REGULATION 2015

B.TECH - AEROSPACE 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/ 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	BAN5L1	PC	Aerodynamics Laboratory	0	0	4	2
8	BAN5L2	PC	Aero Design and Modeling Laboratory	0	0	2	1
9	BAN5L3	PC	Computer Aided Analysis	0	0	2	1
10	BAN5C1	PR	Comprehension – I	0	0	0	1

Total No. of Contact Hours: 32Total 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	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: 33Total 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: 24Total No. of Credits: 16

TOTAL NO. OF CREDITS FOR THE PROGRAM : 198

SUMMARY OF CURRICULUM STRUCTURE AND CREDIT & CONTACT HOUR DISTRIBUTION

S.No.	Sub Area	Credit As per Semester								No. of Credit	% of 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
	Total Credit	27	24	28	26	27	26	24	16	198	100
	Total Contact Hour	27	26	34	33	30	32	30	24	236 Hrs	

Syllabus is not here but it is there in Aeronautical syllabus so can be copied from therre

LIST OF ELECTIVES

Code No.	Course Title	L	T	P	C
BASE01	Theory of Elasticity	3	0	0	3
BANE02	Rockets and Missiles	3	0	0	3
BASE02	Electric Propulsion	3	0	0	3
BASE03	Launch Vehicle Aerodynamics	3	0	0	3

List of Core Elective (CE) I:

List of Core Elective (CE) II:

Syllabus is not there. It is there in Aeronautical Syllabus

Code No.	Course Title	L	T	P	C
BASE04	Space Mechanics	3	0	0	3
BASE05	Guidance and Control	3	0	0	3
BANE07	Theory of Vibrations	3	0	0	3
BASE06	Space Vehicle Design	3	0	0	3

List of Core Elective (CE) III:

Syllabus is not there

Code No.	Course Title	L	T	P	C
BASE07	Spacecraft Attitude Dynamics and Control	3	0	0	3
BANE10	Cryogenic Rocket Propulsion	3	0	0	3
BASE08	Space Mission Design and Analysis	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
BASE09	Solar Thermal Energy	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

Syllabus is not there

List of Non Major Elective (NE) III:

Code No.	Course Title	L	T	P	C
BASE10	High Temperature Gas Dynamics	3	0	0	3
BASE11	Spacecraft Power Systems	3	0	0	3
BANE14	Principles of Turbomachinery in Airbreathing Engines	3	0	0	3

BANE21 Satellite Technology 3 0 0 3

Syllabus is not there

List of Open Elective (OE) I:

Code No.	Course Title	L	T	P	C
BBA001	Principles of Management and Organizational Behavior	3	0	0	3
BASE12	Systems Engineering	3	0	0	3
BANE24	Aerospace Bio – Medical and Life Support Engineering	3	0	0	3

List of Open Elective (OE) II:

Code No.	Course Title	L	T	P	C
BBA008	Total Quality Management	3	0	0	3
BANE25	Industrial Aerodynamics	3	0	0	3
BANE26	Mechanics of Heterogeneous Materials	3	0	0	3

BMA301	MATHEMATICS III	L	T	P	C
	Total Contact Hours – 60	3	1	0	4
	Prerequisite – Mathematics I & II				
	Course Designed by – Department of Mathematics				

OBJECTIVES

1. To introduce Fourier series analysis that is important to many applications in engineering apart from its use in solving boundary value problems.
2. To acquaint the student with Fourier transform techniques used in wide variety of situations.
3. To introduce the effective mathematical tools for the solutions of partial differential equationsthat model several physical processes.
4. To develop Z transform techniques for discrete time systems.
5. To develop the Fourier transform techniques and convolution theorem.

COURSE OUTCOMES

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

CO 1	**Classify** the different methods for solving partial differential equations. **(Understand)**
CO 2	**Apply** Fourier series solution method for engineering problems.**(Apply)**
CO 3	**Analyze**the solutions ofone dimensional and two dimensional boundary value problems in partial differential equations. **(Analyze)**
CO 4	**Apply**the concept of Laplace transform to various engineering problems.**(Apply)**
CO 5	**Evaluate** theengineering problems using inverse Laplace techniques.**(Evaluate)**
CO 6	**Apply** Fourier transform to engineering problems.**(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							H		
CO 3	H	H	H		H							H		
CO 4	H	H	H		H							H		
CO 5	H	H	H	L	H							H		
CO 6	H	H	H	L								H		
Category	**Basic Sciences (BS)**													

<table>
<tr><td>Approval</td><td colspan="2">37th Academic Council Meeting held in May 2015.</td></tr>
<tr><td colspan="3">COURSE CONTENT</td></tr>
<tr><td>UNIT I</td><td>PARTIAL DIFFERENTIAL EQUATIONS</td><td>12</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>UNIT II</td><td>FOURIER SERIES</td><td>12</td></tr>
<tr><td colspan="3">Dirichlet’s conditions – General Fourier series – Half-range Sine and Cosine series – Parseval’s identity – Harmonic Analysis.</td></tr>
<tr><td>UNIT III</td><td>BOUNDARY VALUE PROBLEMS</td><td>12</td></tr>
<tr><td colspan="3">Classifications of second order linear partial differential equation – Solutions of one-dimensional wave equation and one-dimensional heat equation.</td></tr>
<tr><td>UNIT IV</td><td>LAPLACE TRANSFORMS</td><td>12</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>UNIT V</td><td>FOURIER TRANSFORMS</td><td>12</td></tr>
<tr><td colspan="3">Fourier integral theorem – Fourier transform pair-Sine and Cosine transforms – Properties – Transform of simple function – Convolution theorem – Parseval’s identity.</td></tr>
<tr><td colspan="3">Text Books:
1. Grewal, B.S., Higher Engineering Mathematics, Khanna Publications, 2007.</td></tr>
<tr><td colspan="3">References:
1. Glyn James, Advance Modern Engineering Mathematics, Pearson Education, 2007.
2. Kreyszig. E, Advanced Engineering Mathematics, (8th edition), John Wiley & Sons, Singapore, 2000.
3. Kandasamy P et al, Engineering Mathematics, Vol. II & III (4th revised edition), S. Chand & Co., New Delhi, 2000.
4. Narayanan S., Manicavachagom Pillay T. K., Ramanaiah G., Advanced Mathematics for Engineering Students, Volume II & III (2nd edition), S. Viswanathan Printers and Publishers, 1992.
5. Venkataraman M. K., Engineering Mathematics – Vol. III – A & B (13th edition), National Publishing Co., Chennai, 1998.
6. Julius S. Bendat and Allan G BANE20. Piersol., Random Data: Analysis and Measurement Procedures (4th edition), Wiley Series in Probability and Statistics, 2010.
7. https://www.wolfram.com/mathematica/</td></tr>
</table>

BAN301	FUNDAMENTALS OF AERONAUTICS AND ASTRONAUTICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Nil				
	Course Designed by – Department of Aeronautical Engineering.				

OBJECTIVES

1. To equip students with the knowledge about the development of aircrafts and spacecraft through historical reviews and about their basic configurations.
2. To accustom students the various basic aerodynamic terms and about the generation of aerodynamic forces.
3. To introduce students about the basic types of aircraft constructions and materials and the various loads acting on it.
4. To familiarize the studentsabout the different kinds of propulsion for aircrafts and materials for gas turbine engines
5. To acquaint the students about space vehicles, re- entry, heat transfer and basics of satellite technology

COURSE OUTCOMES

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

CO 1	**Describe** the basic components of airplane and various flight vehicles. (**Remember**)
CO 2	**Summarize** the variation of aircraft performance at various altitudes. (**Understand**)
CO 3	**Explain** the structural components of airplane and materials used for aircraft construction. (**Understand**)
CO 4	**Describe** the working of different types of aircraft engines and their performances. (**Understand**)
CO 5	**Discuss** the theory behind rocket propulsion and the problems associated with hypersonic vehicle operation. **(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									M			H	
CO 2	H				L								H	
CO 3	H									M		H	H	
CO 4	H											H	H	
CO 5	H											H	H	

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**
	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, 6th 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 (2nd edition), 1989. 2. Steven, A. Brandt, Randall J. Stiles, John J. Bertin and Ray Whitford, Introduction to Aeronautics: A Design Perspective, AIAA Education series (2nd 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/*	

BAN302	FUNDAMENTALS OF FLUID MECHANICS	L	T	P	C
	Total Contact Hours – 60	3	1	0	4
	Prerequisite – Engineering Physics,Engineering Mechanics, Mathematics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce students about properties of fluid and its classification.
2. To teach Students about fluid statics and dynamics.
3. Significance of similarity and model studies
4. To know about boundary layer concepts and its applications to pipe design.
5. To learn about pumps and turbine design.

