the requirement of materials to perform under these conditions. |                                           |          |
| <b>Total Periods: 45</b>                                                                                                                                                                                                                                                                  |                                           |          |
| <b>Text Books:</b><br>1.Martin J L Turner, Rocket and Spacecraft Propulsion, Springer-Praxis Publishing, 2001<br>2.Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 7th Edition, 2001                                                                        |                                           |          |

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| BANE03                                                                                                                                                                                                                                                                                        | EXPERIMENTAL STRESS ANALYSIS                                                                                      |                                                 | L | T | P | C |
|                                                                                                                                                                                                                                                                                               | Total Contact Hours – 45                                                                                          |                                                 | 3 | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                                                               | Prerequisite – Aircraft Structures I & II                                                                         |                                                 |   |   |   |   |
|                                                                                                                                                                                                                                                                                               | Course Designed by – Department of Aeronautical Engineering                                                       |                                                 |   |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                                                                    |                                                                                                                   |                                                 |   |   |   |   |
| 1. To acquaint with the basics of measurement.                                                                                                                                                                                                                                                |                                                                                                                   |                                                 |   |   |   |   |
| 2. To understand the principle of extensometers, electrical resistance strain gauges and their application in stress analysis.                                                                                                                                                                |                                                                                                                   |                                                 |   |   |   |   |
| 3. To understand the principle of photo elasticity and their application in stress analysis.                                                                                                                                                                                                  |                                                                                                                   |                                                 |   |   |   |   |
| 4. To learn brittle coating and moiré methods in stress analysis.                                                                                                                                                                                                                             |                                                                                                                   |                                                 |   |   |   |   |
| 5. To acquaint with the non-destructive testing methods.                                                                                                                                                                                                                                      |                                                                                                                   |                                                 |   |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                               |                                                                                                                   |                                                 |   |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                               |                                                                                                                   |                                                 |   |   |   |   |
| CO 1                                                                                                                                                                                                                                                                                          | Describe the working principle of different extensometers and their uses. (Understand)                            |                                                 |   |   |   |   |
| CO 2                                                                                                                                                                                                                                                                                          | Compute the strain in loaded structures based on measurement of change in resistance using strain gauges. (Apply) |                                                 |   |   |   |   |
| CO 3                                                                                                                                                                                                                                                                                          | Discuss the techniques used for determination of stress in photo elastic materials. (Understand)                  |                                                 |   |   |   |   |
| CO 4                                                                                                                                                                                                                                                                                          | Explain the concepts of more technique and brittle coating techniques. (Understand)                               |                                                 |   |   |   |   |
| CO 5                                                                                                                                                                                                                                                                                          | Describe the different type of NDT methods. (Understand)                                                          |                                                 |   |   |   |   |
| Category                                                                                                                                                                                                                                                                                      |                                                                                                                   | Professional Elective (PE)                      |   |   |   |   |
| Approval                                                                                                                                                                                                                                                                                      |                                                                                                                   | 37th Academic Council Meeting held in May 2015. |   |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                                                                |                                                                                                                   |                                                 |   |   |   |   |
| UNIT I                                                                                                                                                                                                                                                                                        |                                                                                                                   | MEASUREMENTS AND EXTENSOMETERS                  |   |   |   | 9 |
| Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical, Acoustical and Electrical extensometers and their uses, Advantages and disadvantages.                                                                                                       |                                                                                                                   |                                                 |   |   |   |   |
| UNIT II                                                                                                                                                                                                                                                                                       |                                                                                                                   | ELECTRICAL RESISTANCE STRAIN GAUGES             |   |   |   | 9 |
| Principle of operation and requirements, Types and their uses, Materials for strain gauge, Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.         |                                                                                                                   |                                                 |   |   |   |   |
| UNIT III                                                                                                                                                                                                                                                                                      |                                                                                                                   | PHOTOELASTICITY                                 |   |   |   | 9 |
| Two-dimensional photo elasticity, Photo elastic materials, Concept of light - photoelastic effects, stress optic law, Transmission and Reflection polariscopes, Interpretation of fringe pattern, Compensation and separation techniques, Introduction to three-dimensional photo elasticity. |                                                                                                                   |                                                 |   |   |   |   |
| UNIT IV                                                                                                                                                                                                                                                                                       |                                                                                                                   | BRITTLE COATING AND MOIRE METHODS               |   |   |   | 9 |

|                                                                                                                                                                |                                  |          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------|
| Introduction to Moiré techniques, Brittle coating methods and Holography                                                                                       |                                  |          |
| <b>UNIT V</b>                                                                                                                                                  | <b>NON – DESTRUCTIVE TESTING</b> | <b>9</b> |
| Fundamentals of NDT, Radiography, Ultrasonics, Eddy Current testing, Fluorescent Penetrant Testing, Acoustic Emission Technique                                |                                  |          |
| <b>TEXTBOOKS:</b>                                                                                                                                              |                                  |          |
| 1. Sadhu Singh, “Experimental Stress Analysis”, Khanna Publishers, 2009.                                                                                       |                                  |          |
| <b>REFERENCES:</b>                                                                                                                                             |                                  |          |
| 1. Hetenyi, M., “Hand book of Experimental Stress Analysis”, John Wiley and Sons Inc., New York, 1972.                                                         |                                  |          |
| 2. Max Mark Frocht,” Photo Elasticity”, John Wiley and Sons Inc., New York, 1968                                                                               |                                  |          |
| 3. A.J.Durelli, “Applied Stress Analysis”, Prentice Hall of India Pvt Ltd., New Delhi, 1970                                                                    |                                  |          |
| 4. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., “Experimental Stress Analysis”, Tata McGraw Hill, New Delhi, 1984. |                                  |          |
| 5. James F. Doyle ,”Modern Experimental Stress Analysis “,John Wiley & Sons, 2004.                                                                             |                                  |          |
| 6. Ramesh, K., ” Experimental Stress Analysis”, Indian Institute of Technology Madras, India,E-book,2009.                                                      |                                  |          |
| <b>WEBLINKS:</b>                                                                                                                                               |                                  |          |
| <a href="https://onlinecourses.nptel.ac.in/noc18_me39/preview">https://onlinecourses.nptel.ac.in/noc18_me39/preview</a>                                        |                                  |          |

|                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                         |                                                 |   |   |   |   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|-------------------------------------------------|---|---|---|---|
| BANE04                                                                                                                                                                                                                                                                                                                                                                                          | EXPERIMENTAL AERODYNAMICS                                                                               |                                                 | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                 | Total Contact Hours – 45                                                                                |                                                 | 3 | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                                                                                                                                                                 | Prerequisite – Fundamentals of Fluid Mechanics, Aerodynamics I                                          |                                                 |   |   |   |   |
|                                                                                                                                                                                                                                                                                                                                                                                                 | Course Designed by – Department of Aeronautical Engineering                                             |                                                 |   |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                         |                                                 |   |   |   |   |
| 1. To understand the methods of low speed wind tunnel testing<br>2. To understand the methods of high speed wind tunnel testing<br>3. To acquire knowledge about measurement of pressure, velocity and temperature in flow fields<br>4. To understand the principles of flow visualization and analogue methods<br>5. To understand the principles of data acquisition and uncertainty analysis |                                                                                                         |                                                 |   |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                         |                                                 |   |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                                                                                                 |                                                                                                         |                                                 |   |   |   |   |
| CO 1                                                                                                                                                                                                                                                                                                                                                                                            | Discuss calibration procedures using various instruments and Determine aerodynamic coefficients.(Apply) |                                                 |   |   |   |   |
| CO 2                                                                                                                                                                                                                                                                                                                                                                                            | Explain various types of high-speed wind tunnels and discuss their design parameters.(Understand)       |                                                 |   |   |   |   |
| CO 3                                                                                                                                                                                                                                                                                                                                                                                            | Describe measurement techniques for flow properties.(Understand)                                        |                                                 |   |   |   |   |
| CO 4                                                                                                                                                                                                                                                                                                                                                                                            | Explain different flow visualizations technique in subsonic and supersonic regimes.(Understand)         |                                                 |   |   |   |   |
| CO 5                                                                                                                                                                                                                                                                                                                                                                                            | Discuss data acquisition and error analysis.(Understand)                                                |                                                 |   |   |   |   |
| Category                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                         | Professional Elective (PE)                      |   |   |   |   |
| Approval                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                         | 37th Academic Council Meeting held in May 2015. |   |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                         |                                                 |   |   |   |   |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                          | LOW SPEED WIND TUNNEL TESTING                                                                           |                                                 |   |   |   | 9 |
| Low speed wind tunnels-Power losses in wind tunnel, energy ratio, Calibration, Flow angularity, Yaw Sphere, Yaw meter, Turbulence sphere, Pressure sphere, Wind tunnel balances, boundary correction, calculation of CL and CD for airfoils                                                                                                                                                     |                                                                                                         |                                                 |   |   |   |   |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                         | HIGH SPEED WIND TUNNEL TESTING                                                                          |                                                 |   |   |   | 9 |
| High Speed wind tunnels- Blow down, Induction Type Tunnels, Losses in supersonic tunnels, Second throat, running time estimation, Hypersonic, transonic tunnels, Shock tunnels, Gun tunnels                                                                                                                                                                                                     |                                                                                                         |                                                 |   |   |   |   |
| UNIT III                                                                                                                                                                                                                                                                                                                                                                                        | MEASUREMENT TECHNIQUES                                                                                  |                                                 |   |   |   | 9 |
| Pressure measurement, Hot wire anemometer, laser Doppler anemometer for turbulence and velocity Measurements-Temperature measurement, Measurement of wall shear stress, Rotameters and Ultrasonic flow meters.                                                                                                                                                                                  |                                                                                                         |                                                 |   |   |   |   |
| UNIT IV                                                                                                                                                                                                                                                                                                                                                                                         | FLOW VISUALIZATION AND ANALOGUE METHODS                                                                 |                                                 |   |   |   | 9 |

|                                                                                                                                                                                      |                                                  |          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|----------|
| Smoke tunnel, Tuft method, chemical coating, interferometer, Schlieren and Shadowgraph method<br>Heleshaw Apparatus, Hydraulic analogy, limitations of analogy                       |                                                  |          |
| <b>UNIT V</b>                                                                                                                                                                        | <b>DATA ACQUISITION AND UNCERTAINTY ANALYSIS</b> | <b>9</b> |
| Measurement systems, data acquisition, signal conditioning, multiplexing, data conversion, uncertainty analysis                                                                      |                                                  |          |
| <b>Text Books:</b><br>1. Rathakrishnan. E “Instrumentation, Measurement and Experiments in Fluids”, CRCPress, London, 2007                                                           |                                                  |          |
| <b>References:</b><br>1. Rae W.H and Pope. A “Low speed wind tunnel testing” John Wiley Publication, 1999<br>2. Pope. A andGoin. L “High speed wind tunnel testing” John Wiley, 1985 |                                                  |          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                            |                                                 |   |   |   |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---|---|---|----|
| BANE05                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | HELICOPTER MAINTENANCE                                                                                     |                                                 | L | T | P | C  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Total Contact Hours – 45                                                                                   |                                                 | 3 | 0 | 0 | 3  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Prerequisite – Aircraft Systems and Instrumentation                                                        |                                                 |   |   |   |    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Course Designed by – Department of Aeronautical Engineering                                                |                                                 |   |   |   |    |
| OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |                                                 |   |   |   |    |
| 1. To acquaint with the basic fundamental of helicopter concept.<br>2. To understand the concept of inspection and maintenance of main rotor system.<br>3. To understand the concept of inspection and maintenance of main rotor transmission.<br>4. To understand the concept of inspection and maintenance of power plant and tail rotor.<br>5. To acquaint with airframes and related systems                                                                                                    |                                                                                                            |                                                 |   |   |   |    |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                            |                                                 |   |   |   |    |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                            |                                                 |   |   |   |    |
| CO 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Explain the basic components and working of helicopter.(Understand)                                        |                                                 |   |   |   |    |
| CO 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Explain the balancing of main rotor and Discuss the maintenance procedures in control rigging.(Understand) |                                                 |   |   |   |    |
| CO 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Discuss the main rotor transmission coupling and maintenance steps involved. (Understand)                  |                                                 |   |   |   |    |
| CO 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Discuss installation and modification of fixed wing powerplant. (Understand)                               |                                                 |   |   |   |    |
| CO 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Describe maintenance procedure of power plant and tail rotor system. (Understand)                          |                                                 |   |   |   |    |
| CO 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Explain the maintenance procedures involved in fuselage and airframe systems. (Understand)                 |                                                 |   |   |   |    |
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                            | Professional Elective (PE)                      |   |   |   |    |
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                            | 37th Academic Council Meeting held in May 2015. |   |   |   |    |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                            |                                                 |   |   |   |    |
| (Use of Heat and Mass Transfer Data Book is permitted)                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                            |                                                 |   |   |   |    |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                            | HELICOPTER FUNDAMENTALS                         |   |   |   | 6  |
| Basic components of helicopters and working – Ground handling, bearing – Gears.                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                            |                                                 |   |   |   |    |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                            | MAINTENANCE OF MAIN ROTOR SYSTEM                |   |   |   | 12 |
| Head maintenance – blade alignment – Static main rotor balance – Vibration – Tracking – Span wise dynamic balance – Blade sweeping –Electronic balancing – Dampener maintenance – Counter weight adjustment – Auto rotation adjustments – Mast & Flight Control Rotor - Mast – Stabilizer, dampeners – Swash plate flight control systems collective – Cyclic – Push pull tubes – Torque tubes – Bell cranks – Mixer box – Gradient unit control boosts – Maintenance & Inspection control rigging. |                                                                                                            |                                                 |   |   |   |    |
| UNIT III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                            | MAINTENANCE OF MAIN ROTOR TRANSMISSION          |   |   |   | 12 |

Engine transmission coupling – Drive shaft – Maintenance clutch – Free wheeling units – Spray clutch – Roller unit – Torque meter – Rotor brake – Maintenance of these components – vibrations – Mounting systems – Transmissions.

**UNIT IV**

**MAINTENANCE OF POWERPLANT AND TAIL ROTOR**

**9**

Fixed wing power plant modifications – Installation – Different type of power plant maintenance. Tail rotor system – Servicing tail rotor track – System rigging.

**UNIT V**

**AIRFRAME AND RELATED SYSTEMS**

**6**

Fuselage maintenance – Airframe Systems – Special purpose equipment.

**TEXTBOOKS:**

1. Jeppesen, “Helicopter Maintenance”, Jeppesens and Sons Inc., 2000.

**REFERENCES:**

1. “Civil Aircraft Inspection Procedures”, Part I and II, CAA, English Book House, New Delhi, 1998.

2. Larry Reithmier, “Aircraft Repair Manual”, Palamar Books Marquette, 1992.

**WEBLINKS:**

<http://www.aviationmaintenance.edu/programs/>

|                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                            |                                                 |   |   |   |    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---|---|---|----|
| BANE06                                                                                                                                                                                                                                                                                                                                                                                                                                         | SPACE MECHANICS                                                                                                                            |                                                 | L | T | P | C  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                | Total Contact Hours – 45                                                                                                                   |                                                 | 3 | 0 | 0 | 3  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                | Prerequisite – Engineering Mechanics                                                                                                       |                                                 |   |   |   |    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                | Course Designed by – Department of Aeronautical Engineering                                                                                |                                                 |   |   |   |    |
| OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                            |                                                 |   |   |   |    |
| 1. To introduce to the student about the basic concepts in space mechanics and about the laws that govern motion in space                                                                                                                                                                                                                                                                                                                      |                                                                                                                                            |                                                 |   |   |   |    |
| 2. To enable the student to decide on the locations for satellite injections in to the orbit and the various perturbations on satellites in space                                                                                                                                                                                                                                                                                              |                                                                                                                                            |                                                 |   |   |   |    |
| 3. To acquaint the student about the interplanetary trajectories and to select/design appropriate trajectory according to mission requirements                                                                                                                                                                                                                                                                                                 |                                                                                                                                            |                                                 |   |   |   |    |
| 4. To introduce to the student about the trajectories for ballistic missiles                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                            |                                                 |   |   |   |    |
| 5. To familiarize the student about the different types of materials used in spacecrafts                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                            |                                                 |   |   |   |    |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                            |                                                 |   |   |   |    |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                            |                                                 |   |   |   |    |
| CO 1                                                                                                                                                                                                                                                                                                                                                                                                                                           | Discuss the basic concepts and laws applicable to attracting bodies in the universe.(Understand)                                           |                                                 |   |   |   |    |
| CO 2                                                                                                                                                                                                                                                                                                                                                                                                                                           | Determine orbital parameters of Satellite injection and Discuss methods of satellite perturbations. (Apply)                                |                                                 |   |   |   |    |
| CO 3                                                                                                                                                                                                                                                                                                                                                                                                                                           | Explain two- and three-dimensional interplanetary trajectories and launch of interplanetary spacecrafts. (Understand)                      |                                                 |   |   |   |    |
| CO 4                                                                                                                                                                                                                                                                                                                                                                                                                                           | Estimate the ballistic missile trajectory. (Evaluate)                                                                                      |                                                 |   |   |   |    |
| CO 5                                                                                                                                                                                                                                                                                                                                                                                                                                           | Discuss the materials required for the construction of spacecraft and the impact of space environment on spacecraft materials.(Understand) |                                                 |   |   |   |    |
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                            | Professional Elective (PE)                      |   |   |   |    |
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                            | 37th Academic Council Meeting held in May 2015. |   |   |   |    |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                            |                                                 |   |   |   |    |
| (Use of Heat and Mass Transfer Data Book is permitted)                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                            |                                                 |   |   |   |    |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                                                                         | BASIC CONCEPTS AND THE GENERAL N- BODY PROBLEM                                                                                             |                                                 |   |   |   | 6  |
| The solar system – reference frames and coordinate systems – terminology related to the celestial sphere and its associated concepts – Kepler’s laws of planetary motion and proof of the laws – Newton’s universal law of gravitation - the many body problem- Lagrange-Jacobi identity – the circular restricted three body problem – libration points – the general N-body problem two body problems – relations between position and time. |                                                                                                                                            |                                                 |   |   |   |    |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                                                                        | SATELLITE INJECTION AND SATELLITE PERTURBATIONS                                                                                            |                                                 |   |   |   | 12 |