COURSE OUTCOMES

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

CO 1	**Recall** the concepts of fluids, properties of fluids and its classification. (**Remember**)
CO 2	**Calculate** the flow properties using the fundamental equations of fluid motion. (**Apply**)
CO 3	**Solve** problems based on dimensional analysis and fluid flow analysis. (**Apply**)
CO 4	**Examine t**he pipe line system for minimum head loss. (**Apply**)
CO 5	**Calculate** the performance and operating characteristics of turbines and pumps. **(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												H	
CO 3	H											L	H	
CO 4	H									H			H	
CO 5	H									H			H	

Category	**Professional Core (PC)**

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. (7th edition), 2011. 2. Rathakrishnan, E, Fundamentals of Fluid Mechanics, Prentice-Hall (3rd edition), 2012.		
References: 1. Yunus A Cengel and John M Cimbala, Fluid mechanics: Fundamentals and Applications, Tata McGraw Hill (2nd edition), 2010. 2. Irving H Shames, Mechanics of Fluids, The McGraw Hill companies (4th 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 – 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**

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		
UNIT II	**AIR POWER CYCLES**	**12**
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.		
UNIT III	**VAPOUR POWER CYCLES**	**12**
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.		
UNIT IV	**REFRIGATION AND AIR – CONDITIONING**	**10**
Principles of refrigeration and Psychometric - Vapour compression - Vapour absorption types - Co-efficient of performance, Properties of refrigerants – Basic Principle and types of Air conditioning.		
UNIT V	**THERMODYNAMICS OF AIRCRAFT PROPULSION CYCLES**	**10**
Isentropic flow through passages – Brayton cycle – Brayton cycle with intercooling, reheat and regeneration – Ideal jet propulsion cycles. Basics of heat transfer.		

Text Books:

1. Rathakrishnan E., Fundamentals of Engineering Thermodynamics, Prentice-Hall India, 2012.
2. Nag.P.K.,Engineering Thermodynamics, Tata McGraw-Hill, New Delhi, 2007.

Reference Books:

1. Yunus A Cengel and Michael A Boles., Thermodynamics- an Engineering approach, McGraw Hill Education (7th edition), 2012.
2. Holman.J.P.,Thermodynamics, McGraw-Hill (3rd edition), 2007.
3. Gordon J. Van Wylen and Richard E. Sonntag and Claus Borgnakke., Fundamentals of Classical Thermodynamics – Vol 1, Wiley Eastern, 1994.
4. Arora C.P., Thermodynamics, Tata McGraw-Hill, New Delhi, 2003.
5. Merle C Potter and Craig W Somerton., Thermodynamics for Engineers, Schaum's Outline Series, Tata McGraw-Hill (2nd edition), 2009.
6. *www.thermocalc.com/*
7. *www.grc.nasa.gov/WWW/cdtb/**software**/t-mats.html*

BAN304	FUNDAMENTALS OF STRUCTURAL MECHANICS	L	T	P	C
	Total Contact Hours – 60	3	1	0	4
	Prerequisite – Engineering Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To provide the students, an understanding about the basics of strength of materials
2. To acquaint the student with the procedures for estimating the stresses acting in beams
3. To impart knowledge on estimation of deflections of various types of beams under different loading conditions
4. To develop the basic understanding of torsion of structural members
5. To develop the basic understanding about the bi-axial state of stress and basics of elasticity

COURSE OUTCOMES

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

CO 1	**Compute** the stress developed in statically determinate and indeterminate structures subjected to axial load. (**Apply**)
CO 2	**Sketch** shear force and bending moment diagram for a given beam. (**Apply**)
CO 3	**Determine** the deflection of beams using various methods (**Apply**)
CO 4	**Compute** the shear stress developed in circular shafts and springs subjected to torsional and axial load. (**Apply**)
CO 5	**Determine** the principal stresses developed in structural components using Mohr's Circle. (**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				M								H	
CO 3	H											M	H	
CO 4	H											M	H	
CO 5	H				M					H			H	

Category	**Professional Core (PC)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT		
UNIT I	**INTRODUCTION TO STRENGTH OF MATERIALS**	**16**
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 Poison's ratio, Statically determinate and indeterminate problems in tension and compression – Thermal stress – Impact loading – Composite bars		
UNIT II	**STRESSES IN BEAMS**	**10**
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		
UNIT III	**DEFLECTION OF BEAMS**	**10**
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		
UNIT IV	**TORSION**	**10**
Torsion of solid and hollow circular shafts – Shear stress variation – Power transmission in shafts – Open and closed-coiled helical springs – Stresses in helical springs.		
UNIT V	**BI – AXIAL STRESSES AND ELEMENTS OF ELASTICITY**	**14**
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		
Text Books: 1. Gere & Timoshenko, Mechanics of Materials, McGraw Hill, 1993 2. William Nash, Strength of Materials, Tata McGraw Hill, 2004		
Reference Books: 1. F. P. Beer, E.R. Johnston, and J.T. Dewolf, Mechanics of Materials, McGraw-Hill (4^{th} edition), 2006 2. Dym,C.L., and Shames,I.H., Solid Mechanics, McGraw Hill, Kogakusha, 1973. 3. Stephen Timoshenko, Strength of Materials, Vol I & II, CBS Publishers and Distributors, Third Edition. 4. R.K.Rajput, Strength of Materials, S. Chand and Co., 1999. 5. Timoshenko,S. and Young,D.H., Elements of Strength of Materials, T.VanNostrand Co. Inc., Princeton, N.J., 1977. 6. *www.mdsolids.com/* 7. *https://www.actuspotentia.com/MechMat.shtml*		

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

UNIT I	MECHANISMS	8
Machine Structure – Kinematic link, pair and chain – Grueblers criteria – Constrained motion – Degrees of freedom –Kutzbach criterion - Slider crank and crank rocker mechanisms – Inversions – Applications –Kinematic analysis of simple mechanisms – Determination of velocity and acceleration.		
UNIT II	**FRICTION** Static and dynamic friction, Sliding and rolling friction	**9**
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.		
UNIT III	**GEARING AND CAMS**	**9**
Gear profile and geometry – Nomenclature of spur and helical gears – Gear trains: Simple, Compound gear trains and epicylic gear trains - Determination of speed and torque - Cams – Types of cams and followers.		
UNIT IV	**FORCE ANALYSIS AND BALANCING**	**10**
Introduction to force analysis - Static and dynamic – Inertia force and inertia torque – D'Alembert's principle -Static and dynamic balancing – Single and several masses in different planes –Balancing of reciprocating masses- primary balancing and concepts of secondary balancing – Single and multicylinder engines (Inline) – Balancing of radial V engine – direct and reverse crank method.		
UNIT V	**VIBRATION** Natural and damped frequency, critical damping coefficient	**9**
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.		

Text Books:

1. Rattan.S.S., Theory of Machines, Tata McGraw–Hill Publishing Co, New Delhi, 2004.
2. Balaguru. S., Dynamics of Machinery, SciTech publication (2nd edition), 2009.

Reference Books:

1. Rao, J.S and Dukkipati, R.V, "Mechanism and Machine Theory", Second Edition, Wiley Eastern Ltd., 1992.
2. Malhotra, D.R and Gupta, H.C., "The Theory of Machines", SatyaPrakasam, Tech. India Publications, 1989.
3. Gosh, A. and Mallick, A.K., "Theory of Machines and Mechanisms", Affiliated East West Press,1989.
4. Shigley, J.E. and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw-Hill, 1980.
5. Burton Paul, "Kinematics and Dynamic of Planer Machinery", Prentice Hall, 1979.
6. *ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5593596*
7. *www.simple**machines**.org/*

BCE3L1	**FLUID MECHANICS AND MACHINERIES LAB**	**L**	**T**	**P**	**C**
	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,

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

References:

1. Fluid Mechanics and Machinery Lab Manual, Department of Civil Engineering, 2015

BCE3L2	STRENGTH OF MATERIALS LAB	L	T	P	C
	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,

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

References:

1. Strength of Materials Lab Manual, Department of Aeronautical Engineering, 2015

BME3L1	MACHINE DRAWING	L	T	P	C
	Total Contact Hours – 30	0	0	**4**	2
	Prerequisite – Engineering Graphics				
	Course Designed by – Department of Mechanical Engineering				

OBJECTIVES

1. To give the students an idea of fundamental issues common to almost all areas of machine drawing.
2. To train the student to draw an assembled diagram of a machine part based on the details of individual parts.
3. To help the student to understand the machine drawing, nomenclature and various notations.
4. To train the students to prepare a working drawing of machines.
5. To enable the student to communicate his ideas through drawings.

COURSE OUTCOMES

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

CO 1	**Observe** basic representation of symbols used in Engineering drawings. **(Imitation)**
CO 2	**Acquire** attributes of Production Drawing and Limits, fits, tolerances. **(Manipulation)**
CO 3	**Complete** the assembly of a given set of machine components. **(Manipulation)**

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.**

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.

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.

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 lath, 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.**machine**designonline.com/*

BMA402	NUMERICAL METHODS	L	T	P	C
	Total Contact Hours – 60	3	**1**	0	4
	Prerequisite – Mathematics III, Engineering Physics, Engineering Mechanics				
	Course Designed by – Department of Mathematics				

OBJECTIVES

1. To introduce the solution of equations and Eigen value problems.
2. To acquaint the student with interpolation techniques used in wide variety of situations.
3. To introduce the effective mathematical tools for the solutions of numerical differentiation and integration.
4. To develop the initial value problems for ordinary differential equations.
5. To develop the boundary value problems for ODE and PDE.

COURSE OUTCOMES

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

CO 1	**Apply** numerical techniques to solve equations and linear system of equations. **(Apply)**
CO 2	**Interpolate** the value of a dependent variable in the given data by Newton's forward and backward difference formulae and also unequal intervals. **(Understand)**
CO 3	**Understand** and apply the concept of numerical methods to differentiation and integration. **(Understand)**
CO 4	**Evaluate**initial value problems of ODE by applying single step and multistep methods. **(Evaluate)**
CO 5	**Analyse** the two dimensional and one-dimensional ordinary differential equation with numerical techniques. **(Analyse)**
CO 6	**Solve** the boundary value problems in engineering with the help of finite difference methods. (**Create)**

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		
CO 4	H	H	H		H							H		
CO 5	H	H	H		H							H		
CO 6	H	H	H		H							H		

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.		
Text Books: 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 2. Grewal, B.S., Higher Engineering Mathematics, Khanna Publications, 2007.		
References: 1. M. K. Venkatraman., Numerical Methods, NPC, Chennai. 2. Richard W. Hamming., Numerical Methods for Scientists and Engineers, Dover Publications (2nd edition), 1987. 3. *https://www.wolfram.com/**mathematica**/*		

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 ofstatically 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		
UNIT III	**ENERGY METHODS**	**12**
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		
UNIT IV	**COLUMNS** Ideal column, Governing ODE for Column buckling, Slenderness ratio	**12**
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.		
UNIT V	**FAILURE THEORY**	**12**
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.		
Text Books: 1. Donaldson, B.K., Analysis of Aircraft Structures – An Introduction, McGraw-Hill,1993. 2. Megson T M G, Aircraft Structures for Engineering Students, Edward Arnold Publishers 3. C.T.Sun, Mechanics of aircraft structures, John wiley & sons, inc.		
References: 1. Timoshenko, S., Strength of Materials, Vol. I and II, Princeton D. Von Nostrand Co, 1990. 2. Peer, D. J., and Azar J. J., Aircraft Structures, McGraw – Hill (2nd edition), 1999. 3. Bruhn.E.F., Analysis and design of flight vehicle structures, Tri set of offset company, 1973. 4. Michael C.Y.Niu ,Airframe structural design (ISBN No.962-7128-04-X), 1998 5. Rivello,Theory and Analysis of Flight Structures, McGraw-Hill, 1969. 6. Perry, Aircraft Structures, McGraw-Hill, 1950.		

BAN402	AERODYNAMICS I	L	T	P	C
	Total Contact Hours – 60	3	**1**	0	4
	Prerequisite – Fundamentals of Fluid Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

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

COURSE OUTCOMES

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

CO 1	**Identify** the concepts of various types of flow based on mathematical equations. (**Understand**)
CO 2	**Apply** the concept of inviscid flow theory to solve flow over basic aerodynamic shapes. (**Apply**)
CO 3	**Practice** the construction of airfoils numerically with the help of mathematical transformations. (**Apply**)
CO 4	**Describe** the concept of lift generation and will be able to analyze the factors for efficient wing design. (**Understand**)
CO 5	**Determine** the skin friction drag over surfaces. (**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				L							H	H	
CO 4	H											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 AERODYNAMIC PRINCIPLES**	**10**
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		
UNIT II	**FUNDAMENTALS OF INVISCID FLOWS**	**13**
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		
UNIT III	**AIRFOIL THEORY**	**15**
Complex Potential, Methodology of Conformal Transformation, Kutta-Joukowski transformation and its applications, Karman Trefftz Profiles, Thin Airfoil theory and its applications.		
UNIT IV	**FINITE WING THEORY**	**11**
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.		
UNIT V	**VISCOUS FLOW THEORY**	**11**
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		
Text Books: 1. Anderson, J.D., Fundamentals of Aerodynamics, McGraw Hill Book Co., 1999, Indian Edition		
References: 1. Rathakrishnan, E., Theoretical Aerodynamics, John Wiley & Sons, Inc., 2013 2. Milne Thomson, L.H., Theoretical Aerodynamics, Macmillan, 1985. 3. John J Bertin., Aerodynamics for Engineers, Pearson Education Inc, 5th Edition. 4. Clancy L J., Aerodynamics, John Wiley & sons, 1991.		

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)**

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.		
Text Books: 1. Hill, P.G. & Peterson, C.R, Mechanics & Thermodynamics of Propulsion, Addison – Wesley Longman INC, 1999. 2. Cohen, H. Rogers, G.F.C. and Saravana Muttoo, H.I.H., Gas Turbine Theory, Longman, 1989.		
References: 1. Ahmed F. El-Sayed, Aircraft Propulsion and Gas turbine engines, CRS Press, 2008 2. Saeed Farokhi, Aircraft Propulsion, John Wiley & Sons, Inc., 2009 3. Rolls Royce Jet Engine – 5thEdition – 1996. 4. Oates, G.C., Aero thermodynamics of Aircraft Engine Components, AIAA Education Series.		

BAN404	AIRCRAFT SYSTEMS AND INSTRUMENTATION	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Aeronautics and Astronautics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student with the various aircraft systems
2. To introduce to the student about the different control systems in aircrafts
3. To familiarize the student to the different systems associated with aircraft engines
4. To acquaint the student to the several auxiliary systems in aircrafts
5. To enable the student to understand about the working of basic aircraft instruments

COURSE OUTCOMES

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

CO 1	**Identify** the components of Hydraulic, Pneumatic, Landing gear and brake system. (**Understand**)
CO 2	**Compare** the advantages and disadvantages of conventional and modern flight control systems. (**Understand**)
CO 3	**Explain** the operating principle of various systems associated with the aircraft engines. (**Understand**)
CO 4	**Describe** the working principle of air-conditioning, oxygen, fire protection and ice protection systems. (**Understand**)
CO 5	**Describe** the operating principle of flight and navigation instruments. (**Understand**)
CO 6	**Summarize** the working principle of engine instruments such as tachometers, temperature gauges and Pressure gauges. (**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	H
CO 3	H												H	H
CO 4	H									H			H	H
CO 5	H												H	H
CO 6	H												H	H

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.		
Text Books: 1. McKinley, J.L., and Bent, R.D., Aircraft Maintenance & Repair, McGraw-Hill,1993. 2. General Hand Books of Airframe and Powerplant Mechanics, U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, NewDelhi1995.		
References: 1. Mekinley, J.L. and Bent, R.D., Aircraft Power Plants, McGraw-Hill, 1993. 2. Pallet, E.H.J., Aircraft Instruments & Principles, Pitman & Co., 1993. 3. Treager, S., Gas Turbine Technology, McGraw-Hill, 1997.		