|                                                                                                                                                                                                                                                                                    |                                       |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|-----------|
| General aspects of satellite injection – satellite orbit transfer – various cases – orbit deviations due to injection errors – special and general perturbations – Cowell’s method and Encke’s method – method of variations of orbital elements – general perturbations approach. |                                       |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                    | <b>INTERPLANETARY TRAJECTORIES</b>    | <b>12</b> |
| Two-dimensional interplanetary trajectories – fast interplanetary trajectories – three dimensional interplanetary trajectories – launch of interplanetary spacecraft – trajectory estimation about the target planet – concept of sphere of influence – Lambert’s theorem          |                                       |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                     | <b>BALLISTIC MISSILE TRAJECTORIES</b> | <b>9</b>  |
| Introduction to ballistic missile trajectories – boost phase – the ballistic phase – trajectory geometry – optimal flights – time of flight – re-entry phase – the position of impact point – influence coefficients.                                                              |                                       |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                      | <b>MATERIALS FOR SPACECRAFT</b>       | <b>6</b>  |
| Space environment – peculiarities of space environment – effect of space environment on materials of spacecraft structure – materials required for the construction of space craft – TPS for re-entry space vehicles.                                                              |                                       |           |
| <b>Text Books:</b><br>1. Cornelisse, J.W., “Rocket Propulsion and Space Dynamics”, J.W. Freeman & Co., Ltd, London, 1982<br>2. Parker, E.R., “Materials for Missiles and Spacecraft”, Mc Graw Hill Book Co. Inc., 1982.                                                            |                                       |           |
| <b>References:</b><br>1. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 7th Edition, 2001.                                                                                                                                                          |                                       |           |

|                                                                                                                                                                                                                                                                 |                                                                                                    |  |          |          |          |           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|--|----------|----------|----------|-----------|
| <b>BASE05</b>                                                                                                                                                                                                                                                   | <b>GUIDANCE AND CONTROL</b>                                                                        |  | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b>  |
|                                                                                                                                                                                                                                                                 | Total Contact Hours – 45                                                                           |  | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b>  |
|                                                                                                                                                                                                                                                                 | Prerequisite – Basic Electricals and Electronics, Aircraft Stability and Control                   |  |          |          |          |           |
|                                                                                                                                                                                                                                                                 | Course Designed by – Department of Aeronautical Engineering                                        |  |          |          |          |           |
| <b>OBJECTIVE:</b> To provide the students the basic knowledge of guidance and control                                                                                                                                                                           |                                                                                                    |  |          |          |          |           |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                          |                                                                                                    |  |          |          |          |           |
| <b>CO 1</b>                                                                                                                                                                                                                                                     | <b>Explain</b> the equations governing the aircraft dynamics and the process of liberalizing them. |  |          |          |          |           |
| <b>CO 2</b>                                                                                                                                                                                                                                                     | <b>Discuss</b> the guidance schemes and requirements for aircrafts and missiles                    |  |          |          |          |           |
| <b>CO 3</b>                                                                                                                                                                                                                                                     | <b>Apply</b> the principle of stability and control augmentation systems.                          |  |          |          |          |           |
| <b>CO 4</b>                                                                                                                                                                                                                                                     | <b>Analyze</b> the oscillatory modes and methods of suppressing them                               |  |          |          |          |           |
| <b>CO 5</b>                                                                                                                                                                                                                                                     | <b>Design</b> the controller for lateral, longitudinal and directional control of aircrafts.       |  |          |          |          |           |
| <b>UNIT I</b>                                                                                                                                                                                                                                                   | <b>INTRODUCTION</b>                                                                                |  |          |          |          | <b>4</b>  |
| Introduction to Guidance and control - Definition, Historical background.                                                                                                                                                                                       |                                                                                                    |  |          |          |          |           |
| <b>UNIT II</b>                                                                                                                                                                                                                                                  | <b>AUGMENTATION SYSTEMS</b>                                                                        |  |          |          |          | <b>7</b>  |
| Need for automatic flight control systems, Stability augmentation systems, control augmentation systems, Gain scheduling concepts.                                                                                                                              |                                                                                                    |  |          |          |          |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                 | <b>LONGITUDINAL AUTOPILOT</b>                                                                      |  |          |          |          | <b>12</b> |
| Displacement Autopilot-Pitch Orientation Control system, Acceleration Control System, Glide Slope Coupler and Automatic Flare Control and Flight path stabilization, Longitudinal control law design using back stepping algorithm.                             |                                                                                                    |  |          |          |          |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                  | <b>LATERAL AUTOPILOT</b>                                                                           |  |          |          |          | <b>10</b> |
| Damping of the Dutch Roll, Methods of Obtaining Coordination, Yaw Orientation Control system, turn compensation, Automatic lateral Beam Guidance. Introduction to Fly-by-wire flight control systems, Lateral control law design using back stepping algorithm. |                                                                                                    |  |          |          |          |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                   | <b>MISSILE AND LAUNCH VEHICLE GUIDANCE</b>                                                         |  |          |          |          | <b>12</b> |
| Operating principles and design of guidance laws, homing guidance laws- short range, Medium range and BVR missiles, Launch Vehicle- Introduction, Mission requirements, Implicit guidance schemes, Explicit guidance, Q guidance schemes.                       |                                                                                                    |  |          |          |          |           |
| <b>TEXTBOOKS:</b>                                                                                                                                                                                                                                               |                                                                                                    |  |          |          |          |           |
| 1. Blake Lock, J.H “Automatic control of Aircraft and missiles” John Wiley Sons, New York, 1990.                                                                                                                                                                |                                                                                                    |  |          |          |          |           |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                              |                                                                                                    |  |          |          |          |           |
| 1. Stevens B.L & Lewis F.L, “Aircraft control & simulation”“, John Wiley Sons, New York, 1992.                                                                                                                                                                  |                                                                                                    |  |          |          |          |           |
| 2. Collinson R.P.G, “Introduction to Avionics”, Chapman and Hall, India, 1996.                                                                                                                                                                                  |                                                                                                    |  |          |          |          |           |
| 3. Garnel.P. &East.D.J, “Guided Weapon control systems”, Pergamon Press, Oxford, 1977.                                                                                                                                                                          |                                                                                                    |  |          |          |          |           |
| 4. Nelson R.C “Flight stability & Automatic Control”, McGraw Hill, 1989.                                                                                                                                                                                        |                                                                                                    |  |          |          |          |           |
| 5. Bernad Etkin, ”Dynamic of flight stability and control”, John Wiley, 1972.                                                                                                                                                                                   |                                                                                                    |  |          |          |          |           |
| 6. Jan Roskam, “Airplane Performance, Stability and Control”, DAR Corporation, 1997.                                                                                                                                                                            |                                                                                                    |  |          |          |          |           |

|                                                                                                                                                                                                                                                              |                                                                                         |   |   |   |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|---|---|---|---|
| BANE07                                                                                                                                                                                                                                                       | THEORY OF VIBRATIONS                                                                    | L | T | P | C |
|                                                                                                                                                                                                                                                              | Total Contact Hours – 45                                                                | 3 | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                              | Prerequisite – Engineering Mechanics, Flight Mechanics                                  |   |   |   |   |
|                                                                                                                                                                                                                                                              | Course Designed by – Department of Aeronautical Engineering                             |   |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                                   |                                                                                         |   |   |   |   |
| 1. To know about the role of Vibrations, vibration analysis and ideas about Aero elasticity in engineering and industry.                                                                                                                                     |                                                                                         |   |   |   |   |
| 2. To make thorough understanding of single degree of freedom, Two degrees of freedom and multi degrees of freedom systems and deriving equations to solve for natural frequency.                                                                            |                                                                                         |   |   |   |   |
| 3. To understand the Newton second Law, Energy method and know how to use it to solve single degree of freedom systems.                                                                                                                                      |                                                                                         |   |   |   |   |
| 4. To understand the approximate methods to solve vibration engineering problems in Two degree and multi degree of freedom systems.                                                                                                                          |                                                                                         |   |   |   |   |
| 5. To understand the collars triangle and various aero elastic phenomena in the aircraft structural components.                                                                                                                                              |                                                                                         |   |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                              |                                                                                         |   |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                              |                                                                                         |   |   |   |   |
| CO 1                                                                                                                                                                                                                                                         | Compute the natural frequency of SDOF systems under free and forced vibrations. (Apply) |   |   |   |   |
| CO 2                                                                                                                                                                                                                                                         | Determine the frequency of vibrating body using instruments. (Apply)                    |   |   |   |   |
| CO 3                                                                                                                                                                                                                                                         | Calculate principle mode of vibration for MDOF systems. (Apply)                         |   |   |   |   |
| CO 4                                                                                                                                                                                                                                                         | Calculate the natural frequency of continuous systems. (Apply)                          |   |   |   |   |
| CO 5                                                                                                                                                                                                                                                         | Calculate natural frequency of MDOF systems using approximate methods. (Apply)          |   |   |   |   |
| CO 6                                                                                                                                                                                                                                                         | Discuss the problems in aeroelastic instability and its prevention. (Understand)        |   |   |   |   |
| Category                                                                                                                                                                                                                                                     | Professional Elective (PE)                                                              |   |   |   |   |
| Approval                                                                                                                                                                                                                                                     | 37th Academic Council Meeting held in May 2015.                                         |   |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                               |                                                                                         |   |   |   |   |
| UNIT I                                                                                                                                                                                                                                                       | SINGLE DEGREE OF FREEDOM SYSTEMS                                                        |   |   |   | 9 |
| Vibration Terminologies, Simple harmonic motion, Newton’s law, D’Alembert’s principle, Energy methods, Free vibrations, Damped vibrations, Forced Vibrations with and without damping, support excitation,Transmissibility, Vibration measuring instruments. |                                                                                         |   |   |   |   |
| UNIT II                                                                                                                                                                                                                                                      | MULTI DEGREES OF FREEDOM SYSTEMS                                                        |   |   |   | 9 |
| Two degrees of freedom systems, static and dynamic couplings, Vibration absorbers, Principal co-ordinates, principal modes and orthogonal condition, Eigen value problems, Lagrangean equations and applications.                                            |                                                                                         |   |   |   |   |
| UNIT III                                                                                                                                                                                                                                                     | CONTINUOUS SYSTEMS                                                                      |   |   |   | 9 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                    |          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|----------|
| Vibration of elastic bodies, vibration of strings, Longitudinal –lateral and Torsional vibrations.                                                                                                                                                                                                                                                                                                                                                                                                      |                                    |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>APPROXIMATE METHODS</b>         | <b>9</b> |
| Approximate methods-Rayleigh's method, Dunkerleys method, Holzer method, Matrix iteration method                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>ELEMENTS OF AEROELASCTICITY</b> | <b>9</b> |
| Vibrations due to coupling of bending and torsion, collars triangle, aero elastic instabilities and their prevention, Wing divergence, reversal of aileron control, Flutter and its prevention.                                                                                                                                                                                                                                                                                                         |                                    |          |
| <b>Text Books:</b> <ol style="list-style-type: none"> <li>1. Y.C. Fung, "An Introduction to the Theory of Aeroelasticity", John Wiley &amp; Sons Inc., New York, 2008.</li> <li>2. Thomson W T, 'Theory of Vibration with Application' - CBS Publishers, 1990.</li> </ol>                                                                                                                                                                                                                               |                                    |          |
| <b>References:</b> <ol style="list-style-type: none"> <li>1. Timoshenko S., Vibration Problems in Engineering – John Wiley and Sons, New York, 1993.</li> <li>2. Bisplinghoff R.L., Ashely H and Hogman R.L., Aeroelasticity – Addison Wesley Publication, New York, 1983.</li> <li>3. R.H. Scanlan and R.Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.</li> <li>4. R.D.Blevins, "Flow Induced Vibrations", Krieger Pub Co., 2001</li> </ol> |                                    |          |

This course is not in the curriculum

|                                                                                                      |                                                                             |          |          |          |          |
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| <br><b>BASE06</b> | <b>SPACE VEHICLE DESIGN</b>                                                 | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|                                                                                                      | Total Contact Hours – 45                                                    | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |
|                                                                                                      | Prerequisite – Elements of Aerospace Structures                             |          |          |          |          |
|                                                                                                      | Course Designed by – Department of Aeronautical Engineering                 |          |          |          |          |
| <b>OBJECTIVE:</b> To introduce to the student about the design of a space vehicle                    |                                                                             |          |          |          |          |
| <b>COURSE OUTCOMES</b>                                                                               |                                                                             |          |          |          |          |
| <b>CO 1</b>                                                                                          | Describe the fundamentals of space systems                                  |          |          |          |          |
| <b>CO 2</b>                                                                                          | Demonstrate various space mission program                                   |          |          |          |          |
| <b>CO 3</b>                                                                                          | Examine the challenges in space environment                                 |          |          |          |          |
| <b>CO 4</b>                                                                                          | Classify the method of selection to launch vehicle and methods for re entry |          |          |          |          |
| <b>CO 5</b>                                                                                          | Determine the structural parameters in space system design                  |          |          |          |          |

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| <b>UNIT I</b>                                                                                                                                                                                                                                                    | <b>FUNDAMENTAL ASPECTS OF SPACE SYSTEMS ENGINEERING</b> | <b>9</b> |
| Space Systems Engineering – Definition, Requirements of Systems Engineering, Design Team, Tradeoffs, Top level requirements, Functional requirements, Functional Block diagram, Tradeoff analysis, Communication Systems and Power systems, Technology Tradeoffs |                                                         |          |
| <b>UNIT II</b>                                                                                                                                                                                                                                                   | <b>SPACE MISSIONS</b>                                   | <b>9</b> |

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| Space Missions - Low Earth Orbit, Flight Tests, Earth Observation, Space observation, Medium Altitude Earth Orbit, Geosynchronous Earth Orbit, Communications Satellites, Weather satellites, Lunar and Deep space missions – Inner and outer planetary missions, Observation of small bodies – comets and asteroids, Orbit Design Considerations, Advanced Mission concepts- Large Space structures, Space stations, space colonies, Use of lunar and asteroid materials, Nuclear waste disposal                                             |          |
| <b>UNIT III ENVIRONMENTAL CONSTRAINTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>9</b> |
| Natural and Manmade environments, Earth environment – corrosion due to humidity, Clean room, problems in transporting, Launch environment, Shuttle Vibration, Atmospheric environment – wind shear constraint, density shear, Effect of Polar mesospheric clouds during re – entry, Space and Upper Atmosphere environment – Effect of vacuum on materials, Space plasma and spacecraft charging, Magnetic field, Weightlessness and microgravity, Radiation – Van Allen Radiation belt, Micrometeoroids, Orbital debris, Thermal environment |          |
| <b>UNIT IV LAUNCH VEHICLE SELECTION AND ATMOSPHERIC ENTRY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>9</b> |
| Solid vs Liquid propellant, Hybrid propulsion, Space shuttle payload accommodations, expendable launch vehicles, Atmospheric entry – Requirements, fundamentals of entry flight mechanics, ballistic entry, gliding entry, skip entry, Cross-Range entry, Entry heating, free molecular heating, Thermal protection, Entry vehicle design                                                                                                                                                                                                     |          |
| <b>UNIT V STRUCTURAL DESIGN CONSIDERATIONS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>9</b> |
| Vehicle center of mass, Vehicle moment of inertia, structural loads, load alleviation, modal analysis, fracture mechanics, stress levels and safety factors, large structures, structural materials, films and fabrics                                                                                                                                                                                                                                                                                                                        |          |
| <b>TEXTBOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |
| 1. Michael D.Griffin and James R. French, “ Space Vehicle design” AIAA Education Series, Second Edition, 2004                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |
| 1. NickolayZosimovych, “ Commercial Launch Vehicle Design” , LAP LAMBERT Academic Publishing , 2016                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |
| <b>WEBLINKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |
| <a href="https://www.uclaextension.edu/engineering/engineering-short-courses/course/space-launch-vehicle-design-and-system-engineering">https://www.uclaextension.edu/engineering/engineering-short-courses/course/space-launch-vehicle-design-and-system-engineering</a>                                                                                                                                                                                                                                                                     |          |