BCE407	ENVIRONMENTAL STUDIES	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Engineering Chemistry, Biology for Engineers				
	Course Designed by – Department of Humanities and Sciences				

OBJECTIVES

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

COURSE OUTCOMES

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

CO 1	**Summarize** the types of natural resources and identify the role of an individual in conservation of nature. (**Understand**)
CO 2	**Describe** different eco systems and energy flow in a defined ecosystem. (**Understand**)
CO 3	**Define** ecosystem bio-diversity and the threats to biodiversity. (**Remember**)
CO 4	**Define** types of pollution, effects and control measures of pollution. (**Remember**)
CO 5	**Explain** the need for sustainable development and water conservation. (**Understand**)
CO 6	**Express** the need for population control and the impact of population growth in economy. (**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			M				
CO 3	H					H	H			M				
CO 4	H					H	H							
CO 5	H					H	H		L					
CO	H			L		H	H							

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**
BIODIVERSITY 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. **ENVIRONMENTAL POLLUTION** 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.		
FIELDWORK 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.
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	**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.

References:

1. Aircraft Structures Lab Manual, Department of Aeronautical Engineering, 2015

BME4L1	MANUFACTURING ENGINEERING 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.

9	Surface grinding
10	Study of milling and grinding machines.

References:

1. Machine Shop Lab Manual, Department of Mechanical Engineering, 2015

BAN4L2	**COMPUTER AIDED DESIGNING AND DRAFTING**	**L**	**T**	**P**	**C**
	Total Contact Hours – 15	0	0	2	1
	Prerequisite – Engineering Graphics, Machine Drawing				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student with various computer software for engineering design
2. To familiarize the student with to the various options and types of designs that can be carried out using CATIA software
3. To train the student on the designing of basic mechanical parts
4. To train the student on the assembly of different mechanical parts
5. To train the student on the drafting of the part / model / assembly designed.

COURSE OUTCOMES

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

CO 1	**Master** the geometrical profile and modification tools. **(Precision)**
CO 2	**Create** 3-Dimensional models from 2-Dimensional geometries. **(Naturalization)**
CO 3	**Design** basic Aerospace components using CADD. **(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		M	H	
CO 3	H	M	M		H				H	H			H	

Category	**Professional Core (PC)**
Approval	**37th Academic Council Meeting held in May 2015.**

LIST OF EXPERIMENTS

1	Study of various software for engineering design and drafting.
2	Study of CATIA and its tools.
3	Exercise on 2D drawing.
4	Exercise on pad and groove.
5	Exercise on shaft, mirror and array.

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.

References:

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.		
UNIT II	**SHEAR FLOW IN OPEN SECTIONS**	**12**
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.		
UNIT III	**SHEAR FLOW IN CLOSED SECTIONS**	**12**
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.		
UNIT IV	**BUCKLING OF PLATES** Classical plate theory- assumptions and displacements	**12**
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.		
UNIT V	**STRESS ANALYSIS OF WING AND FUSELAGE**	**12**
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		
UNIT I	**FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW**	**12**
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.		
UNIT II	**SHOCKS AND EXPANSION WAVES**	**14**
Normal shock relations, Prandtl's relation, Hugonoit equation, Raleigh Supersonic Pitot tube equation, Moving normal shock waves, Oblique shocks, θβM 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.		
UNIT III	**TWO-DIMENSIONAL COMPRESSIBLE FLOW**	**14**
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.		
UNIT IV	**HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE CONFIGURATION**	**10**
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.		
UNIT V	**EXPERIMENTAL METHODS**	**10**
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		
Text Books: 1. Anderson, J. D, Modern Compressible Flow, Third Edition, Tata McGraw-Hill & Co., 2012. 2. Rathakrishnan., E, Gas Dynamics, Prentice Hall of India, 2004. 3. Yahya S.M., Fundamentals of Compressible Flows, Third Edition, New Age International Publishers, 2003.		
References: 1. Shapiro, A. H., Dynamics and Thermodynamics of Compressible Fluid Flow, Ronald Press, 1982. 2. Zucrow, M. J. and Anderson, J. D., Elements of Gas Dynamics, McGraw- Hill & Co., 1989. 3. Oosthuizen,P.H., &Carscallen,W.E., Compressible Fluid Flow, McGraw- Hill & Co., 19976. Perry, Aircraft Structures, McGraw-Hill, 1950.		

This course is not there in curriculum

BAS501	Rocket 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 acquaint the student about the basic theory of rocket propulsion.
2. To introduce to the student about the significance and applications of solid propellant rockets.
3. To introduce to the student about the significance and applications of liquid propellant rockets.
4. To help the student understand about the modern propulsion techniques.
5. To help the student understand about the types and performance of rocket nozzle.

COURSE OUTCOMES

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

CO 1	Analyze the propulsion system with performance parameters
CO 2	Describe performance parameters used in solid rocket motor engines
CO 3	Explain the fundamental concept of a liquid rocket engine performance
CO 4	Comprehend and illustrate the basics of hybrid, nuclear rockets in terms of their designing approach
CO 5	Relate the significance of nozzle design.

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									H				H
CO 5	H													H

Category	**Professional Core (PC)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

UNIT I	**THEORY OF ROCKET PROPULSION**	**10**

Brief History – Classification – Rocket Principle and Rocket Equation – Mass Ratio – Specific Impulse – Desirable Parameters of Rockets – Propulsive Efficiency – Performance Parameters – Staging and Clustering of Rockets – Statics Testing of Rockets		
UNIT II	**SOLID PROPELLANT ROCKETS**	**14**
Operating principle – Specific impulse of a rocket – Igniters – Internal ballistics – Selection criteria of solid propellants – propellant grain design considerations – Progressive, Regressive and neutral burning in solid rockets.		
UNIT III	**LIQUID PROPELLANT ROCKETS**	**14**
Liquid propellant rockets – selection of liquid propellants – performance and choice of various feed systems for liquid propellant rockets – hydrazine monopropellant rockets–basics of cryogenic techniques – Cooling in liquid rockets and the associated heat transfer problems – advantages of liquid rockets over solid rockets – draining of propellant tanks under microgravity conditions		
UNIT IV	**MODERN PROPULSION TECHNIQUES**	**12**
Hybrid Rockets, Burning Mechanism, Advantages of Hybrid Rockets over Solid and Liquid Propellant Rockets – Nuclear Rockets – Pulse Detonation Rockets – Beamed Rockets and Sail Propulsion – Basics of Electrothermal, Electrostatic and Electromagnetic Thrusters		
UNIT V	**ROCKET NOZZLE AND PERFORMANCE**	**10**
Nozzle types – Effect of Shape and Area Ratio – Performance Losses, Flow Separation in Nozzles – Mass Flow Rate and Characteristic Velocity – Thrust Coefficient – Bell Nozzle – Unconventional Nozzles, SERN nozzle – Aerospike nozzle, annular nozzles.		
TEXTBOOKS: 1. Ramamurthi, K., "Rocket Propulsion", Trinity Press, First Edition, 2010		
REFERENCES: 1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 8th Edition, 2010. 2. J D Mattingly, "Elements of Propulsion - Gas Turbines and Rockets ", AIAA Education Series, 2006. 3. Thomas A Ward, "Aerospace Propulsion Systems", John Wiley & Sons Inc., New York,2010. 4. DanM.Goebel, Ira Katz, „Fundamentals of Electric Propulsion", John Wiley & Sons Inc, New York, 2003.		

BAN504	**FLIGHT MECHANICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 60	3	**1**	0	4

	Prerequisite – Fundamentals of Aeronautics and Astronautics, Aerodynamics I
	Course Designed by – Department of Aeronautical Engineering

OBJECTIVES

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

COURSE OUTCOMES

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

CO 1	**Calculate** thrust and power required for propeller driven and jet powered aircraft at steady level flight. (**Apply**)
CO 2	**Evaluate** the Range, Endurance, glide and climb performances. **(Evaluate**)
CO 3	**Estimate** the take-off, landing, turning performance using V-n diagram. (**Evaluate**)
CO 4	**Describe** the characteristics of longitudinal stability. **(Understand)**
CO 5	**Evaluate** the lateral and directional stability characteristics. (**Evaluate**)

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	
CO 4	H									H			H	
CO 5	H									H			H	

Category	**Professional Core (PC)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

UNIT I	**STEADY LEVEL FLIGHT**	**12**

International Standard Atmosphere, TAS, IAS and EAS, Streamlined and Bluff body – Skin friction Drag, Pressure Drag and Induced Drag – Drag Polar – Various drags of an airplane – Methods of Drag Reduction -