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| <b>BANE08</b>                                                                                                                                                                                                                                                                        | <b>HELICOPTER AERODYNAMICS</b>                                                                      |                                                        | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|                                                                                                                                                                                                                                                                                      | Total Contact Hours – 45                                                                            |                                                        | 3        | 0        | 0        | 3        |
|                                                                                                                                                                                                                                                                                      | Prerequisite – Fundamentals of Aeronautics and Astronautics, Aerodynamics I                         |                                                        |          |          |          |          |
|                                                                                                                                                                                                                                                                                      | Course Designed by – Department of Aeronautical Engineering                                         |                                                        |          |          |          |          |
| <b>OBJECTIVES</b>                                                                                                                                                                                                                                                                    |                                                                                                     |                                                        |          |          |          |          |
| 1. To acquaint with the basics of rotating wing concept.<br>2. To understand the concept of hovering flight dynamics.<br>3. To understand the concept of forward flight dynamics.<br>4. To analyze the climb and descent performance.<br>5. To acquaint with ground effect machines. |                                                                                                     |                                                        |          |          |          |          |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                               |                                                                                                     |                                                        |          |          |          |          |
| <b>At the end of Course, Students will be able to,</b>                                                                                                                                                                                                                               |                                                                                                     |                                                        |          |          |          |          |
| <b>CO<br/>1</b>                                                                                                                                                                                                                                                                      | <b>Describe</b> various helicopter configurations and their working principles. <b>(Understand)</b> |                                                        |          |          |          |          |
| <b>CO<br/>2</b>                                                                                                                                                                                                                                                                      | <b>Estimate</b> the rotor performance parameters for hover flight. <b>(Evaluate)</b>                |                                                        |          |          |          |          |
| <b>CO<br/>3</b>                                                                                                                                                                                                                                                                      | <b>Discuss</b> the forward flight dynamic performance parameters. <b>(Understand)</b>               |                                                        |          |          |          |          |
| <b>CO<br/>4</b>                                                                                                                                                                                                                                                                      | <b>Discuss</b> the power required for climb and descent. <b>(Understand)</b>                        |                                                        |          |          |          |          |
| <b>CO<br/>5</b>                                                                                                                                                                                                                                                                      | <b>Discuss</b> the working principle and applications of hovercraft. <b>(Understand)</b>            |                                                        |          |          |          |          |
| <b>Category</b>                                                                                                                                                                                                                                                                      |                                                                                                     | <b>Professional Elective (PE)</b>                      |          |          |          |          |
| <b>Approval</b>                                                                                                                                                                                                                                                                      |                                                                                                     | <b>37th Academic Council Meeting held in May 2015.</b> |          |          |          |          |
| <b>COURSE CONTENT</b>                                                                                                                                                                                                                                                                |                                                                                                     |                                                        |          |          |          |          |
| <b>UNIT I</b>                                                                                                                                                                                                                                                                        | <b>INTRODUCTION TO ROTATING WING CONCEPT</b>                                                        |                                                        |          |          |          | <b>9</b> |
| Evolution of helicopter-Helicopter configurations - Configurations based on Torque reaction – Jet rotors and compound helicopters –Methods of Control, rotor blade pitch control, –Collective pitch and and                                                                          |                                                                                                     |                                                        |          |          |          |          |

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| Cyclic pitch – Lead – Lag and flapping hinges.                                                                                                                                                                                         |                                      |          |
| <b>UNIT II</b>                                                                                                                                                                                                                         | <b>HOVERING FLIGHT DYNAMICS</b>      | <b>9</b> |
| Actuator disc theory-Blade Element Theory-ideal twist Induced & profile power-Figure of merit-Thrust and power coefficients-calculation of drag, torque, power-Ground effect in hover- Estimation of hover ceiling.                    |                                      |          |
| <b>UNIT III</b>                                                                                                                                                                                                                        | <b>FORWARD FLIGHT DYNAMICS</b>       | <b>9</b> |
| Forward flight performance-Parasite drag and Power-Stall limitations-flapping-cyclic Pitch - Autorotation in hover and in forward flight-Dead man's curve.                                                                             |                                      |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                         | <b>CLIMB AND DESCENT PERFORMANCE</b> | <b>9</b> |
| Vertical flight-flow patterns surrounding the rotor-Power required in climb and descent- Descent speed calculations-Take-off techniques.                                                                                               |                                      |          |
| <b>UNIT V</b>                                                                                                                                                                                                                          | <b>GROUND EFFECT MACHINES</b>        | <b>9</b> |
| Types – Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machines – Drag of hovercraft on land and water –Applications of hovercraft.                                                      |                                      |          |
| <b>Text Books:</b><br>1. Gupta. L “Helicopter Engineering”, Himalayan Books, 1996<br>2. Seddon. J “Basic Helicopter Aerodynamics” AIAA education series, 1990.                                                                         |                                      |          |
| <b>References:</b><br>1. Gessow A & Myers G.C “Aerodynamics of Helicopter” Mac Millan& Co, 1987<br>2. Saunders “Dynamics of Helicopter flight”, John Wiley, 1975<br>3. Newman. S “Foundation of Helicopter Flight” Halsted Press, 1994 |                                      |          |

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| <b>BANE09</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>AIRCRAFT ENGINE REPAIR AND MAINTENANCE</b>                                                                                                                       | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Total Contact Hours – 45                                                                                                                                            | 3        | 0        | 0        | 3        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Prerequisite – Aircraft Propulsion, Basic aircraft maintenance and repair                                                                                           |          |          |          |          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Course Designed by – Department of Aeronautical Engineering                                                                                                         |          |          |          |          |
| <b>OBJECTIVES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                     |          |          |          |          |
| 1. To know about the hydraulic, pneumatic, brake and landing gear systems principle, function of components, types and operation of typical system.<br>2. To study and differentiate conventional and modern aircraft control systems and engine control systems<br>3. To study about layout, components, functions of fuel, lubrication, starting, ignition systems of piston and jet engines.<br>4. To understand air-conditioning, air cycle, vapor cycle, oxygen, deicing, anti icing and fire protection systems of aero plane.<br>5. To study construction and operation of flight, navigation instruments and engine instruments installed in the aero plane. |                                                                                                                                                                     |          |          |          |          |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                     |          |          |          |          |
| <b>At the end of Course, Students will be able to,</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                     |          |          |          |          |
| <b>CO 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Describe</b> the inspection and troubleshooting procedure for piston engine components. <b>(Understand)</b>                                                      |          |          |          |          |
| <b>CO 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Explain</b> the inspection and troubleshooting methods of aircraft propeller. <b>(Understand)</b>                                                                |          |          |          |          |
| <b>CO 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Discuss</b> the overhauling and testing procedure for aircraft reciprocating engine. <b>(Understand)</b>                                                         |          |          |          |          |
| <b>CO 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Describe</b> the checks and maintenance procedures followed in gas turbine engines and <b>select</b> appropriate trouble shooting technique. <b>(Understand)</b> |          |          |          |          |
| <b>CO 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Discuss</b> the overhauling procedure of aircraft gas turbine engine. <b>(Understand)</b>                                                                        |          |          |          |          |
| <b>Category</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Professional Elective (PE)</b>                                                                                                                                   |          |          |          |          |
| <b>Approval</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>37th Academic Council Meeting held in May 2015.</b>                                                                                                              |          |          |          |          |
| <b>COURSE CONTENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                     |          |          |          |          |

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| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>INSPECTIONS AND TROUBLE SHOOTING OF PISTON ENGINES</b>    | <b>9</b> |
| Need for Inspection, maintenance and trouble shooting in Piston engine – Inspection of all components – Daily and routine checks – Overhaul procedures – Compression testing of cylinders – Special inspection schedules – Engine fuel, control and exhaust systems – Engine mount and super charger – Details of carburetion and injection systems for small and large engines – Ignition system components – Spark plug – Maintenance and inspection check to be carried out.                                             |                                                              |          |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>INSPECTION AND TROUBLE SHOOTING OF PROPELLER</b>          | <b>9</b> |
| Propeller theory - operation, construction assembly and installation -Pitch change mechanism-Propeller axially system- Damage and repair criteria - General Inspection procedures - Checks on constant speed propellers - Pitch setting, Propeller Balancing, Blade cuffs, Governor/Propeller operating conditions.                                                                                                                                                                                                         |                                                              |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>OVERHAULING OF PISTON ENGINES</b>                         | <b>9</b> |
| Symptoms of failure - Fault diagnostics - Case studies of different piston engine systems - Rectification during testing equipments for overhaul: Tools and equipments requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and for visual inspection - Methods and instruments for non destructive testing techniques - Equipment for replacement of parts and their repair. Engine testing: Engine testing procedures and schedule preparation - Online maintenance |                                                              |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>INSPECTION AND TROUBLE SHOOTING OF GAS TURBINE ENGINE</b> | <b>9</b> |
| Gas turbine engine inspection & checks – Use of instruments for online maintenance – Maintenance procedures of gas turbine engines – Trouble shooting and rectification procedures – Component maintenance procedures – Systems maintenance procedures. Special inspection procedures: Foreign Object Damage – Blade damage – etc. Gas turbine testing procedures – test schedule preparation – Storage of Engines – Preservation and de-preservation procedures.                                                           |                                                              |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>OVERHAULING OF GAS TURBINE ENGINES</b>                    | <b>9</b> |
| Gas turbine Engine Overhaul procedures – Inspections and cleaning of components – Repairs schedules for overhaul – Balancing of Gas turbine components. Trouble Shooting - Procedures for rectification – Condition monitoring of the engine on ground and at altitude – engine health monitoring and corrective methods.                                                                                                                                                                                                   |                                                              |          |
| <b>Text Books:</b><br>1. KROES & WILD, “Aircraft Power plants”, 7th Edition – McGraw Hill, New York, 1994.                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                              |          |
| <b>References:</b><br>1. TURBOMECA, “Gas Turbine Engines”, The English Book Store, New Delhi, 1995.<br>2. UNITED TECHNOLOGIES PRATT & WHITNEY, “The Aircraft Gas turbine Engine and its Operation”, The English Book Store, New Delhi.                                                                                                                                                                                                                                                                                      |                                                              |          |

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---|---|---|---|
| BANE10                                                                                                                                                                                                                                                                                                 | CRYOGENIC ROCKET PROPULSION                                                                                    |                                                 | L | T | P | C |
|                                                                                                                                                                                                                                                                                                        | Total Contact Hours – 45                                                                                       |                                                 | 3 | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                                                                        | Prerequisite – Engineering Thermodynamics, Advanced aerospace propulsion                                       |                                                 |   |   |   |   |
|                                                                                                                                                                                                                                                                                                        | Course Designed by – Department of Aeronautical Engineering                                                    |                                                 |   |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                                                                             |                                                                                                                |                                                 |   |   |   |   |
| 1. To introduce to the student the basics of cryogenic systems and associated processes.                                                                                                                                                                                                               |                                                                                                                |                                                 |   |   |   |   |
| 2. To acquaint the student with the propellants used in cryogenic technology.                                                                                                                                                                                                                          |                                                                                                                |                                                 |   |   |   |   |
| 3. To introduce the various equipment and accessories used in cryogenic rocket propulsion.                                                                                                                                                                                                             |                                                                                                                |                                                 |   |   |   |   |
| 4. To familiarize the student to the different flow circuits and parts in a cryogenic engine.                                                                                                                                                                                                          |                                                                                                                |                                                 |   |   |   |   |
| 5. To enable the student to understand about various challenges in implementing cryogenic rocket technology.                                                                                                                                                                                           |                                                                                                                |                                                 |   |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                        |                                                                                                                |                                                 |   |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                        |                                                                                                                |                                                 |   |   |   |   |
| CO<br>1                                                                                                                                                                                                                                                                                                | Discuss the basic components of cryogenic systems. (Understand)                                                |                                                 |   |   |   |   |
| CO<br>2                                                                                                                                                                                                                                                                                                | Explain the types of cryogenic propellant used and their storage and handling. (Understand)                    |                                                 |   |   |   |   |
| CO<br>3                                                                                                                                                                                                                                                                                                | Discuss cryo equipment and accessories of cryogenic engine system. (Understand)                                |                                                 |   |   |   |   |
| CO<br>4                                                                                                                                                                                                                                                                                                | Discuss various subsystem involved in the operation of cryogenic engine and their design aspects. (Understand) |                                                 |   |   |   |   |
| CO<br>5                                                                                                                                                                                                                                                                                                | Discuss the challenges in cryogenic rocket technology. (Understand)                                            |                                                 |   |   |   |   |
| Category                                                                                                                                                                                                                                                                                               |                                                                                                                | Professional Elective (PE)                      |   |   |   |   |
| Approval                                                                                                                                                                                                                                                                                               |                                                                                                                | 37th Academic Council Meeting held in May 2015. |   |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                                                                         |                                                                                                                |                                                 |   |   |   |   |
| UNIT I                                                                                                                                                                                                                                                                                                 |                                                                                                                | INTRODUCTION TO CRYOGENIC SYSTEMS               |   |   |   | 9 |
| Cryogenic systems and basic components, Properties of Cryogenic fluids, Liquefaction systems, ideal, Cascade, Linde Hampson and Claude cycles and their derivatives; Refrigerators: Stirling, Gifford-McMahon cycles and their derivatives. Cryogenic Insulations: Foam, Fibre, powder and Multilayer. |                                                                                                                |                                                 |   |   |   |   |
| UNIT II                                                                                                                                                                                                                                                                                                |                                                                                                                | CRYO FUEL SYSTEMS                               |   |   |   | 9 |

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| Cryogenic and semi – cryogenic propellants - Hydrogen - properties, and pretreatment - Liquefaction of hydrogen - Linde, Claude and helium - hydrogen condensing cycles, Ortho-para conversion. Storage and handling of liquefied hydrogen                                                                                                                                                                                                                             |                                                  |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>CRYO EQUIPMENT AND ACCESSORIES</b>            | <b>9</b> |
| Mechanical and Thermal Properties of engineering materials at low temperatures; Compressors: types, construction and characteristics; Expansion machines: characteristics of reciprocating and turbine expanders, design of J-T expander; Heat exchangers: types, design approaches and selection criteria, Design of cryogenic storage vessels, transfer devices, insulation system, valves; Characteristics of cryogenic pumps, Instrumentation in cryogenic systems |                                                  |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>CRYOGENIC ENGINES</b>                         | <b>9</b> |
| Fluid circuits of various cryogenic engines and semi-cryogenic engines; Design of regeneratively cooled combustion chamber, film cooling, dump cooling, transpiration cooling and radiation cooling. Design of expansion nozzle- characteristics, Design of injector-hydraulic characteristics; Engine thrust and mixture ratio control, Igniters, Propellant tanks.                                                                                                   |                                                  |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>CHALLENGES IN CRYOGENIC ROCKET TECHNOLOGY</b> | <b>9</b> |
| Problems in storage and handling of cryogenic propellants: safety aspects, Thermal protection systems for stage tanks, Thermal stratification- destratification, Geysering effect – geysering elimination, Zero “g” problems – restart mechanism.                                                                                                                                                                                                                      |                                                  |          |
| <b>TEXTBOOKS:</b><br>1. “A text book of Cryogenics”, “Valery V. Kostionk”, Discovery Publishing House, 2010. (Units 1 to 3)<br>2. “Operation of a Cryogenic Rocket Engine”, “Kitsche, Wolfgang”, Springer Publications, 2011. (Units 4 & 5)                                                                                                                                                                                                                            |                                                  |          |
| <b>REFERENCES:</b><br>1. “Rocket Propulsion Elements”, “Sutton G. P., Bibliarz”                                                                                                                                                                                                                                                                                                                                                                                        |                                                  |          |
| <b>WEBLINKS:</b><br><a href="https://nptel.ac.in/courses/112101004/">https://nptel.ac.in/courses/112101004/</a>                                                                                                                                                                                                                                                                                                                                                        |                                                  |          |