Effect on Drag Polar. Steady level flight, Thrust required and Power required, Thrust available and Power available for propeller driven and jet powered aircraft, Effect of altitude, conditions for minimum drag and minimum power required		
UNIT II	**RANGE, ENDURANCE, CLIMB AND GLIDE PERFORMANCE**	**12**
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- Effect of design parameters for propeller and jet aircrafts, Absolute and service ceiling, Cruise climb, Gliding flight, Glide hodograph		
UNIT III	**TAKE OFF, LANDING AND TURNING PERFORMANCE**	**10**
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.		
UNIT IV	**LONGITUDINAL STABILITY**	**14**
General concepts, 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, Total longitudinal stability, Neutral point-Stick fixed and Stick free aspects, Free elevator factor, static margin, Hinge moment, Power effects on stability-propeller and jet aircrafts, 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, solving the stability quartic, Phugoid motion, Factors affecting the period and damping.		
UNIT V	**LATERAL AND DIRECTIONAL STABILITY**	**12**
Directional stability-yaw and sideslip, contribution to static directional stability by wing, fuselage, vertical tail, Power effects on directional stability-propeller and jet aircrafts, Rudder lock and Dorsal fin, Directional control, rudder control power, rudder requirements, adverse yaw, asymmetric power condition, spin recovery, Lateral stability-Dihedral effect, contribution of various components, lateral control, aileron control power, strip theory, roll control by spoilers, aileron reversal, aileron reversal speed		
Text Books: 1. Anderson, Jr., J.D. Aircraft Performance and Design, McGraw-Hill International Edition, 2012. 2. Houghton,E.L. and Carruthers, N.B. Aerodynamics for engineering students, Edward Amold Publishers, 2000		
References: 1. Nelson, R.C." Flight Stability & Automatic Control", McGraw Hill, 2005. 2.Pamadi, B.N. Performance, Stability, Dynamics, and Control of Airplanes, AIAA Education Series, 2004 3. McCormick, B.W. "Aerodynamics, Aeronautics & Flight Mechanics", John Wiley, 1995. 4. Babister, A.W. "Aircraft Stability and response", Pergamon Press, 1996. 5. Etkin, B., "Dynamics of Flight Stability and Control", John Wiley, New York, 1982. 6. Perkins C.D. &Hage R.E. "Airplane performance, stability and control", John Wiley & Sons 1976.		

BME505	**MANUFACTURING ENGINEERING**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3

	Prerequisite – Nil
	Course Designed by – Department of Aeronautical Engineering

OBJECTIVES

1. To introduce student about various metal working process
2. To impart theoretical knowledge about the metal cutting and machining process.
3. Introduce students about various special purpose machine and milling machine.
4. Introducing students about various drilling, boring and surface finish operations.
5. Introduce students about various non-conventional process and high energy rate forming process.

COURSE OUTCOMES

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

CO 1	**Describe** various metal forming process and different types of welding.(**Understand**)
CO 2	**Calculate** the forces involved in metal cutting process and **Estimate** the tool life,machining time and economics. (**Apply**)
CO 3	**Describe** types of lathe and their construction. (**Understand**)
CO 4	**Explain** the process of shaping, planing and milling operations. (**Understand**)
CO 5	**Discuss** the process involved in drilling, boring, broaching, surface finishing. (**Understand**)
CO 6	**Describe** the working principle of various Non-traditional machining techniques. (**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										L			
CO 3	H													
CO 4	H									M				
CO 5	H													
CO 6	H									M		L		

Category	**Professional Core (PC)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

UNIT I	METAL WORKING PROCESS	8

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

UNIT II	THEORY OF METAL CUTTING AND MACHINING PROCESSES	12

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.

UNIT III	SHAPER, PLANER AND MILLING PROCESS	8

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

UNIT IV	DRILLING, BORING, BROACHING, SURFACE FINISHING PROCESS	8

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.

UNIT V	NON-TRADITIONAL MACHINING PROCESSES AND HIGH ENERGY RATE FORMING PROCESSES	9

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.

Text Books:

1. P.C. Sharma., A text book of Production Technology, S.Chand& Company ltd, 2007.
2. P.N.Rao. Manufacturing Technology-Foundry Forging and Welding, TMH publishing co, 2009.

References:

1. W.A.J. Chapman., Workshop Technology. Vol I, II& III, 1975, ELBS.
2. Roy A Lindberg, Process and Material Manufacture, PHI, 1995.
3. Kalpakjan, Manufacturing Engineering and Technology, Addison Wesley, 2005.
4. Hajra Chowdary S.K, The fundamentals of work shop technology Vol. I & II, Media publishers, 1997.

BAN5V1	VALUE ADDED PROGRAM I	L	T	P	C
	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.

References:

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

References:

1. Aerodynamics Lab Manual, Department of Aeronautical Engineering, 2015

BAN5L2	AERO DESIGN AND MODELING LABORATORY	L	T	P	C
	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,

CO 1	**Design** and fabricate the Aircraft Structural components with appropriate materials. (**Naturalization**)
CO 2	**Conduct** flight testing of powered glider and RC plane. (**Precision**)
CO 3	**Observe** Performance characteristics of Glider and RC plane. (**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						M		H	H		M	H	

Category	**Professional Core (PC)**
Approval	**37th Academic Council Meeting held in May 2015.**

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.

References:

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.

References:

1. CAA Lab Manual, Department of Aeronautical Engineering, 2015

BSS601	VALUE EDUCATION AND PROFESSIONAL	L	T	P	C

	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

UNIT II	SOCIAL VALUES (INDIVIDUAL AND SOCIAL WELFARE)	9
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.		
UNIT III	**MIND CULTURE & TENDING PERSONAL HEALTH**	**9**
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		
UNIT IV	**ENGINEERING AS SOCIAL EXPERIMENTATION AND ENGINEERS'S RESPONSIBILITIES FOR SAFETY**	**9**
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.		
UNIT V	**ENGINEER'S RESPONSIBILITIES FOR RIGHTS AND GLOBAL ISSUES**	**9**
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. Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Eye Witnesses and Advisors – Moral Leadership		

Text Books:

1.Value Education for Health, Happiness and Harmony, The World Community Service, Centre Vethathiri Publications (Unit 1 – III).

2.Mike W Martin and Roland Schinzinger, Ethics In Engineering, Tata Mcgraw Hill, Newyork 2005 (Units IV & V)

References:

1. Philosophy of Universal Magnetism (Bio - magnetism, Universal Magnetism) The World Community Service Centre Vethathiri Publications (for Unit III)
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)
3. R S Nagaarazan, Textbook on Professional Ethics and Human Values, New Age International Publishers, 2006 (for Units IV-V)
4. Charles D Fledderman, Engineering Ethics, Prentice Hall, New Mexico, 2004(for Units IV-V)

BAN601	AEROSPACE STRUCTURAL MATERIALS AND COMPOSITES	L	T	P	C
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	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	**Discuss** various materials used in aerospace applications. (**Understand**)
CO 2	**Compute** the properties of isotropic, anisotropic and orthotropic materials. (**Apply**)
CO 3	**Calculate** the properties of laminated composites along natural and arbitrary axis. (**Apply**)
CO 4	**Determine** the stiffness matrix, stress and strain of laminated composite plate with different orientations. (**Apply**)
CO 5	**Interpret** the properties and failure modes in composite plates and sandwich panels. (**Apply**)
CO 6	**Describe** the manufacturing process of fibers and fabrication methods of composites. (**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											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.		
Text Books: 1. Jones, R.M., "Mechanics of Composite Materials", Taylor & Francis, II Edition, 2000. 2. Madhuji Mukhapadhyay, "Mechanics of Composite Materials and Structures", University Press, 2004		
References: 1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995. 2. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989. 3. Autar K Kaw, "Mechanics of Composite Materials", CRC Press, 1997. 4. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Nostrand Reinhold Co., New York 1998. 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 1	**Compare** various functional approximation methods for structural problems. (**Analyze**)
CO 2	**Calculate** the nodal field variables for one dimensional structure. (**Apply**)
CO 3	**Determine** the stiffness matrix and stress developed in two dimensional structures. (**Apply**)
CO 4	**Calculate** the nodal displacements and stress for axi-symmetric structures. (**Apply**)
CO 5	**Analyze t**he static and dynamic behavior of structures. (**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									M			H	
CO 2	H											M	H	
CO 3	H											M	H	
CO 4	H									M			H	
CO 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		
UNIT II	**ONE DIMENSIONAL SYSTEMS**	**12**
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		
UNIT III	**TWO DIMENSIONAL SYSTEMS**	**12**
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		
UNIT IV	**THREE DIMENSIONAL SYSTEMS**	**12**
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		
UNIT V	**APPLICATIONS OF FEM TO AEROSPACE STRUCTURES**	**12**
Linear static analysis - nonlinear static analysis – dynamic analysis-simple harmonic motion-damping consideration-forced vibration - Case studies and problems using software packages and programming.		

TEXTBOOKS:

1. Tirupathi. R. Chandrapatha and Ashok D. Belegundu", Introduction to Finite Elements in Engineering", Prentice Hall India, Fourth Edition, 2011.

REFERENCES:

1. Reddy J.N.,"An Introduction to Finite Element Method ",McGraw Hill , 3rd edition, 2005.
2. Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw Hill, 2nd 2001.
3. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.
4. Rao. S.S., "Finite Element Methods in Engineering", Butterworth and Heinemann, Fourth Edition, 2005.
5. Daryl L. Logan, "A First Course in the Finite Element Method", 5th Edition, PWS Publishing Company, Boston, 2010.

WEBLINKS:

https://nptel.ac.in/courses/112104116/

BAN603	CONTROL ENGINEERING	L	T	P	C
	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,

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

UNIT I	**SYSTEM AND REPRESENTATION**	**9**

Basic elements in control systems – Open and closed loop systems – Electrical analogy of mechanical systems – Transfer function – Block diagram reduction techniques.

UNIT II	**TIME RESPONSE**	**9**

Time response – Time domain specifications – Types of test input- I and II order system response – Error coefficients – Generalized error series – Steady state error- P, PI, PID modes of feedback control – Time response analysis.

UNIT III	**FREQUENCY RESPONSE**	**9**

Frequency response – Bode plot- polar plot – Determination of closed loop response from open loop response – Correlation between frequency domain and time domain specifications.

UNIT IV	**CONCEPT OF STABILITY**	**9**

Characteristics equation – Root Locus construction - Routh Hurwitz stability criterion

UNIT V	**SAMPLED DATA SYSTEMS**	**9**

Sampled data control systems- functional elements – sampling process- z-transforms-properties inverse z transforms – ZOH and First Order Hold process- pulse transfer functions – step response – Introduction to digital control system, Digital Controllers and Digital PID controller

Text Books:

1. OGATO, Modern Control Engineering, Fifth Edition, Prentice-Hall of India Pvt.Ltd., New Delhi, 2010.
2. Azzo, J.J.D. and C.H. Houpis, Feedback control system analysis and synthesis, McGraw-Hill international 3rs Edition, 1998.

References:

1. Kuo, B.C. Automatic control systems, Prentice-Hall of India Pvt.Ltd., New Delhi, 2009.
2. Houpis, C.H. and Lamont, G.B. Digital control Systems, McGraw Hill Book co., New York, U.S.A. 1995.
3. Naresh K Sinha, Control Systems, New Age International Publishers, New Delhi, 1998.

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
2. To enhance the presentation skills of the student
3. To familiarize the student on attractive resume writing
4. To familiarize the student on Interviews and Group Discussions
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.

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.

References:

1. Value Added Program II Preparatory Material, Department of Aeronautical Engineering, 2015

BAN6L1	AIRCRAFT SYSTEM LABORATORY	L	T	P	C
	Total Contact Hours – 30	0	0	4	2
	Prerequisite – Aircraft Systems and Instrumentation.				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. Appreciate the need of various aircraft systems, components, accessories and its functions.
2. Understand the importance of aircraft system maintenance and checks.
3. Understand the jacking procedure, levelling and symmetric checks done in the aircraft.
4. Understand the rigging procedure of the aircraft, Understand the operation of Brake torque load test and fuel clogging test
5. Develop the skills of trouble shooting and rectification of snags.

COURSE OUTCOMES

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

CO 1	**Observe** Aircraft ground operations. (**Imitation**)
CO 2	**Conduct** Checks to ensure the airworthiness of aircraft. (**Precision**)
CO 3	**Refine** the performance of aircraft systems. (**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				H

Category	**Professional Core (PC)**
Approval	**37th Academic Council Meeting held in May 2015.**

LIST OF EXPERIMENTS

1	Aircraft systems observations during Ground run.
2	Aircraft “Mooring” procedure.
3	Aircraft “Symmetry Check” procedure.
4	Procedure to find the centre of gravity of Aircraft.
5	“Study of aircraft fuel system components.

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.

References:

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.
2. Understand the importance of velocity in supersonic circular and noncircular jets.
3. Understand the determination of wall jet velocity profile in the aircraft.
4. Understand the need of operation of a ramjet engine.
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.

9	Operation of a subsonic Ramjet engine.
10	Determine the calorific value of Fuel using Bomb Calorimeter.

References:

1. Propulsion Lab Manual, Department of Aeronautical Engineering, 2015

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.

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.

References:

1. Aircraft Performance and Design, "John D Anderson", Tata McGraw Hill Publications
2. Analysis and Design of Flight Vehicle Structures, E F Bruhn
3. CADD and CAA Lab Manuals, Department of Aeronautical Engineering, 2015

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 1	**Solve** the well posed and ill posed problems. (**Apply**)
CO 2	**Apply** appropriate Finite Difference schemes for solving PDE. (**Apply**)
CO 3	**Analyze** various explicit and implicit methods for a converging solution. (**Analyze**)
CO 4	**Solve** the steady state diffusion and convection problems using finite volume method. (**Apply**)
CO 5	**Identify** suitable turbulence model for fluid flow problems. (**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												H	
CO 4	H									H		H	H	
CO 5	H											H	H	

Category	**Professional Core (PC)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

<table>
<tr><td>UNIT I</td><td>FUNDAMENTAL CONCEPTS</td><td>10</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>UNIT II</td><td>INTRODUCTION TO FINITE DIFFERENCE METHOD EQUATIONS</td><td>9</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>UNIT III</td><td>FINITE DIFFERENCE METHOD FOR DIFFUSION</td><td>8</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>UNIT IV</td><td>FINITE VOLUME METHOD FOR DIFFUSION AND CONVECTION</td><td>10</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>UNIT V</td><td>TURBULENCE MODELLING</td><td>8</td></tr>
<tr><td colspan="3">Turbulence models, mixing length model, Two equation (k-€) models – High and low Reynolds number models. Large eddy simulation- Direct numerical simulation.</td></tr>
<tr><td colspan="3">Text Books:
1. Jiyuan Tu, Guan,HengYeoh, Chaoqun Liu, “Computational Fluid Dynamics A Practical Approach” Springer Verlag,2012.
2. J. D.Anderson, “Computational Fluid Dynamics”, McGraw Hill International, 2012.</td></tr>
<tr><td colspan="3">References:
1. H.K. Versteeg and W. Malalsekera “An Introduction to Computational Fluid Dynamics, The Finite Volume Method”, Longman Scientific & Technical, 2007.
2. T. J. Chung, “Computational Fluid Dynamics”, Cambridge University Press, 2002.
3. C. Hirch, “Numerical Computation of Internal and External Flows” Volume-2, John Wiley and Sons, 1994.</td></tr>
</table>

This course is not there in curriculum
This course is SAME as BANE21

BAS701	**SATELLITE TECHNOLOGY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Basic Electricals and Electronics, Mechanics of Machines				
	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)**

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			H	
CO 3	H												H	
CO 4	H									H			H	
CO 5	H												H	

Category	**Professional Core (PC)**
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	**SATELLITE DYNAMICS**	**9**
Fundamental of satellite 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**
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.		
UNIT IV	**SPACECRAFT CONTROL**	**9**
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		
UNIT V	**POWER SYSTEM AND BUS ELECTRONICS**	**9**
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, Kaetc), their characteristics and applications- Coding Systems – Onboard computer- Ground checkout Systems.		

Text Books:

1. Spacecraft Thermal Control, Hand Book, Aerospace Press, 2002.
2. Introduction Space Flight, Francis J. Hale Prentice Hall, 1994.

References:

1. Analysis and Design of Flight Vehicle Structures, Tri-State off set company, USA, 1980.
2. Space Systems Engineering Rilay, FF, McGraw Hill, 1982.
3. Principles of Astronautics Vertregt. M., Elsevier Publishing Company, 1985

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 ofsemi-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. 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.		
Text Books: 1. Sachdeva, S.C. “Fundamentals of Engineering, Heat and Mass Transfer, Wiley Eastern Ltd. Fourth Edition, New Delhi, 2012. 2. Holman, J.P., "Heat Transfer ", McGraw Hill Book Co., Inc., New York, TenthEdition.,2009.		
References: 1. Sutton, G.P., "Rocket Propulsion Elements ", John Wiley and Sons, 8th Edition.2010. 2. Lienhard J. H., “A Heat Transfer Text Book”, Phlogiston Press, U.S.A., 2008. 3. Ozisik M.N.,”Heat Transfer A Basic Approach”, The McGraw-Hill Company, reprint 1995.		