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| BANE11                                                                                                       | THEORY OF PLATES AND SHELLS                                                                                                  |                                                 | L | T | P | C |
|                                                                                                              | Total Contact Hours – 45                                                                                                     |                                                 | 3 | 0 | 0 | 3 |
|                                                                                                              | Prerequisite – Fundamentals of Structural Mechanics                                                                          |                                                 |   |   |   |   |
|                                                                                                              | Course Designed by – Department of Aeronautical Engineering                                                                  |                                                 |   |   |   |   |
| OBJECTIVES                                                                                                   |                                                                                                                              |                                                 |   |   |   |   |
| 1. To acquaint with the classical plate theory.                                                              |                                                                                                                              |                                                 |   |   |   |   |
| 2. To analyze the plates of various shapes.                                                                  |                                                                                                                              |                                                 |   |   |   |   |
| 3. To learn the concept of Eigen value analysis.                                                             |                                                                                                                              |                                                 |   |   |   |   |
| 4. To learn various numerical approximation method for plate analysis.                                       |                                                                                                                              |                                                 |   |   |   |   |
| 5. To acquaint the concept of shell structures.                                                              |                                                                                                                              |                                                 |   |   |   |   |
| COURSE OUTCOMES                                                                                              |                                                                                                                              |                                                 |   |   |   |   |
| At the end of Course, Students will be able to,                                                              |                                                                                                                              |                                                 |   |   |   |   |
| CO 1                                                                                                         | Explain the classical plate theory subjected to Axi-symmetric loading. (Understand)                                          |                                                 |   |   |   |   |
| CO 2                                                                                                         | Use Navier’s method and Levy’s method to obtain solution for rectangular plates under different boundary conditions. (Apply) |                                                 |   |   |   |   |
| CO 3                                                                                                         | Illustrate the stability and free vibration analysis of rectangular plates. (Understand)                                     |                                                 |   |   |   |   |
| CO 4                                                                                                         | Apply various approximate methods on rectangular plates for stability analysis. (Apply)                                      |                                                 |   |   |   |   |
| CO 5                                                                                                         | Describe the concepts of shell type structures and bending theories for circular cylindrical shells. (Understand)            |                                                 |   |   |   |   |
| Category                                                                                                     |                                                                                                                              | Professional Elective (PE)                      |   |   |   |   |
| Approval                                                                                                     |                                                                                                                              | 37th Academic Council Meeting held in May 2015. |   |   |   |   |
| COURSE CONTENT                                                                                               |                                                                                                                              |                                                 |   |   |   |   |
| UNIT I                                                                                                       |                                                                                                                              | CLASSICAL PLATE THEORY                          |   |   |   | 9 |
| Classical Plate Theory – Assumptions – Differential Equations – Boundary Conditions – Axi-Symmetric Loading. |                                                                                                                              |                                                 |   |   |   |   |
| UNIT II                                                                                                      |                                                                                                                              | PLATES OF VARIOUS SHAPES                        |   |   |   | 9 |
| Navier’s Method of Solution for Simply Supported Rectangular Plates – Levy’s Method of Solution for          |                                                                                                                              |                                                 |   |   |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                             |          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|----------|
| Rectangular Plates under Different Boundary Conditions – Annular Plates – Plates of other shapes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>EIGEN VALUE ANALYSIS</b> | <b>9</b> |
| Stability and Free Vibration Analysis of Rectangular Plates.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                             |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>APPROXIMATE METHODS</b>  | <b>9</b> |
| Rayleigh – Ritz, Galerkin Methods– Finite Difference Method – Application to Rectangular Plates for Static, Free Vibration and Stability Analysis.                                                                                                                                                                                                                                                                                                                                                                                                                     |                             |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>SHELLS</b>               | <b>9</b> |
| Basic Concepts of Shell Type of Structures – Membrane and Bending Theories for Circular Cylindrical Shells.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                             |          |
| <b>Text Books:</b> <ol style="list-style-type: none"> <li>1. Timoshenko, S.P. Winowsky. S., and Kreger, Theory of Plates and Shells, McGraw Hill Book Co., 1990.</li> <li>2. Varadhan. T. K. &amp; Bhaskar.K., “Analysis of Plates – Theory and Problems”, Narosa Publishing House, 2000</li> </ol>                                                                                                                                                                                                                                                                    |                             |          |
| <b>References:</b> <ol style="list-style-type: none"> <li>1. Flugge, W. Stresses in Shells, Springer – Verlag, 1985.</li> <li>2. Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, McGraw Hill Book Co.1986.</li> <li>3. Harry Kraus, ‘Thin Elastic Shells’, John Wiley and Sons, 1987.</li> <li>4. Llyod Hamilton, Donald, “Beams, Plates and Shells”, McGraw Hill, 1976.</li> <li>5. Ansel Ugural, Stresses in Plates &amp; Shells, McGraw Hill, 1981</li> <li>6. Reddy.J.N., “Theory &amp; Analysis of Elastic Plates”, CRC, I Edition, 1999</li> </ol> |                             |          |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|---|---|---|---|
| BANE12                                                                                                                                                                                                                                                                                                                                                                                                                                                           | HYPERSONIC AERODYNAMICS                                                                                         |                                                        | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Total Contact Hours – 45                                                                                        |                                                        | 3 | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Prerequisite – Aerodynamics I & II                                                                              |                                                        |   |   |   |   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Course Designed by – Department of Aeronautical Engineering                                                     |                                                        |   |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                 |                                                        |   |   |   |   |
| 1. To study the environment around hypersonic vehicles created by strong shock waves.<br>2. To introduce students to real gas effects caused by high temperature conditions.<br>3. To study pressure and heat transfer phenomena at the stagnation point of a hypersonic vehicle.<br>4. To study the distribution of pressure around a general vehicle shape.<br>5. To study the distribution of heat transfer and skin friction around a general vehicle shape. |                                                                                                                 |                                                        |   |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                 |                                                        |   |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                 |                                                        |   |   |   |   |
| CO 1                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Recall the concepts of compressible flows and differentiate between supersonic and hypersonic flows. (Remember) |                                                        |   |   |   |   |
| CO 2                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Discuss simple solution methods of hypersonic inviscid flows. (Understand)                                      |                                                        |   |   |   |   |
| CO 3                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Discuss the basics of viscous hypersonic flows. (Understand)                                                    |                                                        |   |   |   |   |
| CO 4                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Describe the shock shear layer interaction in hypersonic flows. (Understand)                                    |                                                        |   |   |   |   |
| CO 5                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Discuss basics of high temperature flows. (Understand)                                                          |                                                        |   |   |   |   |
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                 | Professional Elective (PE)                             |   |   |   |   |
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                 | 37th Academic Council Meeting held in May 2015.        |   |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                 |                                                        |   |   |   |   |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                 | FUNDAMENTALS OF HYPERSONIC AERODYNAMICS                |   |   |   | 9 |
| Introduction to hypersonic aerodynamics-differences between hypersonic aerodynamics and supersonic aerodynamics-concept of thin shock layers-hypersonic flight paths – hypersonic similarity parameters-shock wave and expansion wave relations of inviscid hypersonic flows.                                                                                                                                                                                    |                                                                                                                 |                                                        |   |   |   |   |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                 | SIMPLE SOLUTION METHODS FOR HYPERSONIC IN VISCID FLOWS |   |   |   | 9 |

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| Local surface inclination methods-Newtonian theory-modified Newtonian law-tangent wedge and tangent cone and shock expansion methods-approximate theory-thin shock layer theory.                                                                                                                                                                                           |                                                 |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                            | <b>VISCOUS HYPERSONIC FLOW THEORY</b>           | <b>9</b> |
| Boundary layer equation for hypersonic flow-hypersonic boundary layers-self similar and non self similar boundary layers-solution methods for non self similar boundary layers aerodynamic heating.                                                                                                                                                                        |                                                 |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                             | <b>VISCOUS INTERACTIONS IN HYPERSONIC FLOWS</b> | <b>9</b> |
| Introduction to the concept of viscous interaction in hypersonic flows-strong and weak viscous interactions-hypersonic viscous interaction similarity parameter-introduction to shock wave boundary layer interactions.                                                                                                                                                    |                                                 |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                              | <b>INTRODUCTION TO HIGH TEMPERATURE EFFECTS</b> | <b>9</b> |
| Nature of high temperature flows-chemical effects in air-real and perfect gases-Gibb's free energy and entropy-chemically reacting mixtures-recombination and dissociation.                                                                                                                                                                                                |                                                 |          |
| <b>TEXTBOOKS:</b><br>1. Ethirajan Rathakrishnan., "High Enthalpy Gas Dynamics", John Wiley and Sons, 2015                                                                                                                                                                                                                                                                  |                                                 |          |
| <b>REFERENCES:</b><br>1. John. D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", AIAA Series, New York, 2006.<br>2. John. D. Anderson. Jr., "Modern compressible flow with historical perspective", McGraw Hill Publishing Company, New York, 1996.<br>3. John. T Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc., Washington. D.C., 1994. |                                                 |          |
| <b>WEBLINKS:</b><br><a href="https://nptel.ac.in/courses/101103003/">https://nptel.ac.in/courses/101103003/</a>                                                                                                                                                                                                                                                            |                                                 |          |

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| <b>BANE13</b>                                                                                                                                                                                                                                                                                                                  | <b>AN INTRODUCTION TO COMBUSTION</b>                                                                                                                  |                                                        | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|                                                                                                                                                                                                                                                                                                                                | Total Contact Hours – 45                                                                                                                              |                                                        | 3        | 0        | 0        | 3        |
|                                                                                                                                                                                                                                                                                                                                | Prerequisite – Fundamentals of Aerothermodynamics, Aircraft Propulsion                                                                                |                                                        |          |          |          |          |
|                                                                                                                                                                                                                                                                                                                                | Course Designed by – Department of Aeronautical Engineering                                                                                           |                                                        |          |          |          |          |
| <b>OBJECTIVES</b>                                                                                                                                                                                                                                                                                                              |                                                                                                                                                       |                                                        |          |          |          |          |
| 1. To acquaint with the basics of combustion.<br>2. To understand the combustion process in aircraft piston engines.<br>3. To understand the combustion process in gas turbine engines.<br>4. To understand the combustion process in scramjet engines.<br>5. To understand the combustion process in rocket engines.          |                                                                                                                                                       |                                                        |          |          |          |          |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                         |                                                                                                                                                       |                                                        |          |          |          |          |
| <b>At the end of Course, Students will be able to,</b>                                                                                                                                                                                                                                                                         |                                                                                                                                                       |                                                        |          |          |          |          |
| <b>CO 1</b>                                                                                                                                                                                                                                                                                                                    | <b>Explain</b> thermo chemical reaction associated with combustion process and the various parameters affecting burning velocity. <b>(Understand)</b> |                                                        |          |          |          |          |
| <b>CO 2</b>                                                                                                                                                                                                                                                                                                                    | <b>Select</b> apt fuel for optimum combustion in piston engines. <b>(Analyze)</b>                                                                     |                                                        |          |          |          |          |
| <b>CO 3</b>                                                                                                                                                                                                                                                                                                                    | <b>Compare</b> the ramjet and gas turbine combustion chamber design. <b>(Understand)</b>                                                              |                                                        |          |          |          |          |
| <b>CO 4</b>                                                                                                                                                                                                                                                                                                                    | <b>Analyze</b> the challenges associated with supersonic combustion. <b>(Analyze)</b>                                                                 |                                                        |          |          |          |          |
| <b>CO 5</b>                                                                                                                                                                                                                                                                                                                    | <b>Discuss</b> combustion process in solid, liquid propellant rockets and hybrid rockets. <b>(Understand)</b>                                         |                                                        |          |          |          |          |
| <b>Category</b>                                                                                                                                                                                                                                                                                                                |                                                                                                                                                       | <b>Professional Elective (PE)</b>                      |          |          |          |          |
| <b>Approval</b>                                                                                                                                                                                                                                                                                                                |                                                                                                                                                       | <b>37th Academic Council Meeting held in May 2015.</b> |          |          |          |          |
| <b>COURSE CONTENT</b>                                                                                                                                                                                                                                                                                                          |                                                                                                                                                       |                                                        |          |          |          |          |
| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                                  | <b>INTRODUCTION TO COMBUSTION</b>                                                                                                                     |                                                        |          |          |          | <b>9</b> |
| Thermochemical equations – heat of reaction- first, second and third order reactions – premixed flames – diffusion flames – measurement of burning velocity – various methods – effect of various parameters on burning velocity – flame stability – deflagration – detonation – Rankine-Hugoniot curves – radiation by flames |                                                                                                                                                       |                                                        |          |          |          |          |

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| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                          | <b>COMBUSTION IN AIRCRAFT PISTON ENGINES</b> | <b>9</b> |
| Introduction to combustion in aircraft piston engines – various factors affecting the combustion efficiency<br>- fuels used for combustion in aircraft piston engines and their selection – detonation in piston engine<br>combustion and the methods to prevent the detonation                                                                                         |                                              |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                         | <b>COMBUSTION IN GAS TURBINE ENGINES</b>     | <b>9</b> |
| Combustion in gas turbine combustion chambers - recirculation – combustion efficiency, factors affecting combustion efficiency, fuels used for gas turbine combustion chambers – combustion stability – ramjet combustion – differences between the design of ramjet combustion chambers and gas turbine combustion chambers- flame holders types – numerical problems. |                                              |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                          | <b>COMBUSTION IN SCRAMJET ENGINES</b>        | <b>9</b> |
| Introduction to supersonic combustion – need for supersonic combustion for hypersonic air-breathing propulsion- supersonic combustion controlled by diffusion, mixing and heat convection – analysis of reactions and mixing processes - supersonic burning with detonation shocks - various types of supersonic combustors.                                            |                                              |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                           | <b>COMBUSTION IN ROCKET ENGINES</b>          | <b>9</b> |
| Solid propellant combustion - double and composite propellant combustion – various combustion models – combustion in liquid rocket engines – single fuel droplet combustion model – combustion hybrid rockets                                                                                                                                                           |                                              |          |
| <b>Text Books:</b><br>1. Stephen R turns, "An Introduction to Combustion", Tata Mc. Graw Hill Publishing Co., Ltd., New Delhi, Reprint 2013.<br>2. Lefebvre AG and Dilip R ballal, "Gas Turbine Combustion", CRC press ,Third Edition, 2010.                                                                                                                            |                                              |          |
| <b>References:</b><br>1. Warnatz J, Maas U and Dibble RW, "Combustion", Springer, Fourth Edition, 2006.<br>2. Beer, J.M., and Chiger, N.A. "Combustion Aerodynamics", Applied Science Publishers Ltd., London, 1981.<br>3. Sharma, S.P., and Chandra Mohan, "Fuels and Combustion", Tata Mc. Graw Hill Publishing Co., Ltd., New Delhi, 1987                            |                                              |          |

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| BANE14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | PRINCIPLES OF TURBO MACHINERY IN<br>AIR BREATHING ENGINES                                       | L                                               | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Total Contact Hours – 45                                                                        | 3                                               | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Prerequisite – Aircraft Propulsion                                                              |                                                 |   |   |   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Course Designed by – Department of Aeronautical Engineering                                     |                                                 |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                 |                                                 |   |   |   |
| 1. To familiarize the student on the working principle of air breathing engines                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                 |                                                 |   |   |   |
| 2. To enable the student to be able to design axial flow compressors and fans based on the operating requirements                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                 |                                                 |   |   |   |
| 3. To student should be able to design axial flow turbines based on the operating requirements                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                 |                                                 |   |   |   |
| 4. To acquaint the student about the designing procedure for centrifugal compressors                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                 |                                                 |   |   |   |
| 5. To enable the student to design radial flow turbines based on operating conditions                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                 |                                                 |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                 |                                                 |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                 |                                                 |   |   |   |
| CO<br>1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Recall basic thermodynamic laws and working principles of Gas Turbines. (Remember)              |                                                 |   |   |   |
| CO<br>2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Discuss the operating principle of centrifugal compressor using velocity triangle. (Understand) |                                                 |   |   |   |
| CO<br>3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Describe the operating principle of axial flow compressor using velocity triangle. (Understand) |                                                 |   |   |   |
| CO<br>4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Discuss the basic theory of axial and radial Turbine. (Understand)                              |                                                 |   |   |   |
| CO<br>5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Discuss Turbine blade cooling(Understand)                                                       |                                                 |   |   |   |
| CO6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Describe Turbine Compressor matching.(Understand)                                               |                                                 |   |   |   |
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                 | Professional Elective (PE)                      |   |   |   |
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                 | 37th Academic Council Meeting held in May 2015. |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                 |                                                 |   |   |   |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                 | INTRODUCTION TO TURBOMACHINERIES                |   |   | 9 |
| Turbomachinery- definition, Classification of Turbomachines, Power absorbing and power producing turbomachines, Centrifugal compressor-components, Axial compressor-components, Single stage and multi stage, subsonic and transonic axial compressors, Radial turbine-components, Axial turbine-single and multistage, Review of basic laws-conservation of mass, momentum and energy, Euler’s turbo machine equation, simple gas turbine cycle, Variation of thrust and SFC with Mach number and altitude for typical turbojet engine |                                                                                                 |                                                 |   |   |   |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                 |           |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>CENTRIFUGAL COMPRESSORS</b>                  | <b>13</b> |
| Work done and pressure rise, impeller, velocity triangle, slip factor, power input factor, Coriolis acceleration, diffuser, compressibility effects, inlet Mach number for impeller and diffuser, prewhirl, Compressor characteristics, non-dimensional quantities, stage pressure ratio, Instability-surge, rotating stall, choking                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                 |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>AXIAL FLOW COMPRESSORS</b>                   | <b>9</b>  |
| Basic operation, stator, rotor, velocity triangle, factors affecting stage pressure ratio, de Haller number, diffusion factor, degree of reaction, radial equilibrium of fluid element, basic design process, estimation of number of stages, considerations in blade design, blade cascade, compressibility effects, axial compressor characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                 |           |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>AXIAL AND RADIAL TURBINES</b>                | <b>9</b>  |
| Elementary theory of axial flow turbines, blade loading coefficient, flow coefficient, degree of reaction, rotor blade loss, Vortex theory-Free vortex design, constant nozzle angle design, choice of blade profile, pitch and chord, rotor blade stresses, Firtree root, limiting factors in turbine design, Radial flow turbine                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                 |           |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>MATCHING OF COMPONENTS AND BLADE COOLING</b> | <b>9</b>  |
| Component characteristics-compressor, turbine, off-design operation, load characteristics, equilibrium running, matching of two turbines in series, turbine blade cooling                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                 |           |
| <b>Text Books:</b> <ol style="list-style-type: none"> <li>1. Ganesan. V, “Gas Turbines”, Tata McGraw Hill Education, 3rd Edition, 2010 (Units 1 to 4)</li> <li>2. Cohen H, Rogers GFC, and Saravanamuttoo HIH, “Gas Turbine Theory” Addison Wesley Longman Limited, 1998 (Unit 5)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                 |           |
| <b>References:</b> <ol style="list-style-type: none"> <li>1. El-Wakil, M M; Powerplant Technology, 1984, McGraw-Hill Pub.</li> <li>2. NASA-SP-290, Axial Flow turbines, 2002 (re-release), NTIS, USA.</li> <li>3. J H Horlock, Axial flow compressors, Butterworths, 1958, UK.</li> <li>4. J H Horlock, Axial Flow Turbines, Butterworths, 1965, UK.</li> <li>5. B Lakshminarayana; Fluid Mechanics and Heat Transfer in turbomachineries, 1995, USA.</li> <li>6. Nicholas Cumpsty, Compressor Aerodynamics, 2004, Kreiger Publications, USA.</li> <li>7. Johnson I.A., Bullock R.O. NASA-SP-36, Axial Flow Compressors, 2002 (re-release), NTIS.</li> <li>8. Ahmed F. El-Sayed; Aircraft Propulsion and Gas Turbine Engines; CRC press, 2008.</li> <li>9. Philip G.Hill and Carl Peterson, " Mechanics and Thermodynamics of Propulsion" International Student Edition, Addison Wesley Longman, Inc, Second Edition, 1999</li> <li>10. Walsh, P.P. and Fletcher, P., “ Gas Turbine Performance” Wiley India Pvt.Ltd., Second Edition, 2004</li> </ol> |                                                 |           |

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| <b>BANE15</b>                                                                                                                                                     | <b>NANO SCIENCE TECHNOLOGY</b>                                                                                                     |                                                        | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|                                                                                                                                                                   | Total Contact Hours – 45                                                                                                           |                                                        | 3        | 0        | 0        | 3        |
|                                                                                                                                                                   | Prerequisite – Engineering Physics, Fundamentals of Structural Mechanics                                                           |                                                        |          |          |          |          |
|                                                                                                                                                                   | Course Designed by – Department of Aeronautical Engineering                                                                        |                                                        |          |          |          |          |
| <b>OBJECTIVES</b>                                                                                                                                                 |                                                                                                                                    |                                                        |          |          |          |          |
| <b>COURSE OUTCOMES</b>                                                                                                                                            |                                                                                                                                    |                                                        |          |          |          |          |
| <b>At the end of Course, Students will be able to,</b>                                                                                                            |                                                                                                                                    |                                                        |          |          |          |          |
| <b>CO 1</b>                                                                                                                                                       | <b>Memorize</b> the fundamentals of nanoscale materials and the scope of nanoscience and technology. <b>(Remember)</b>             |                                                        |          |          |          |          |
| <b>CO 2</b>                                                                                                                                                       | <b>Describe</b> the types of nanostructures and quantum size effects in nanostructures. <b>(Understand)</b>                        |                                                        |          |          |          |          |
| <b>CO 3</b>                                                                                                                                                       | <b>Discuss</b> the synthesis of nanomaterials and methods of nanomaterials preparation. <b>(Understand)</b>                        |                                                        |          |          |          |          |
| <b>CO 4</b>                                                                                                                                                       | <b>Define</b> the Mechanical, optical, electronic, magnetic, thermal and chemical properties of nanomaterials. <b>(Understand)</b> |                                                        |          |          |          |          |
| <b>CO 5</b>                                                                                                                                                       | <b>List</b> the physical properties of nanostructured materials. <b>(Apply)</b>                                                    |                                                        |          |          |          |          |
| <b>Category</b>                                                                                                                                                   |                                                                                                                                    | <b>Professional Elective (PE)</b>                      |          |          |          |          |
| <b>Approval</b>                                                                                                                                                   |                                                                                                                                    | <b>37th Academic Council Meeting held in May 2015.</b> |          |          |          |          |
| <b>COURSE CONTENT</b>                                                                                                                                             |                                                                                                                                    |                                                        |          |          |          |          |
| <b>UNIT I</b>                                                                                                                                                     |                                                                                                                                    | <b>INTRODUCTION</b>                                    |          |          |          | <b>9</b> |
| Introduction to nanoscale materials - atomic & molecular size. Scientific revolutions-nanotechnology application area. Scope of nanoscience and technology        |                                                                                                                                    |                                                        |          |          |          |          |
| <b>UNIT II</b>                                                                                                                                                    |                                                                                                                                    | <b>NANOSTRUCTURES AND DIMENSIONS</b>                   |          |          |          | <b>9</b> |
| Classification of nanostructures-zero, one, two and three dimensional nanostructures. Size Dependency in Nanostructures-quantum size effects in nanostructures.   |                                                                                                                                    |                                                        |          |          |          |          |
| <b>UNIT III</b>                                                                                                                                                   |                                                                                                                                    | <b>NANOMATERIAL SYNTHESIS</b>                          |          |          |          | <b>9</b> |
| Synthesis of nanomaterials-top down and bottom up approach. Method of nanomaterials preparation – wet chemical synthesis-mechanical grinding-gas phase synthesis. |                                                                                                                                    |                                                        |          |          |          |          |

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| <b>UNIT IV</b>                                                                                                                                                                                                                       | <b>NANOMATERIAL PROPERTIES</b>                         | <b>9</b> |
| Surface to volume ratio. Surface properties of nanoparticles. Mechanical, optical, electronic, magnetic, thermal and chemical properties of nanomaterials. Size dependent properties-size dependent absorption spectra.Shape impact. |                                                        |          |
| <b>UNIT V</b>                                                                                                                                                                                                                        | <b>PHYSICAL PROPERTIES OF NANOSTRUCTURED MATERIALS</b> | <b>9</b> |
| Quantum dots-optical properties and applications. Carbon nanotubes-physical properties and applications. Magnetic behavior of nanomaterials. Electronic transport in quantum wires.                                                  |                                                        |          |
| <b>TEXTBOOKS:</b>                                                                                                                                                                                                                    |                                                        |          |
| 1. T. Pradeep, “Nano the Essential Nanoscience and Nanotechnology”, Tata McGraw hill, 2007.                                                                                                                                          |                                                        |          |
| <b>REFERENCES:</b>                                                                                                                                                                                                                   |                                                        |          |
| 1. Charles P. Poole, Frank J. Owens, “Introduction to Nanotechnology”, Wiley Interscience, 2003.                                                                                                                                     |                                                        |          |
| 2. Mark A. Ratner, Daniel Ratner, “Nanotechnology: A gentle introduction to the next Big Idea”, Prentice Hall<br>P7R:1st Edition, 2002.                                                                                              |                                                        |          |
| 3. J. Dutta, H. Hoffmann, “Nanomaterials”, Topnano-21, 2003.                                                                                                                                                                         |                                                        |          |
| 4. Mick Wilson, Kamali Kannargare., Geoff Smith, “Nano technology: Basic Science and Emerging technologies”, Overseas Press, 2005.                                                                                                   |                                                        |          |
| <b>WEBLINKS:</b>                                                                                                                                                                                                                     |                                                        |          |
| <a href="https://www.edx.org/learn/nanotechnology">https://www.edx.org/learn/nanotechnology</a>                                                                                                                                      |                                                        |          |

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| BANE16                                                                                                                                                                                                                                                                     | UNMANNED AERIAL VEHICLE                                                                                |                                                 | L | T | P | C |
|                                                                                                                                                                                                                                                                            | Total Contact Hours – 45                                                                               |                                                 | 3 | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                                            | Prerequisite – Fundamentals of Aeronautics and Astronautics, Flight Mechanics                          |                                                 |   |   |   |   |
|                                                                                                                                                                                                                                                                            | Course Designed by – Department of Aeronautical Engineering                                            |                                                 |   |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                                                 |                                                                                                        |                                                 |   |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                                            |                                                                                                        |                                                 |   |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                            |                                                                                                        |                                                 |   |   |   |   |
| CO 1                                                                                                                                                                                                                                                                       | Discuss theunmanned aircraft systems and their selection criteria. (Understand)                        |                                                 |   |   |   |   |
| CO 2                                                                                                                                                                                                                                                                       | Explain the aerodynamics and airframe configurations of UAV. (Understand)                              |                                                 |   |   |   |   |
| CO 3                                                                                                                                                                                                                                                                       | List the different types of UAVs and their performance parameters. (Apply)                             |                                                 |   |   |   |   |
| CO 4                                                                                                                                                                                                                                                                       | Discuss the various communication and navigation systems used in UAVs. (Understand)                    |                                                 |   |   |   |   |
| CO 5                                                                                                                                                                                                                                                                       | Describe the concept behind the operation of Horizontal Takeoff and landing of aircrafts. (Understand) |                                                 |   |   |   |   |
| Category                                                                                                                                                                                                                                                                   |                                                                                                        | Professional Elective (PE)                      |   |   |   |   |
| Approval                                                                                                                                                                                                                                                                   |                                                                                                        | 37th Academic Council Meeting held in May 2015. |   |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                                             |                                                                                                        |                                                 |   |   |   |   |
| UNIT I                                                                                                                                                                                                                                                                     |                                                                                                        | INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS       |   |   |   | 9 |
| The Systemic Basis of UAS-System Composition- Conceptual Phase-Preliminary Design-Selection of the System- Some Applications of UAS                                                                                                                                        |                                                                                                        |                                                 |   |   |   |   |
| UNIT II                                                                                                                                                                                                                                                                    |                                                                                                        | AERODYNAMICS AND AIRFRAME CONFIGURATIONS        |   |   |   | 9 |
| Lift-induced Drag - Parasitic Drag - Rotary-wing Aerodynamics - Response to Air Turbulence - Airframe Configurations Scale Effects - Packaging Density – Aerodynamics - Structures and Mechanisms - Selection of power-plants - Modular Construction - Ancillary Equipment |                                                                                                        |                                                 |   |   |   |   |
| UNIT III                                                                                                                                                                                                                                                                   |                                                                                                        | CHARACTERISTICS OF AIRCRAFT TYPES               |   |   |   | 9 |

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| Long-endurance, Long-range Role Aircraft – Medium-range, Tactical Aircraft - Close-range/Battlefield Aircraft - MUAV Types - MAV and NAV Types - UCAV - Novel Hybrid Aircraft Configurations - Research UAV                                                                                                                           |                                  |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                        | <b>COMMUNICATIONS NAVIGATION</b> | <b>9</b> |
| Communication Media - Radio Communication - Mid-air Collision (MAC) Avoidance - Communications Data Rate and Bandwidth Usage - Antenna Types NAVSTAR Global Positioning System (GPS) - TACAN - LORAN C - Inertial Navigation - Radio Tracking - Way-point Navigation                                                                  |                                  |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                         | <b>CONTROL AND STABILITY</b>     | <b>9</b> |
| HTOL Aircraft - Helicopters - OTE/OTE/SPH - Convertible Rotor Aircraft - Payload Control - Sensors -culmon filter- Autonomy                                                                                                                                                                                                           |                                  |          |
| <b>Text Books:</b><br>1. Reg Austin., Unmanned Aircraft Systems, John Wiley and Sons., 2010                                                                                                                                                                                                                                           |                                  |          |
| <b>References:</b><br>1. Milman & Halkias, “Integrated Electronics”, McGraw Hill, 1999.<br>2. Malvino & Leach, “Digital Principles & Applications”, McGraw Hill, 1986<br>3. Collinson R.P.G, “Introduction to Avionics”, Chapman and Hall, India, 1996<br>4. BernadEtkin, “Dynamic of flight stability and control”, John Wiley, 1972 |                                  |          |

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| BANE17                                                                                                                                                                                                                                                                                                            | BOUNDARY LAYER THEORY                                                                                                       |                                                 | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                   | Total Contact Hours – 45                                                                                                    |                                                 | 3 | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                                                                                   | Prerequisite – Maths                                                                                                        |                                                 |   |   |   |   |
|                                                                                                                                                                                                                                                                                                                   | Course Designed by – Department of Aeronautical Engineering                                                                 |                                                 |   |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                                                                                        |                                                                                                                             |                                                 |   |   |   |   |
| 1. To acquaint with the fundamentals of viscous flow.<br>2. To learn the different regime of viscous flow and its solution.<br>3. To understand the concept of laminar boundary layer.<br>4. To understand the concept of turbulent boundary layer.<br>5. To acquaint the concept of compressible boundary layer. |                                                                                                                             |                                                 |   |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                   |                                                                                                                             |                                                 |   |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                   |                                                                                                                             |                                                 |   |   |   |   |
| CO 1                                                                                                                                                                                                                                                                                                              | Recall the fundamental equations of viscous flow and basics of boundary layer theory. (Understand)                          |                                                 |   |   |   |   |
| CO 2                                                                                                                                                                                                                                                                                                              | Discuss the solutions of simplified viscous flow equations. (Understand)                                                    |                                                 |   |   |   |   |
| CO 3                                                                                                                                                                                                                                                                                                              | Discuss the equations and methods used for solving the flow field of laminar boundary layer over a flat plate. (Understand) |                                                 |   |   |   |   |
| CO 4                                                                                                                                                                                                                                                                                                              | Describe the basics of Turbulent boundary layer. (Understand)                                                               |                                                 |   |   |   |   |
| CO 5                                                                                                                                                                                                                                                                                                              | Describe the basics of Compressible boundary layer. (Understand)                                                            |                                                 |   |   |   |   |
| Category                                                                                                                                                                                                                                                                                                          |                                                                                                                             | Professional Elective (PE)                      |   |   |   |   |
| Approval                                                                                                                                                                                                                                                                                                          |                                                                                                                             | 37th Academic Council Meeting held in May 2015. |   |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                    |                                                                                                                             |                                                 |   |   |   |   |
| UNIT I                                                                                                                                                                                                                                                                                                            |                                                                                                                             | FUNDAMENTAL EQUATIONS OF VISCOUS FLOW           |   |   |   | 9 |
| Fundamental equations of viscous flow, Conservation of mass, Conservation of Momentum-Navier-Stokes equations, Energy equation, Mathematical character of basic equations, Dimensional parameters in viscous flow, Non dimensionalising the basic equations and boundary conditions, vorticity                    |                                                                                                                             |                                                 |   |   |   |   |

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| considerations, creeping flow, boundary layer flow                                                                                                                                                                                                                                                                                                                                                                                                                                |                                              |          |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>SOLUTIONS OF VICOUS FLOW EQUATIONS</b>    | <b>9</b> |
| Solutions of viscous flow equations, Couette flows, Hagen-Poiseuille flow, Flow between rotating concentric cylinders, Combined Couette-Poiseuille Flow between parallel plates, Creeping motion, Stokes solution for an immersed sphere, Development of boundary layer, Displacement thickness, momentum and energy thickness.                                                                                                                                                   |                                              |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>LAMINAR BOUNDARY LAYER EQUATIONS</b>      | <b>9</b> |
| Laminar boundary layer equations, Flat plate Integral analysis of Karman – Integral analysis of energy equation – Laminar boundary layer equations – boundary layer over a curved body-Flow separation-similarity solutions, Blasius solution for flat-plate flow, Falkner–Skan wedge flows, Boundary layer temperature profiles for constant plate temperature –Reynold's analogy, Integral equation of Boundary layer – Pohlhausen method – Thermal boundary layer calculations |                                              |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>TURBULENT BOUNDARY LAYER EQUATIONS</b>    | <b>9</b> |
| Turbulence-physical and mathematical description, Two-dimensional turbulent boundary layer equations — Velocity profiles – The law of the wall – The law of the wake – Turbulent flow in pipes and channels – Turbulent boundary layer on a flat plate – Boundary layers with pressure gradient, Eddy Viscosity, mixing length , Turbulence modeling                                                                                                                              |                                              |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>COMPRESSIBLE BOUNDARY LAYER EQUATIONS</b> | <b>9</b> |
| Compressible boundary layer equations, Recovery factor, similarity solutions, laminar supersonic Cone rule, shock-boundary layer interaction                                                                                                                                                                                                                                                                                                                                      |                                              |          |
| <b>Text Books:</b><br>1. White, F. M., Viscous Fluid Flow, McGraw-Hill & Co., Inc., New York, 2005.                                                                                                                                                                                                                                                                                                                                                                               |                                              |          |
| <b>References:</b><br>1. Schlichting, H., Boundary Layer Theory, McGraw-Hill, New York, 2000.<br>2. Reynolds, A, J., Turbulent Flows Engineering, John Wiley and Sons, 1980.                                                                                                                                                                                                                                                                                                      |                                              |          |