BAN7L1	**AIRFRAME AND AERO ENGINE REPAIR LAB**	**L**	**T**	**P**	**C**
	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,

CO 1	**Demonstrate** the various procedures and techniques for the Airframe repair (**Manipulation**)
CO 2	**Demonstrate** the procedures and techniques followed in Aero Engine inspection . (**Manipulation**)
CO 3	**Perform** engine dismantling and Assembling **(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	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

BAS7L2	SATELLITE DESIGN 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 : To help the student to understand the process of satellite design.

COURSE OUTCOMES

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

CO 1	Perform investigation on accessories in nano satellites
CO 2	Design of satellite subsystems
CO 3	Demonstrate the systems in nano satellite

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				H				H	H		H	H	
Category	**Professional Core (PC)**													
Approval	**37th Academic Council Meeting held in May 2015.**													

LIST OF EXPERIMENTS

1	Introduction – Payload Specifications and Requirements
2	Study of Various Types of Sensors and Accessories in Nano Satellites
3	Cost Estimation and Feasibility Studies
4	Design and Fabrication of a Structural Framework for a Nano Satellites
5	Demonstration of Onboard GPS for recovery
6	Design of Communication System for Data Transfer
7	Design of Thermal Protection System
8	Design of Electro Magnetic Shield
9	Exercise on Selection of Appropriate Power Source and Distribution System
10	Assembling and Packing of Nano Satellite

References:

1. Analysis and Design of Flight Vehicle Structures, Tri-State off set company, USA, 1980.
2. Space Systems Engineering Riley, FF, McGraw Hill, 1982.

BAN7L3	AIRCRAFT DESIGN PROJECT II	L	T	P	C
	Total Contact Hours – 30	0	0	4	2
	Prerequisite – Flight Mechanics, Aircraft Structures I & II, Aerodynamics I & II, Aircraft Design Project I, Computer Aided Design and Analysis				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce to the student about the various kinds of loads acting on an airplane and about the detailed structural design of an aircraft
2. To enable the student to be able to estimate the loads on aircraft's wing and fuselage
3. To enable the student to able to perform a detailed design of the aircraft's wing and fuselage components
4. To enable the student to make a detailed design report and a layout of aircraft drawings
5. To enable the student to model the designed aircraft and perform a flow analysis and structural analysis

COURSE OUTCOMES

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

CO 1	**Observe** safety flying critical flying load limits. **(Imitation)**
CO 2	**Design** of fuselage and wing structural members. **(Articulation)**
CO 3	**Integrate** all the design parameters to assemble an aircraft. **(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	H		H	H	
CO 2	H	H	H		H				H	H		H	H	
CO 3	H	H	H		H				H	H		H	H	

Category	**Professional Core (PC)**
Approval	**37th Academic Council Meeting held in May 2015.**

LIST OF EXPERIMENTS

1	V-n diagram for the design study.
2	Gust and maneuverability envelopes.
3	Critical loading performance and final V-n graph calculation.
4	Structural design study – Theory approach.
5	Load estimation of wings.
6	Load estimation of fuselage.
7	Balancing and Maneuvering loads on tail plane, Aileron and Rudder loads.

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.

References:

1. Aircraft Performance and Design, "John D Anderson", Tata McGraw Hill Publications
2. Analysis and Design of Flight Vehicle Structures, E F Bruhn
3. CADD and CAA Lab Manuals, Department of Aeronautical Engineering, 2015

BAN7P1	Project Phase 1	L	T	P	C
	Total Contact Hours – 30	0	0	4	2
	Prerequisite – Nil				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student with theoretical and experimental studies related to aeronautical science.
2. To enable the student to get involved in key area of research in the branch of study.
3. To perform the literature studies and survey that will help in formulating the problem statement.
4. To enable the student to understand the concept of the acquired statement to get the idea about the work.
5. To work according to the acquired idea and to develop report in the form as specified in the guidelines.

COURSE OUTCOMES

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

CO 1	**Observe** the current market scenario to develop new or modify the existing product. **(Imitation)**
CO 2	**Complete** the concept design of the project. **(Manipulation)**
CO 3	**Point out** the methodology for implementation of design. **(Manipulation)**

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	H	H
CO 2	H	H	H	H	H	H		H	H	H	H	H	H	H
CO 3	H	H	H	H	H	H		H	H	H	H	H	H	H

Category	**Professional Core (PC)**
Approval	**37th Academic Council Meeting held in May 2015.**

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.

BAN8P1	PROJECT WORK	L	T	P	C
	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				

OBJECTIVE :

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.

COURSE OUTCOMES

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

CO 1	**Tell** the value of achieving perfection in projects implementation & completion. **(Imitation)**
CO 2	**Build** the skills, competencies and point of view of designed concepts. **(Naturalization)**
CO 3	**Replicate** professional skills in Presentation, Technical report writing, critical thinking and decision making. **(Manipulation)**

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	H	H
CO 2	H	H	H	H	H	H		H	H	H	H	H	H	H
CO 3	H	H	H	H	H	H		H	H	H	H	H	H	H

BAN8C1	COMPREHENSION	L	T	P	C
	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,

CO 1	**Recollect** the core engineering concepts. **(Remember)**
CO 2	**Acquire** Presentation Skills to face job interviews. **(Apply)**
CO 3	**Write** competitive examinations for successful career. **(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													
CO 2	H								H	M				
CO 3	H								H					

BASE01	**THEORY OF ELASTICITY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Nil				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

To make the student understand the elastic behavior of different structural components under various loadings and boundary conditions.

COURSE OUTCOMES

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

CO 1	The student will know about the basic equations of elasticity
CO 2	The student will be able to solve plane stress and plane strain problems using modules
CO 3	The student will know the procedure of coordinates system.
CO 4	The student will understand the procedure of conduct torsion problems
CO 5	The student will get an idea of theory of plates and shells

Category	**Professional Elective (PE)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

UNIT I	**BASIC EQUATIONS OF ELASTICITY**	**9**

Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant’s principle - Principal Stresses, Stress Ellipsoid - Stress invariants

UNIT II	**PLANE STRESS AND PLANE STRAIN PROBLEMS**	**9**

Airy’s stress function, Bi-harmonic equations, Polynomial solutions, Simple two dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams.

UNIT III	**POLAR COORDINATES**	**9**

Equations of equilibrium, Strain - displacement relations, Stress – strain relations, Airy’s stress function, Axi – symmetric problems, Introduction to Dunder’s table, Curved beam analysis, Lame’s, Kirsch, Michell’s and Boussinesque problems – Rotating discs

UNIT IV	**TORSION**	**9**

Navier’s theory, St. Venant’s theory, Prandtl’s theory on torsion, semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections. Membrane Analogy.

UNIT V	**INTRODUCTION TO THEORY OF PLATES AND SHELLS**	**9**

Classical plate theory – Assumptions – Governing equations – Boundary conditions – Navier's method of solution for simply supported rectangular plates – Levy's method of solution for rectangular plates under different boundary conditions.

Text Books:

1. 1. Timoshenko, S., and Goodier, T.N., "Theory of Elasticity", McGraw–Hill Ltd., Tokyo, 1990.

References:

1. Enrico Volterra & J.H. Caines, "Advanced Strength of Materials", Prentice Hall, New Jersey, 1991.
2. Wng, C.T., "Applied Elasticity", McGraw–Hill Co., New York, 1993.
3. Sokolnikoff, I.S., "Mathematical Theory of Elasticity", McGraw–Hill New York,1978.