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| BANE18                                                                                                                                                                                                                                                 | FATIGUE AND FRACTURE MECHANICS                                                                         | L                                               | T | P | C |
|                                                                                                                                                                                                                                                        | Total Contact Hours – 45                                                                               | 3                                               | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                        | Prerequisite – Fundamentals of Structural Mechanics                                                    |                                                 |   |   |   |
|                                                                                                                                                                                                                                                        | Course Designed by – Department of Aeronautical Engineering                                            |                                                 |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                             |                                                                                                        |                                                 |   |   |   |
| 1. To familiarize the student about the basic terminologies of fatigue and fracture mechanics.                                                                                                                                                         |                                                                                                        |                                                 |   |   |   |
| 2. To enable the student to grasp the various statistical tools used in fatigue analysis.                                                                                                                                                              |                                                                                                        |                                                 |   |   |   |
| 3. To acquaint the student about the physical processes taking place during fatigue.                                                                                                                                                                   |                                                                                                        |                                                 |   |   |   |
| 4. To introduce to the student about the mechanism taking place during fracture.                                                                                                                                                                       |                                                                                                        |                                                 |   |   |   |
| 5. To make the student realize about the importance of fatigue and fracture mechanics in aerospace industry.                                                                                                                                           |                                                                                                        |                                                 |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                        |                                                                                                        |                                                 |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                        |                                                                                                        |                                                 |   |   |   |
| CO<br>1                                                                                                                                                                                                                                                | Calculate the stress concentration in structures subjected to fatigue loads. (Analyze)                 |                                                 |   |   |   |
| CO<br>2                                                                                                                                                                                                                                                | Describe statistical methods to determine the strain in structures under fatigue loading. (Understand) |                                                 |   |   |   |
| CO<br>3                                                                                                                                                                                                                                                | Describe various stages of failures due to fatigue load. (Understand)                                  |                                                 |   |   |   |
| CO<br>4                                                                                                                                                                                                                                                | Determine stress in cracked structures. (Apply)                                                        |                                                 |   |   |   |
| CO<br>5                                                                                                                                                                                                                                                | Design composite material-based structures subjected to fatigue load which are fail-safe. (Create)     |                                                 |   |   |   |
| Category                                                                                                                                                                                                                                               |                                                                                                        | Professional Elective (PE)                      |   |   |   |
| Approval                                                                                                                                                                                                                                               |                                                                                                        | 37th Academic Council Meeting held in May 2015. |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                         |                                                                                                        |                                                 |   |   |   |
| UNIT I                                                                                                                                                                                                                                                 |                                                                                                        | FATIGUE OF STRUCTURES                           |   |   | 9 |
| S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber’s stress concentration factors - Plastic stress concentration factors - Notched S.N. curves. |                                                                                                        |                                                 |   |   |   |
| UNIT II                                                                                                                                                                                                                                                |                                                                                                        | STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR        |   |   | 9 |
| Low cycle and high cycle fatigue - Coffin - Manson’s relation - Transition life - cyclic strain hardening and                                                                                                                                          |                                                                                                        |                                                 |   |   |   |

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| softening - Analysis of load histories - Cycle counting techniques -Cumulative damage - Miner's theory - <b>Other theories.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                    |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>PHYSICAL ASPECTS OF FATIGUE</b> | <b>9</b> |
| Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                    |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>FRACTURE MECHANICS</b>          | <b>9</b> |
| <b>Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Irwin extension of Griffith's theory to ductile materials - stress analysis of "cracked bodies - Effect of thickness on fracture toughness - stress intensity factors for typical geometries.</b>                                                                                                                                                                                                                                                                                                        |                                    |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>FATIGUE DESIGN AND TESTING</b>  | <b>9</b> |
| <b>Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                    |          |
| <b>TEXTBOOKS:</b><br>1. Matej Billy, "Cyclic Deformation and Fatigue of Metals", Elsevier Science Ltd., 1993. (Units 1 to 3)<br>2. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India, 2009. (Unit 4)<br>3. Barrois W, Ripely, E.L., "Fatigue of aircraft structure", Pergamon press. Oxford, 1983 (Unit 5)                                                                                                                                                                                                                                                                |                                    |          |
| <b>REFERENCES:</b><br>1. K. R.Y. Simha, Fracture Mechanics for Modern Engineering Design, Universities Press (India) Limited, 2001<br>2. D. Broek, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, Dordrecht, 1986.<br>3. T.L. Anderson, Fracture Mechanics - Fundamentals and Applications, 3rd Edition, Taylor and Francis Group, 2005<br><b>WEBLINKS:</b><br><a href="https://ocw.mit.edu/courses/materials-science-and-engineering/3-35-fracture-and-fatigue-fall-2003/">https://ocw.mit.edu/courses/materials-science-and-engineering/3-35-fracture-and-fatigue-fall-2003/</a> |                                    |          |

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| <b>BANE19</b>                                                                                                                                                                                                                                                                                                                                                                      | <b>HIGH TEMPERATURE MATERIALS</b>                                                                                                            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|                                                                                                                                                                                                                                                                                                                                                                                    | Total Contact Hours – 45                                                                                                                     | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |
|                                                                                                                                                                                                                                                                                                                                                                                    | Prerequisite – Fundamentals of Structural Mechanics                                                                                          |          |          |          |          |
|                                                                                                                                                                                                                                                                                                                                                                                    | Course Designed by – Department of Aeronautical Engineering                                                                                  |          |          |          |          |
| <b>OBJECTIVES</b>                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                              |          |          |          |          |
| 1. To acquaint the student with the fundamentals of creep.<br>2. To make the student understand about design with creep resistance.<br>3. To familiarize the student about fracture, cracks and their mechanics.<br>4. To introduce to the student about oxidation and corrosion in hot environments.<br>5. To acquaint the student with various super alloys and other materials. |                                                                                                                                              |          |          |          |          |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                              |          |          |          |          |
| <b>At the end of Course, Students will be able to,</b>                                                                                                                                                                                                                                                                                                                             |                                                                                                                                              |          |          |          |          |
| <b>CO<br/>1</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>Discuss</b> the effect of creep on the functional life of components. <b>(Understand)</b>                                                 |          |          |          |          |
| <b>CO<br/>2</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>Explain</b> the creep resistance of ductile and brittle materials. <b>(Understand)</b>                                                    |          |          |          |          |
| <b>CO<br/>3</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>Describe</b> the effect of different alloys and oxides materials behaviour from low temperature to high temperature . <b>(Understand)</b> |          |          |          |          |
| <b>CO<br/>4</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>Discuss</b> the fracture mechanism maps for different alloys and oxides. <b>(Understand)</b>                                              |          |          |          |          |
| <b>CO<br/>5</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>Describe</b> the process of oxidation and different oxidations prevention techniques. <b>(Understand)</b>                                 |          |          |          |          |
| <b>CO<br/>6</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>Discuss</b> the various types of super alloys and its strengthening mechanisms. <b>(Understand)</b>                                       |          |          |          |          |
| <b>Category</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>Professional Elective (PE)</b>                                                                                                            |          |          |          |          |
| <b>Approval</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>37th Academic Council Meeting held in May 2015.</b>                                                                                       |          |          |          |          |
| <b>COURSE CONTENT</b>                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                              |          |          |          |          |
| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                                                                                      | <b>CREEP</b>                                                                                                                                 |          |          |          | <b>9</b> |
| Factors influencing functional life of components at elevated temperatures, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate.                                                                                                                                                   |                                                                                                                                              |          |          |          |          |

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| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                               | <b>DESIGN FOR CREEP RESISTANCE</b>      | <b>9</b> |
| Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monkman-Grant relationship.                                                                                                                                                                                                                                |                                         |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                              | <b>FRACTURE</b>                         | <b>9</b> |
| Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage fracture, and ductile fracture due to micro void coalescence-diffusion controlled void growth; fracture maps for different alloys and oxides.                                                                                                                                               |                                         |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                               | <b>OXIDATION AND HOT CORROSION</b>      | <b>9</b> |
| Oxidation, Pilling, Bedworth ratio, kinetic laws of oxidation- defect structure and control of oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion, interaction of hot corrosion and creep, methods of combat hot corrosion.                                                               |                                         |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                | <b>SUPER ALLOYS AND OTHER MATERIALS</b> | <b>9</b> |
| Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase, embrittlement, solidification of single crystals, Intermetallics, high temperature ceramics.                                                                                                        |                                         |          |
| <b>Text Books:</b> <ol style="list-style-type: none"> <li>1. Raj. R., "Flow and Fracture at Elevated Temperatures", American Society for Metals, USA, 1985.</li> <li>2. Hertzberg R. W., "Deformation and Fracture Mechanics of Engineering materials", 4th Edition, John Wiley, USA, 1996.</li> <li>3. Courtney T.H, "Mechanical Behavior of Materials", McGraw-Hill, USA, 1990.</li> </ol> |                                         |          |
| <b>References:</b> <ol style="list-style-type: none"> <li>1. Boyle J.T, Spencer J, "Stress Analysis for Creep", Butterworths, UK, 1983.</li> <li>2. Bressers. J., "Creep and Fatigue in High Temperature Alloys", Applied Science, 1981.</li> <li>3. McLean D., "Directionally Solidified Materials for High Temperature Service", The Metals Society, USA, 1985.</li> </ol>                 |                                         |          |



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| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>AERODYNAMICS THEORY &amp; WIND TURBINE TYPES</b>                          | <b>9</b> |
| Airfoil terminology, Blade element theory, Blade design, Rotor performance and dynamics, Balancing technique (Rotor & Blade), Types of loads; Sources of loads Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator                                                                                                                                            |                                                                              |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>GEAR COUPLED GENERATOR WIND TURBINE COMPONENTS AND THEIR CONSTRUCTION</b> | <b>9</b> |
| Electronics Sensors /Encoder /Resolvers, Wind Measurement : Anemometer & Wind Vane, Grid Synchronization System, Soft Starter, Switchgear [ACB/VCB], Transformer, Cables and assembly, Compensation Panel, Programmable Logic Control, UPS, Yaw & Pitch System : AC Drives, Safety Chain Circuits, Generator Rotor Resistor controller (Flexi Slip), Differential Protection Relay for Generator, Battery/Super Capacitor Charger & Batteries/ Super Capacitor for Pitch System, Transient Suppressor / Lightning Arrestors, Oscillation & Vibration sensing. |                                                                              |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>DIRECT ROTOR COUPLED GENERATOR</b>                                        | <b>9</b> |
| Excited Rotor Synch. Generator / PMG Generator, Control Rectifier, Capacitor Banks, Step Up / Boost Converter (DC-DC Step Up), Grid Tied Inverter, Power Management, Grid Monitoring Unit (Voltage and Current), Transformer, Safety Chain Circuits                                                                                                                                                                                                                                                                                                           |                                                                              |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>MODERN WIND TURBINE CONTROL &amp; MONITORING SYSTEM</b>                   | <b>9</b> |
| Details of Pitch System & Control Algorithms, Protections used & Safety Consideration in Wind turbines, Wind Turbine Monitoring with Error codes, SCADA & Databases: Remote Monitoring and Generation Reports, Operation & Maintenance for Product Life Cycle, Balancing technique (Rotor & Blade), FACTS control & LVRT & New trends for new Grid Codes.                                                                                                                                                                                                     |                                                                              |          |
| <b>Text Books:</b><br>1. Kaldellis J.K, Standalone and Hybrid Wind Energy Systems, CRC Press, 2010<br>2. Mario Garcia –Sanz, Constantine H. Houppis, Wind Energy Systems, CRC Press 2012                                                                                                                                                                                                                                                                                                                                                                      |                                                                              |          |
| <b>References:</b><br>1. Freris, L.L., Wind Energy Conversion Systems, Prentice Hall, 1990<br>2. Spera, D.A., Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press, 1994.<br>3. Duffie, A and Beckmann, W. A., Solar Engineering of Thermal Processes, John Wiley, 1991.<br>4. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, 1996.                                                                                                                                               |                                                                              |          |

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| BANE21                                                                                                                                                                                                                                                                                           | SATELLITE TECHNOLOGY                                                                    |                                                 | L | T | P | C |
|                                                                                                                                                                                                                                                                                                  | Total Contact Hours – 45                                                                |                                                 | 3 | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                                                                  | Prerequisite – Basic Electrical and Electronics, Engineering Mechanics                  |                                                 |   |   |   |   |
|                                                                                                                                                                                                                                                                                                  | Course Designed by – Department of Aeronautical Engineering                             |                                                 |   |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                                                                       |                                                                                         |                                                 |   |   |   |   |
| 1. To introduce to the student about different types of satellites and their functions                                                                                                                                                                                                           |                                                                                         |                                                 |   |   |   |   |
| 2. To accustom the student to the governing equations of motion and orbital mechanics                                                                                                                                                                                                            |                                                                                         |                                                 |   |   |   |   |
| 3. To acquaint the student to the structure of the satellites and the components used and their thermal protection                                                                                                                                                                               |                                                                                         |                                                 |   |   |   |   |
| 4. To familiarize the student about the control system for spacecraft                                                                                                                                                                                                                            |                                                                                         |                                                 |   |   |   |   |
| 5. To enable the student to understand about the power system in a satellite and the various bus electronics used                                                                                                                                                                                |                                                                                         |                                                 |   |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                  |                                                                                         |                                                 |   |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                  |                                                                                         |                                                 |   |   |   |   |
| CO 1                                                                                                                                                                                                                                                                                             | Discuss the basics of satellites and its system's functions. (Understand)               |                                                 |   |   |   |   |
| CO 2                                                                                                                                                                                                                                                                                             | Describe the fundamentals of orbital mechanics and the coordinate systems. (Understand) |                                                 |   |   |   |   |
| CO 3                                                                                                                                                                                                                                                                                             | Analyze the satellite structures and thermal protection systems. (Analyze)              |                                                 |   |   |   |   |
| CO 4                                                                                                                                                                                                                                                                                             | Express the attitude controls and its stabilization schemes. (Understand)               |                                                 |   |   |   |   |
| CO 5                                                                                                                                                                                                                                                                                             | Summarize various types of power systems and bus electronics. (Understand)              |                                                 |   |   |   |   |
| Category                                                                                                                                                                                                                                                                                         |                                                                                         | Professional Elective (PE)                      |   |   |   |   |
| Approval                                                                                                                                                                                                                                                                                         |                                                                                         | 37th Academic Council Meeting held in May 2015. |   |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                                                                   |                                                                                         |                                                 |   |   |   |   |
| UNIT I                                                                                                                                                                                                                                                                                           |                                                                                         | INTRODUCTION TO SATELLITE SYSTEMS               |   |   |   | 9 |
| Common satellite applications and missions – Typical spacecraft orbits – Definitions of spin the three axis stabilization-Space environment – Launch vehicles – Satellite system and their functions (structure, thermal, mechanisms, power, propulsion, guidance and control, bus electronics). |                                                                                         |                                                 |   |   |   |   |
| UNIT II                                                                                                                                                                                                                                                                                          |                                                                                         | ORBITAL MECHANICS                               |   |   |   | 9 |
| Fundamental of flight dynamics – Time and coordinate systems – Orbit determination and prediction – Orbital maneuvers – GPS systems and application for satellite/orbit determination – Ground station network requirements.                                                                     |                                                                                         |                                                 |   |   |   |   |
| UNIT III                                                                                                                                                                                                                                                                                         |                                                                                         | SATELLITE STRUCTURES & THERMAL CONTROL          |   |   |   | 9 |

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| Satellite mechanical and structural configuration: Satellite configuration choices, launch loads, separation induced loads, deployment requirements – Design and analysis of satellite structures – Structural materials and fabrication – The need of thermal control: externally induced thermal environment – Internally induced thermal environment - Heat transfer mechanism: internal to the spacecraft and external heat load variations – Thermal control systems: active and passive methods. |                                         |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>SPACECRAFT CONTROL</b>               | <b>9</b> |
| Control requirements: attitude control and station keeping functions, type of control maneuvers – Stabilization schemes: spin stabilization, gravity gradient methods, 3 axis stabilization – Commonly used control systems: mass expulsion systems, momentum exchange systems, gyro and magnetic torque - Sensors star and sun sensors, earth sensor, magnetometers and inertial sensors                                                                                                              |                                         |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>POWER SYSTEM AND BUS ELECTRONICS</b> | <b>9</b> |
| Solar panels: Silicon and Ga-As cells, power generation capacity, efficiency – Space battery systems – battery types, characteristics and efficiency parameters – Power electronics. Telemetry and telecommand systems: Tm & TC functions, generally employed communication bands (UHF/VHF, S, L, Ku, Ka etc), their characteristics and applications- Coding Systems – Onboard computer- Ground checkout Systems.                                                                                     |                                         |          |
| <b>Text Books:</b><br>1. Spacecraft Thermal Control, Hand Book, Aerospace Press, 2002.<br>2. Introduction Space Flight, Francis J. Hale Prentice Hall, 1994.                                                                                                                                                                                                                                                                                                                                           |                                         |          |
| <b>References:</b><br>1. Analysis and Design of Flight Vehicle Structures, Tri-State off set company, USA, 1980.<br>2. Space Systems Engineering Rilay, FF, McGraw Hill, 1982.<br>3. Principles of Astronautics Vertregt. M., Elsevier Publishing Company, 1985<br>4.Space Communications Systems, Richard.F, Filipowsky Eugen I Muehllorf Prentice Hall, 1995<br>5. Space Vehicle Design, Michael D. Griffin and James R. French, AIAAEducation Series, 1991.                                         |                                         |          |

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| <b>BANE22</b> | <b>AIRCRAFT RULES AND REGULATIONS<br/>CAR I &amp; II</b>    | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|               | Total Contact Hours – 45                                    | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |
|               | Prerequisite – Professional Courses                         |          |          |          |          |
|               | Course Designed by – Department of Aeronautical Engineering |          |          |          |          |

**OBJECTIVE:**

1. To familiarize the student about the CAR series A & B.
2. To familiarize the student about the CAR series C & D.
3. To familiarize the student about the CAR series E & F.
4. To familiarize the student about the CAR series L & M.
5. To familiarize the student about the CAR series T & X.

## COURSE OUTCOMES

**At the end of Course, Students will be able to,**

|      |                                                                                                                                                |
|------|------------------------------------------------------------------------------------------------------------------------------------------------|
| CO 1 | <b>Identify</b> the aircraft airworthiness and to list the responsibilities of owners/operators. <b>(Understand)</b>                           |
| CO 2 | <b>Discuss</b> the procedures involved in defect recording, monitoring, investigation, reporting and maintenance Programs. <b>(Understand)</b> |
| CO 3 | <b>Explain</b> the procedures of approval for aircraft manufacturing and maintenance industries. <b>(Understand)</b>                           |
| CO 4 | <b>Outline</b> the procedures followed to conduct AME examinations and license issue. <b>(Analyze)</b>                                         |
| CO 5 | <b>Discuss</b> the procedures followed in flight testing of aircrafts and the miscellaneous requirements. <b>(Understand)</b>                  |

|                 |                                                        |
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| <b>Category</b> | <b>Professional Elective (PE)</b>                      |
| <b>Approval</b> | <b>37th Academic Council Meeting held in May 2015.</b> |

## COURSE CONTENT

|               |                                 |          |
|---------------|---------------------------------|----------|
| <b>UNIT I</b> | <b>CAR SERIES “A” &amp; “B”</b> | <b>9</b> |
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C.A.R series 'A' - procedure for civil air worthiness Requirements and responsibility operators vis-a-vis Air Worthiness directorate - Responsibilities of operators/owners; procedure of CAR issue, amendments etc; objectives and targets of airworthiness directorate; airworthiness regulations and safety oversight of engineering activities of operations.

C.A.R. series “B” – issue approval of cockpit check list, MEL, CDL - Deficiency list (MEL & CDL); preparation and use of cockpit check list and emergency check list.

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| <b>UNIT II</b> | <b>CAR SERIES “C” &amp; “D”</b> | <b>9</b> |
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|-------------------------------------------------------------------------------|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C.A.R. series 'C' - defect recording, monitoring, investigation and reporting | - | Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings & recordings; Maintenance control by reliability Method. |
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C.A.R. series 'D'-aircraft maintenance Programs - Reliability Program (Engines); Aircraft maintenance

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                 |          |
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| Program& their approval - On condition maintenance of reciprocating engines; TBO - Revision Program; Maintenance of fuel and oil uplift and consumption records - Light aircraft engines; Fixing routine maintenance periods and component TBOs - Initial & revisions.                                                                                                                                                                                                                                                                                                                                                                                             |                                 |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>CAR SERIES “E” &amp; “F”</b> | <b>9</b> |
| C.A.R. series 'E' - approval of organizations - Approval of organizations in categories A, B, C, D, E, F, & G; Requirements of infrastructure at stations other than parent base.<br>C.A.R. series 'F' - air worthiness and continued air worthiness - Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness                                                                                                                                              |                                 |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>CAR SERIES “L” &amp; “M”</b> | <b>9</b> |
| C.A.R. series 'L' - aircraft maintenance engineer – licensing - Issue of AME License, its classification and experience requirements, Complete Series 'L'.<br>C.A.R. series 'M' Mandatory Modifications / Inspections.                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                 |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>CAR SERIES “T” &amp; “X”</b> | <b>9</b> |
| C.A.R. series 'T' - flight testing of aircraft - Flight testing of (Series) aircraft for issue of C of A; Flight testing of aircraft for which C or A had been previously issued.<br>C.A.R. series 'X' - miscellaneous requirements - Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use of furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of taxi permit; Procedure for issue of type approval of aircraft components and equipment including instruments. |                                 |          |
| <b>TEXTBOOKS:</b><br>1. " Aircraft Manual (India) ", The English Book Store, 17-1, Connaught Circus, New Delhi.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                 |          |
| <b>REFERENCES:</b><br>1. " Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness) ", Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi.<br>2. "Aeronautical Information Circulars (relating to Airworthiness) ", from DGCA Advisory Circulars ", form DGCA.                                                                                                                                                                                                                                                                                                                                                        |                                 |          |
| <b>WEBLINKS:</b><br><a href="https://dgca.gov.in/digigov-portal/">https://dgca.gov.in/digigov-portal/</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                 |          |

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| <b>BBA001</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>PRINCIPALS OF MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR</b>                                                    |  | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Total Contact Hours – 45                                                                                        |  | 3        | 0        | 0        | 3        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Prerequisite – Professional Courses                                                                             |  |          |          |          |          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Course Designed by – Department of Management Studies                                                           |  |          |          |          |          |
| <b>OBJECTIVES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                 |  |          |          |          |          |
| 1. To acquaint the student about the management, various types of management function and structure.<br>2. To give insight of various methods of management of organization and managerial aspects.<br>3. To acquaint the student with various functions of organizational behavior.<br>4. To get exposure regarding its applications and recent developments of group dynamics and trade union<br>5. To help the student understand about the professional ethics and social responsibilities. |                                                                                                                 |  |          |          |          |          |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                 |  |          |          |          |          |
| <b>At the end of Course, Students will be able to,</b>                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                 |  |          |          |          |          |
| <b>CO 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Describe</b> the structure of management and the functions of each department. <b>(Remember)</b>             |  |          |          |          |          |
| <b>CO 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Understand</b> business, trading, partnership and methods to overcome pitfalls. <b>(Understand)</b>          |  |          |          |          |          |
| <b>CO 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Analyze</b> the causes of accidents and the minimization methods. <b>(Analyze)</b>                           |  |          |          |          |          |
| <b>CO 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Explain</b> Organizational behavior and factors influencing personality. <b>(Understand)</b>                 |  |          |          |          |          |
| <b>CO 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Define</b> group, Communication, Barriers and factors contributing effective leadership. <b>(Understand)</b> |  |          |          |          |          |
| <b>CO 6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Summarize</b> the various ethics to be followed in different workplace. <b>(Understand)</b>                  |  |          |          |          |          |
| <b>Category</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Professional Elective (PE)</b>                                                                               |  |          |          |          |          |
| <b>Approval</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>37th Academic Council Meeting held in May 2015.</b>                                                          |  |          |          |          |          |
| <b>COURSE CONTENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                 |  |          |          |          |          |
| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>MANAGEMENT FUNCTIONS &amp; STRUCTURE</b>                                                                     |  |          |          |          | <b>9</b> |
| Management – Definition – Basic Function – Contribution of Taylor & Fayol. Types of structure – Line, staff, Functional, Committee, and Project & Matrix – Structures. Departmentalization – Centralization – Decentralization – span of control. Management By Objectives – Management By Exception.                                                                                                                                                                                           |                                                                                                                 |  |          |          |          |          |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>MANAGEMENT OF ORGANISATION</b>                                                                               |  |          |          |          | <b>9</b> |
| Forms of Business / Industrial Ownership – Sole Trader, Partnership, Company, Performance Appraisal – Basic Principles – Pitfalls – Methods to Overcome. Industrial Safety – Causes of Accidents – Cost of Accident – How to minimize Accidents. Plant Layout & Maintenance – Need, Types & Managerial Aspects.                                                                                                                                                                                 |                                                                                                                 |  |          |          |          |          |

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| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                         | <b>ORGANISATIONAL BEHAVIOUR</b> | <b>9</b> |
| OB – Definition – Nature & Scope – <b>Contributing Disciplines</b> – Importance of OB to Managers. Personality – <b>Definition – Theories – Factors Influencing Personality. Motivation – Definition – Theories.</b> Theory X & Y – Transactional Analysis. Morale & Job Satisfaction – Factors Influencing Job Satisfaction.                           |                                 |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                          | <b>GROUP DYNAMICS</b>           | <b>9</b> |
| Group – <b>Definition – Types</b> – Determinants of Group Cohesiveness – Communication – <b>Process – Barriers</b> – Effective Communication. Leadership Theories – <b>Factors Contributing to Effective Leadership</b> – Role of Trade Union in Organizations – Functions of Trade Union – <b>Why Trade Union is required?</b> – Types of Trade Union. |                                 |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                           | <b>PROFESSIONAL ETHICS</b>      | <b>9</b> |
| Ethics in Workplace – Formulation of Ethics – Managerial Ethics – Managing Ethical Behaviour – Codes of Ethics – <b>Encouraging Ethical Behaviour</b> – Social Responsibility – <b>Spirituality.</b>                                                                                                                                                    |                                 |          |
| <b>Text Books:</b><br>1. Gupta C.B., Management Theory and Practice, 14th Edition, Sultan Chand & Sons, 2009.<br>2. Dr. Prasad L.M., Principle & Practice of Management, 7th Edition, Sultan Chand & Sons, 2008.                                                                                                                                        |                                 |          |
| <b>References:</b><br>1. Aswathappa, Organizational Behaviour, 8th Edition, Himalaya Publishing House, 2010.<br>2. Dr. Prasad L.M., Organizational Behaviour, 4th Edition, Sultan Chand & Sons, 2008.<br>3. Harold Koontz, Principles of Management, 1st Edition, Tata McGraw Hill, 2004.                                                               |                                 |          |

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| BANE23                                                                                                                                                                                                                                                                                                                                                                                            | AIRPORT MANAGEMENT                                                                                    |                                                 | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                   | Total Contact Hours – 45                                                                              |                                                 | 3 | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                                                                                                                                                                   | Prerequisite – Professional Courses                                                                   |                                                 |   |   |   |   |
|                                                                                                                                                                                                                                                                                                                                                                                                   | Course Designed by – Department of Aeronautical Engineering                                           |                                                 |   |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                       |                                                 |   |   |   |   |
| 1. To introduce to the student about air transportation, various organizations involved and about the administrative structure in aviation.                                                                                                                                                                                                                                                       |                                                                                                       |                                                 |   |   |   |   |
| 2. To accustom the student about economic parameters in an aviation industry.                                                                                                                                                                                                                                                                                                                     |                                                                                                       |                                                 |   |   |   |   |
| 3. To introduce to the student about the processes involved in airline scheduling.                                                                                                                                                                                                                                                                                                                |                                                                                                       |                                                 |   |   |   |   |
| 4. To acquaint the student about the various processes to ensure aircraft reliability.                                                                                                                                                                                                                                                                                                            |                                                                                                       |                                                 |   |   |   |   |
| 5. To familiarize the student about the technologies used in aircraft maintenance.                                                                                                                                                                                                                                                                                                                |                                                                                                       |                                                 |   |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                       |                                                 |   |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                                                                                                   |                                                                                                       |                                                 |   |   |   |   |
| CO 1                                                                                                                                                                                                                                                                                                                                                                                              | State the Role of ICAO and IATA. (Remember)                                                           |                                                 |   |   |   |   |
| CO 2                                                                                                                                                                                                                                                                                                                                                                                              | Describe aircraft forecasting and fleet planning and to do route analysis. (Understand)               |                                                 |   |   |   |   |
| CO 3                                                                                                                                                                                                                                                                                                                                                                                              | Summarize the flight operations and various methods of flight scheduling. (Understand)                |                                                 |   |   |   |   |
| CO 4                                                                                                                                                                                                                                                                                                                                                                                              | Discuss the condition monitoring maintenance and ageing aircraft maintenance production. (Understand) |                                                 |   |   |   |   |
| CO 5                                                                                                                                                                                                                                                                                                                                                                                              | List the equipment and tools for aircraft maintenance. (Apply)                                        |                                                 |   |   |   |   |
| Category                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                       | Professional Elective (PE)                      |   |   |   |   |
| Approval                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                       | 37th Academic Council Meeting held in May 2015. |   |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                       |                                                 |   |   |   |   |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                       | INTRODUCTION                                    |   |   |   | 9 |
| Development of air transportation, comparison with other modes of transport – Role of IATA, ICAO – The general aviation industry airline – Factors affecting general aviation, use of aircraft, airport: airline management and organization – levels of management, functions of management, Principles of organization planning the organization – chart, staff departments & line departments. |                                                                                                       |                                                 |   |   |   |   |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                       | AIRLINE ECONOMICS                               |   |   |   | 9 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                           |          |
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| <p>Forecasting – Fleet size, Fleet planning, the aircraft selection process, operating cost, passenger capacity, load factor etc. – Passenger fare and tariffs – Influence of geographical, economic &amp; political factors on routes and route selection.</p> <p>Fleet Planning: The aircraft selection process – Fleet commonality, factors affecting choice of fleet, route selection and Capital acquisition – Valuation &amp; Depreciation – Budgeting, Cost planning – Aircrew evaluation – Route analysis – Aircraft evaluation.</p> |                                           |          |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>PRINCIPLES OF AIRLINES SCHEDULING</b>  | <b>9</b> |
| <p>Equipment maintenance, Flight operations and crew scheduling, Ground operations and facility limitations, equipments and types of schedule – hub &amp; spoke scheduling, advantages / disadvantages &amp; preparing flight plans – Aircraft scheduling in line with aircraft maintenance practices.</p>                                                                                                                                                                                                                                   |                                           |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>AIRCRAFT RELIABILITY</b>               | <b>9</b> |
| <p>Aircraft reliability – The maintenance schedule &amp; its determinations – Condition monitoring maintenance – Extended range operations (EROPS) &amp; ETOPS – Ageing aircraft maintenance production.</p>                                                                                                                                                                                                                                                                                                                                 |                                           |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>TECHNOLOGY IN AIRCRAFT MAINTENANCE</b> | <b>9</b> |
| <p>Airlines scheduling (with reference to engineering) – Product support and spares – Maintenance sharing – Equipments and tools for aircraft maintenance – Aircraft weight control – Budgetary control.</p> <p>On board maintenance systems – Engine monitoring – Turbine engine oil maintenance – Turbine engine vibration monitoring in aircraft – Life usage monitoring – Current capabilities of NDT – Helicopter maintenance – Future of aircraft maintenance.</p>                                                                     |                                           |          |
| <p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. FEDRIC J.H., “Airport Management”, 2000.</li> <li>2. C.H. FRIEND, “Aircraft Maintenance Management”, 2000.</li> </ol>                                                                                                                                                                                                                                                                                                                                                    |                                           |          |
| <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Gene Kropf, “Airline Procedures”.</li> <li>2. Wilson &amp; Bryon, “Air Transportation”.</li> <li>3. Philip Locklin D, “Economics Of Transportation”.</li> <li>4. “Indian Aircraft Manual” – Dgca Pub.</li> <li>5. Alexander T Wells, “Air Transportation”, Wadsworth Publishing Company, California, 1993</li> </ol>                                                                                                                                                     |                                           |          |

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| <b>BANE24</b> | <b>AEROSPACE BIO – MEDICAL AND LIFE<br/>SUPPORT ENGINEERING</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|               | Total Contact Hours – 45                                        | 3        | 0        | 0        | 3        |
|               | Prerequisite – Basic Electrical and Electronics                 |          |          |          |          |
|               | Course Designed by – Department of Aeronautical Engineering     |          |          |          |          |

#### **OBJECTIVES**

1. To apply engineering methods to the study of astronaut adaptation to reduced gravity environments.
2. To use analytical techniques, such as structural idealizations, control theory, electrical circuit, and mechanical system analogs to model astronaut performance.
3. To enable quantitative assessment of the effectiveness of countermeasures.
4. To consider the socio-political implications for advanced technological R&D (e.g., space policy, health policy, international collaboration).
5. To teach, perform outreach, and demonstrate mastery of a chosen engineering concept.

#### **COURSE OUTCOMES**

**At the end of Course, Students will be able to,**

|                 |                                                                                                                     |
|-----------------|---------------------------------------------------------------------------------------------------------------------|
| <b>CO<br/>1</b> | <b>Explain</b> physiological problems associated with human in space flight. <b>(Understand)</b>                    |
| <b>CO<br/>2</b> | <b>Interpret</b> the equations of motion for human organ systems during space flight. <b>(Understand)</b>           |
| <b>CO<br/>3</b> | <b>Prepare</b> mechanical and electrical models of human systems for studying astronaut performance. <b>(Apply)</b> |
| <b>CO<br/>4</b> | <b>Discuss</b> the life support systems onboard the space flight. <b>(Understand)</b>                               |
| <b>CO<br/>5</b> | <b>Discover</b> life activities and specialties of space suit. <b>(Apply)</b>                                       |

|                 |                                                        |
|-----------------|--------------------------------------------------------|
| <b>Category</b> | <b>Professional Elective (PE)</b>                      |
| <b>Approval</b> | <b>37th Academic Council Meeting held in May 2015.</b> |

#### **COURSE CONTENT**

|                                                                                                                                                                       |                                        |          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|----------|
| <b>UNIT I</b>                                                                                                                                                         | <b>INTRODUCTION</b>                    | <b>9</b> |
| Physiological problems associated with human space flight – review of terminologies                                                                                   |                                        |          |
| <b>UNIT II</b>                                                                                                                                                        | <b>BIO – MECHANICS IN SPACE FLIGHT</b> | <b>9</b> |
| Bone Mechanics, Muscle Mechanics, Musculoskeletal Dynamics, and the Cardiovascular System during space flight – their equations of motion                             |                                        |          |
| <b>UNIT III</b>                                                                                                                                                       | <b>BIO – MECHANICAL MODELING</b>       | <b>9</b> |
| Structural idealizations – mechanical and electrical modeling of muscle groups – musculoskeletal groups – joints, electrical analogies to model astronaut performance |                                        |          |
| <b>UNIT IV</b>                                                                                                                                                        | <b>LIFE SUPPORT SYSTEMS</b>            | <b>9</b> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                   |          |
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| Onboard environment control systems – waste product management and recycling system – bio – monitoring and control                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                   |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>EXTRA – VEHICULAR ACTIVITY</b> | <b>9</b> |
| Extra Vehicular activity – challenges – specialties of space suits – life support system for EVA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                   |          |
| <b>Text Books:</b> <ol style="list-style-type: none"> <li>1. “Space Physiology”, Beckers, Frank, Bart Verheyden, Andre E Aubert, Wiley Encyclopaedia of Bio – medical engineering, John Wiley and Sons, Inc., 2006</li> <li>2. “Fundamentals of Space Life Sciences”, Diamandis, Peter H. Edited by Susanne Churchill. Malabar, FL: Krieger Publishing Co., 1997.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                   |          |
| <b>References:</b> <ol style="list-style-type: none"> <li>1. “Human Anatomy Manual: The Skeleton”, Gatesville, TX, Medical Plastics Laboratory, Inc., 1997</li> <li>2. Gomi, Hiroaki, and Mitsuo Kawato. "Equilibrium-Point Control Hypothesis Examined by Measured Arm Stiffness during Multijoint Movement." Science 272, no. 5258 (1996): 117-120.</li> <li>3. Aubert, A.E., F. Beckers, and B. Verheyden. "Cardiovascular Function and Basics of Physiology in Microgravity." Acta Cardiol 60, no. 2 (2005): 129-151.</li> <li>4. Flash, T. "The Control of Hand Equilibrium Trajectories in Multi-joint Arm Movements." Biological Cybernetics 57 (1987): 257-274.</li> <li>5. Bizzi, E., W. Chapple, and N. Hogan. "Mechanical Properties of Muscles: Implications for Motor Control." Trends in Neurosciences 5, no. 11 (1982): 395-398.</li> <li>6. Shenkman, Boris S., and Inessa B. Kozlovskaya. "Results of Studies of the Effects of Space Flight Factors of Human Physiological Systems and Psychological Status, and Suggestions of Future Collaborative Activities between the NSBRI and the IBMP." Section 3: Muscles. State Research Center of Russian Federation Institute for Biomedical Problems Report, Moscow, 2000.</li> <li>7. Stuster, J., C. Bachelard, and P. Suedfeld. "The Relative Importance of Behavioral Issues during Long-duration ICE Missions." Aviat. Space Env. Med. (September 2000): A17-A25.</li> <li>8. Brubakk, A. "Man in Extreme Environments." Aviat. Space Env. Med. (September 2000): A126-A130.</li> </ol> |                                   |          |

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| BBA008                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | TOTAL QUALITY MANAGEMENT                                                                                              |                                                 | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Total Contact Hours – 45                                                                                              |                                                 | 3 | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Prerequisite – Nil                                                                                                    |                                                 |   |   |   |   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Course Designed by – Department of Management Studies                                                                 |                                                 |   |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                       |                                                 |   |   |   |   |
| 1. To acquaint the student about the management, various types of management function and structure.                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                       |                                                 |   |   |   |   |
| 2. To give insight of various methods of management of organization and managerial aspects.                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                       |                                                 |   |   |   |   |
| 3. To acquaint the student with various functions of organizational behavior.                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                       |                                                 |   |   |   |   |
| 4. To get exposure regarding its applications and recent developments of group dynamics and trade union                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                       |                                                 |   |   |   |   |
| 5. To help the student understand about the professional ethics and social responsibilities.                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                       |                                                 |   |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                       |                                                 |   |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                       |                                                 |   |   |   |   |
| CO 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Develop action plans for customer centric business on the basis of various quality philosophies.(Apply)               |                                                 |   |   |   |   |
| CO 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Apply total quality management techniques for design and manufacture of highly reliable products and services.(Apply) |                                                 |   |   |   |   |
| CO 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Develop statistical process control charts for monitoring the health of manufacturing systems. (Apply)                |                                                 |   |   |   |   |
| CO 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Solve various industrial problems using Six Sigma and related techniques.(Apply)                                      |                                                 |   |   |   |   |
| CO 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Establish quality management system and environmental management system for product and service industries.(Apply)    |                                                 |   |   |   |   |
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                       | Professional Elective (PE)                      |   |   |   |   |
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                       | 37th Academic Council Meeting held in May 2015. |   |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                       |                                                 |   |   |   |   |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                       | INTRODUCTION                                    |   |   |   | 9 |
| Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs – Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.                                                                                                                     |                                                                                                                       |                                                 |   |   |   |   |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                       | TQM PRINCIPLES                                  |   |   |   | 9 |
| Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership –Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure. |                                                                                                                       |                                                 |   |   |   |   |
| UNIT III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                       | STATISTICAL PROCESS CONTROL (SPC)               |   |   |   | 9 |

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| <b>The seven tools of quality</b> , Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, <b>Process capability</b> , Concept of six sigma, <b>New seven Management tools</b> .                                                                                                                                                                                                                                                    |                        |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>TQM TOOLS</b>       | <b>9</b> |
| Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – <b>House of Quality</b> , QFD Process, <b>Benefits</b> , Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – <b>Concept, Improvement Needs</b> , FMEA – <b>Stages of FMEA</b> .                                                                                                                                                                                                                                         |                        |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>QUALITY SYSTEMS</b> | <b>9</b> |
| Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – <b>Elements, Implementation of Quality System, Documentation</b> , Quality Auditing, TS16949, ISO 14000 – <b>Concept, Requirements and Benefits</b> .                                                                                                                                                                                                                                                                                                      |                        |          |
| <b>Text Books:</b><br>1. Dale H. Besterfield, et al., “Total Quality Management”, Pearson Education, Inc.2003. (Indian reprint 2004). ISBN 81-297-0260-6.                                                                                                                                                                                                                                                                                                                                                                              |                        |          |
| <b>References:</b><br>1. Evans. J. R. & Lindsay. W,M “The Management and Control of Quality”, (5th Edition),South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).<br>2. Feigenbaum.A.V. “Total Quality Management”, McGraw-Hill, 1991.<br>3. Oakland.J.S. “Total Quality Management”, Butterworth Heinemann Ltd., Oxford,1989.<br>4. Narayana V. and Sreenivasan, N.S. “Quality Management – Concepts and Tasks”,New Age International 1996.<br>5. Zeiri. “Total Quality Management for Engineers”, Wood Head Publishers, 1991. |                        |          |

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| BANE25                                                                                                                                                                                                                                         | INDUSTRIAL AERODYNAMICS                                                                                            |                                                 | L | T | P | C |
|                                                                                                                                                                                                                                                | Total Contact Hours – 45                                                                                           |                                                 | 3 | 0 | 0 | 3 |
|                                                                                                                                                                                                                                                | Prerequisite – Aerodynamics I                                                                                      |                                                 |   |   |   |   |
|                                                                                                                                                                                                                                                | Course Designed by – Department of Aeronautical Engineering                                                        |                                                 |   |   |   |   |
| OBJECTIVES                                                                                                                                                                                                                                     |                                                                                                                    |                                                 |   |   |   |   |
| 1. To introduce to the student about the aerodynamics taking place in the atmosphere                                                                                                                                                           |                                                                                                                    |                                                 |   |   |   |   |
| 2. To familiarize the student about the aerodynamics of flow over bluff bodies and its effect on those bodies                                                                                                                                  |                                                                                                                    |                                                 |   |   |   |   |
| 3. To acquaint the student about the various mechanisms and procedures by which energy can be extracted from the wind                                                                                                                          |                                                                                                                    |                                                 |   |   |   |   |
| 4. To accustom the student about the aerodynamics of flow around buildings, towers and bridges and also about ventilation and architectural aerodynamics                                                                                       |                                                                                                                    |                                                 |   |   |   |   |
| 5. To familiarize the student about the loads on a structure due to wind and the resulting vibrations and their calculations                                                                                                                   |                                                                                                                    |                                                 |   |   |   |   |
| COURSE OUTCOMES                                                                                                                                                                                                                                |                                                                                                                    |                                                 |   |   |   |   |
| At the end of Course, Students will be able to,                                                                                                                                                                                                |                                                                                                                    |                                                 |   |   |   |   |
| CO 1                                                                                                                                                                                                                                           | Discuss weather terminology and terrain structure.(Understand)                                                     |                                                 |   |   |   |   |
| CO 2                                                                                                                                                                                                                                           | Compare the flow characteristics over automobile bodies for drag reductions(Analyze)                               |                                                 |   |   |   |   |
| CO 3                                                                                                                                                                                                                                           | Discuss the concepts of wind turbines and its applications(Understand)                                             |                                                 |   |   |   |   |
| CO 4                                                                                                                                                                                                                                           | Discuss the codes of practice and analyze properties of externals and internal flows over buildings (Understand)   |                                                 |   |   |   |   |
| CO 5                                                                                                                                                                                                                                           | Discuss the concepts of induced vibrations and their effect over launch vehicles and civil structures (Understand) |                                                 |   |   |   |   |
| Category                                                                                                                                                                                                                                       |                                                                                                                    | Professional Elective (PE)                      |   |   |   |   |
| Approval                                                                                                                                                                                                                                       |                                                                                                                    | 37th Academic Council Meeting held in May 2015. |   |   |   |   |
| COURSE CONTENT                                                                                                                                                                                                                                 |                                                                                                                    |                                                 |   |   |   |   |
| UNIT I                                                                                                                                                                                                                                         |                                                                                                                    | ATMOSPHERIC BOUNDARY LAYER                      |   |   |   | 9 |
| Atmospheric circulation-Local winds-Terrain types-Mean velocity profiles-Power law and logarithm law- wind speeds-Turbulence profiles-Roughness parameters-simulation techniques in wind tunnels                                               |                                                                                                                    |                                                 |   |   |   |   |
| UNIT II                                                                                                                                                                                                                                        |                                                                                                                    | BLUFF BODY AERODYNAMICS                         |   |   |   | 9 |
| Boundary layers and separation-Two dimensional wake and vortex formation-Strouhal and Reynolds numbers-Separation and reattachments-Power requirements and drag coefficients of automobiles- Effects of cut back angle-aerodynamics of trains. |                                                                                                                    |                                                 |   |   |   |   |
| UNIT III                                                                                                                                                                                                                                       |                                                                                                                    | WIND ENERGY COLLECTORS                          |   |   |   | 9 |

|                                                                                                                                                                                                                                                          |                                |          |
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| Horizontal and vertical axis machines-energy density of different rotors-Power coefficient-Betz coefficient by momentum theory.                                                                                                                          |                                |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                           | <b>BUILDING AERODYNAMICS</b>   | <b>9</b> |
| Pressure distribution on low rise buildings-wind forces on buildings-Environmental winds in city blocks-special problems of tall buildings-building codes-ventilation and architectural aerodynamics                                                     |                                |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                            | <b>FLOW INDUCED VIBRATIONS</b> | <b>9</b> |
| Vortex shedding, lock & effects of Reynolds number on wake formation in turbulent flows- across wind galloping-wake galloping-along wind galloping of circular cables-oscillation of tall structures and launch vehicles under wind loads-stall flutter. |                                |          |
| <b>Text Books:</b><br>1. Blevins R.D “Flow Induced Vibrations”, Van Nostrand, 1990<br>2.Sovran, M(ed) “Aerodynamic drag mechanism of bluff bodies and road vehicles”,Plenum Press, N.Y, 1990                                                             |                                |          |
| <b>References:</b><br>1. Sachs P “Wind Forces in Engineering”, Pergamon Press, 1988<br>2. Scorer R.S “Environmental Aerodynamics”, Ellis Harwood Ltd, England, 1978<br>3. Calvert N.G “Wind Power Principles”, Charles Griffin & Co London, 1979.        |                                |          |

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| <b>BANE26</b> | <b>MECHANICS OF HETEROGENEOUS</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|---------------|-----------------------------------|----------|----------|----------|----------|

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------|---|---|---|-----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>MATERIALS</b>                                                                                          |                                                        |   |   |   |           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Total Contact Hours – 45                                                                                  |                                                        | 3 | 0 | 0 | 3         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Prerequisite – Engineering Physics I, Fundamentals of Structural Mechanics                                |                                                        |   |   |   |           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Course Designed by – Department of Aeronautical Engineering                                               |                                                        |   |   |   |           |
| <b>OBJECTIVES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                           |                                                        |   |   |   |           |
| 1. To introduce to the student about the various heterogeneous materials.<br>2. To accustom the student to the mechanics of heterogeneous materials.<br>3. To acquaint the student to the structure of particulate, fibrous and cellular solids and their properties.<br>4. To familiarize the student about the hierarchical structure in heterogeneous materials.<br>5. To enable the student to understand various design considerations in application of heterogeneous materials. |                                                                                                           |                                                        |   |   |   |           |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                           |                                                        |   |   |   |           |
| <b>At the end of Course, Students will be able to,</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                           |                                                        |   |   |   |           |
| <b>CO<br/>1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Summarize</b> various material structures and different crystal properties. <b>(Understand)</b>        |                                                        |   |   |   |           |
| <b>CO<br/>2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Predict</b> the stiffness and strength of different directions. <b>(Understand)</b>                    |                                                        |   |   |   |           |
| <b>CO<br/>3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Memorize</b> the properties of Particulate, fibrous and cellular solids. <b>(Remember)</b>             |                                                        |   |   |   |           |
| <b>CO<br/>4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Define</b> the various aspects of hierarchical structure of heterogeneous materials. <b>(Remember)</b> |                                                        |   |   |   |           |
| <b>CO<br/>5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Explain</b> the eutectic structure and gradient effects. <b>(Understand)</b>                           |                                                        |   |   |   |           |
| <b>Category</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                           | <b>Professional Elective (PE)</b>                      |   |   |   |           |
| <b>Approval</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                           | <b>37th Academic Council Meeting held in May 2015.</b> |   |   |   |           |
| <b>COURSE CONTENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                           |                                                        |   |   |   |           |
| <b>UNIT I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                           | <b>INTRODUCTION</b>                                    |   |   |   | <b>9</b>  |
| Material heterogeneity. Survey of laminated, fibrous, particulate, cellular and porous, platelet structures. Single crystal properties and polycrystal properties. Heterogeneity of biological materials and designed heterogeneity. Strength of fibers. Constituent materials. Griffith's experiments, stress concentrations. Concept of equivalent homogeneity. Micro and nanostructures.                                                                                            |                                                                                                           |                                                        |   |   |   |           |
| <b>UNIT II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                           | <b>STRUCTURE OF HETEROGENEOUS MATERIALS</b>            |   |   |   | <b>9</b>  |
| Unidirectional fibrous media. Bounds on physical properties: Voigt and Reuss bounds; Hashin-Shtrikman. Prediction of stiffness and strength for different directions. Symmetry and physical properties. Crystal symmetry classes. Generalized Hooke's law of elasticity. Modulus and compliance matrices. Anisotropy and dielectric and piezoelectric properties. Thermal expansion. Experimental methods.                                                                             |                                                                                                           |                                                        |   |   |   |           |
| <b>UNIT III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                           | <b>PARTICULATE, FIBROUS AND CELLULAR SOLIDS</b>        |   |   |   | <b>12</b> |

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| <p>Structure. Particulate materials. Dental composites, metal matrix composites, asphalt. Toughened polymers via compliant inclusions. Stiffness vs. volume fraction. Self healing polymers. Attainment of the Hashin-Shtrikman bounds. Unidirectional fibrous materials; stiffness, strength, thermal expansion. Fibrous solids with short-fibers. Nano-tubes as fibers. Platelet reinforcement. Shear lag model. Laminates. Polycrystalline aggregates. Piezoelectric composites. Metal matrix composites. Structure property relations of cellular solids. Lightweight cellular solids. Foams, structural honeycombs, sandwich structures. Polymer lattice structures. Syntactic foams. Poisson's ratio of composites and foams. Applications.</p> |                               |          |
| <b>UNIT IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>HIERARCHICAL STRUCTURE</b> | <b>6</b> |
| <p>Structure within structure. Bone, wood, tendon and other materials of biological origin. Fibrous aspects of bone structure. Tendon and ligament as fibrous biological materials. Biological cellular solids. Cellular architecture of bone, wood, bamboo.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                               |          |
| <b>UNIT V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>DESIGN CONSIDERATIONS</b>  | <b>9</b> |
| <p>Fracture mechanics, stress concentrations, free-edge effects. In situ composites; eutectic structure. Gradient effects. Role of microstructure size. Generalized continuum models; Cosserat elasticity. Toughness: empirical criteria; causal mechanisms. Spongy impact absorber, bone cement.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                               |          |
| <p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. L. J. Gibson, and M. F. Ashby, Cellular Solids, Cambridge, (1999).</li> <li>2. M. F. Ashby and D. R. H. Jones, Engineering Materials, 2nd ed. Butterworth, (1998).</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                               |          |
| <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. J. F. Nye, Physical Properties of Crystals, Oxford, (1976).</li> <li>2. B. D. Agarwal and L. J. Broutman, Analysis and Performance of Fiber Composites, J. Wiley, 2nd ed. (1990).</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                               |          |