<table>
<tr><td rowspan="4">BANE02</td><td>ROCKETS AND MISSILES</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Total Contact Hours – 45</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Prerequisite – Aerodynamics, Aircraft Stability and Control, Avionics, Aircraft Structural Materials and Composites</td></tr>
<tr><td colspan="5">Course Designed by – Department of Aeronautical Engineering</td></tr>
<tr><td colspan="6">OBJECTIVE: To learn about the aerodynamics and stability of Rockets and Missiles.</td></tr>
<tr><td colspan="6">COURSE OUTCOMES
At the end of Course, Students will be able to,</td></tr>
<tr><td>CO 1</td><td colspan="5">Describe combustion mechanisms in solid and liquid propellant rockets. (Understand)</td></tr>
<tr><td>CO 2</td><td colspan="5">Compute the forces and moments acting on rockets and missile while passing through atmosphere. (Apply)</td></tr>
<tr><td>CO 3</td><td colspan="5">Analyze the trajectory of rockets and missiles in free space and gravitational field. (Analyze)</td></tr>
<tr><td>CO 4</td><td colspan="5">Summarize different thrust vector control techniques and stage separation inrockets. (Understand)</td></tr>
<tr><td>CO 5</td><td colspan="5">Apply suitable materials used for their construction. (Apply)</td></tr>
<tr><td>Category</td><td colspan="5">Professional Elective (PE)</td></tr>
<tr><td>Approval</td><td colspan="5">37th Academic Council Meeting held in May 2015.</td></tr>
<tr><td colspan="6">COURSE CONTENT</td></tr>
<tr><td>UNIT I</td><td colspan="4">ROCKET SYSTEMS</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>UNIT II</td><td colspan="4">AERODYNAMICS OF ROCKETS AND MISSILES</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>UNIT III</td><td colspan="4">ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD</td><td>9</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">STAGING AND CONTROL OF ROCKETS AND MISSILES</td><td>9</td></tr>
<tr><td colspan="6">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</td></tr>
</table>

injection thrust vector control – numerical problems on stage separation and multistaging.		
UNIT V	**MATERIALS FOR ROCKETS AND MISSILES**	**9**
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.		
Total Periods: 45		
Text Books: 1.Martin J L Turner, Rocket and Spacecraft Propulsion, Springer-Praxis Publishing, 2001 2.Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 7th Edition, 2001		

BASE02	ELECTRIC PROPULSION	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Rocket Propulsion				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce basic physics of electric propulsion systems.

COURSE OUTCOMES

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

CO 1	LIST different types of techniques used in electric PROPULSION(Remember)
CO 2	Discuss the properties of ionized gases (Understand)
CO 3	Classify electro thermal propulsive engines (understand)
CO 4	Identify the engines working based on electromagnetic propulsion(Understand)
CO 5	Explain the field electric propulsive systems

Category	**Professional Elective (PE)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

UNIT I	**INTRODUCTION TO THE BASIC PHYSICS OF ELECTRIC PROPULSION SYSTEMS**	**9**

Historical outline - Definition of Electric Propulsion - High impulse Space Missions - Exhaust velocity and specific impulse - Power supply penalty – Electric charges and Electrostatic fields - Currents and Magnetic interactions - Time dependent fields and Electromagnetic wave propagation - Application to ionized gas flows

UNIT II	**PHYSICS OF IONIZED GASES**	**9**

Atomic structure of gases - Ionization processes - Particle collisions in an ionized gas - Electrical conductivity of an ionized gas - Kinetic Theory

UNIT III	**ELECTRO-THERMAL PROPULSION**	**9**

One dimensional model - Enthalpy of high temperature gases - Frozen flow efficiency - Resistojets - Electrical discharges - Arcjets - Operation and Analysis - Materials - Advantages and Disadvantages

UNIT IV	**ELECTROMAGNETIC PROPULSION**	**9**

The Lorentz force - Magnetogasdynamics channel flow - Ideal steady flow acceleration - Thermal and viscous losses - Geometry considerations - Self induced fields - Sources of the conducting gas - The magneto plasmadynamic arc - Magneto- plasmadynamic (MPD) thrusters - Pulsed plasma acceleration - Pulsed plasma thrusters (PPT) - Quasi steady acceleration - Pulsed inductive acceleration - Traveling wave acceleration

UNIT V	**ELECTROSTATIC PROPULSION**	**9**
One dimensional space-charge flows - Basic relationships - The acceleration- deceleration concept - Ion engines - Design and Performance - Hall effect – Hall thrusters - Field emission electric propulsion (FEEP) - Colloid thrusters		
TEXTBOOKS: 1. 1. Robert G. Jahn, "Physics of Electric Propulsion", McGraw-Hill Series, New York, 1968.		
REFERENCES: 1. George W. Sutton, "Engineering Magneto hydrodynamics", Dover Publications Inc., New York, 2005 2. George P. Sutton & Oscar Biblarz, "Rocket Propulsion Elements, John Wiley & Sons Inc., New York, 8th Edition, 2010. **WEBLINKS:** https://engineering.purdue.edu/ProEd/courses/electric-propulsion https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-522-space-propulsion-spring-2015/		

BASE03	LAUNCH VEHICLE AERODYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Applied Dynamics and Vibrations, Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

To acquaint the students with the fundamentals of the aerodynamics of launch vehicles

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	**BASICS OF HIGH SPEED AERODYNAMICS**	**9**
Compressible flows-Isentropic relations-mathematical relations of flow properties across shock and expansion waves-fundamentals of Hypersonic Aerodynamics		
UNIT II	**BOUNDARY LAYER THEORY**	**9**
Basics of boundary layer theory-compressible boundary layer-shock shear layer interaction -Aerodynamic heating-heat transfer effects		
UNIT III	**LAUNCH VEHICLE CONFIGURATIONS AND DRAG ESTIMATION**	**9**
Types of Rockets and missiles-various configurations-components-forces on the vehicle during atmospheric flight-nosecone design and drag estimation.		
UNIT IV	**AERODYNAMICS OF SLENDER AND BLUNTBODIES**	**9**
Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles-determination of aero elastic effects.		
UNIT V	**AERODYNAMIC ASPECTS OF LAUNCHING PHASE**	**9**

Booster separation-crosswind effects-specific consideration sin missile launching-missile integration and separation-methods of evaluation and determination-Stability and Control Characteristics of Launch Vehicle Configuration-Wind tunnel tests –Comparison with CFD Analysis.

Text Books:

1. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw-Hill BookCo. NewYork, 2010. (Units 1 & 2)
2. Chin SS, Missile Configuration Design, McGrawHill, New York, 1961. (Unit 3)
3. Anderson, J.D., "Hypersonic and High Temperature Gas Dynamics", AIAA Education Series.(Units 4 &

References:

1. Nielson, Jack N, Stever, Gutford, "Missile Aerodynamics", McGraw Hill, New York, 1960.
2. Anderson Jr.,D.,–"Modern compressible flows", McGraw-Hill BookCo.,NewYork1999.
3. Charles D.Brown, "Spacecraft Mission Design", AIAA Education Series, Published by AIAA, 1998
4. Elements of Space Technology for Aerospace Engineers", Meyer Rudolph X, Academic Press,1999

Code is wrong. It is BASE04

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.		
UNIT III	**INTERPLANETARY TRAJECTORIES**	**12**
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		
UNIT IV	**BALLISTIC MISSILE TRAJECTORIES**	**9**
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.		
UNIT V	**MATERIALS FOR SPACECRAFT**	**6**
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.		

Text Books:

1.Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman &Co., Ltd, London, 1982

2. Parker, E.R., "Materials for Missiles and Spacecraft", Mc Graw Hill Book Co. Inc., 1982.

References:

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 7th Edition, 2001.

Course is repeated.
See Previous page

BASE04	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.		
UNIT III	**INTERPLANETARY TRAJECTORIES**	**12**
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		
UNIT IV	**BALLISTIC MISSILE TRAJECTORIES**	**9**
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.		
UNIT V	**MATERIALS FOR SPACECRAFT**	**6**
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.		

Text Books:

1.Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman &Co., Ltd, London, 1982
2. Parker, E.R., "Materials for Missiles and Spacecraft", Mc Graw Hill Book Co. Inc., 1982.

References:

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 7th Edition, 2001.

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.		
UNIT IV	**APPROXIMATE METHODS**	**9**
Approximate methods-Rayleigh"s method, Dunkerleys method, Holzer method, Matrix iteration method		
UNIT V	**ELEMENTS OF AEROELASCTICITY**	**9**
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.		

Text Books:

1. Y.C. Fung, "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York, 2008.
2. Thomson W T, 'Theory of Vibration with Application' - CBS Publishers, 1990.

References:

1. Timoshenko S., Vibration Problems in Engineering – John Wiley and Sons, New York, 1993.
2. Bisplinghoff R.L., Ashely H and Hogman R.L., Aeroelasticity – Addision Wesley Publication, New Tork, 1983.
3. R.H. Scanlan and R.Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.
4. R.D.Blevins, "Flow Induced Vibrations", Krieger Pub Co., 2001

BANE08	HELICOPTER AERODYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Aeronautics and Astronautics, Aerodynamics I				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint with the basics of rotating wing concept.
2. To understand the concept of hovering flight dynamics.
3. To understand the concept of forward flight dynamics.
4. To analyze the climb and descent performance.
5. To acquaint with ground effect machines.

COURSE OUTCOMES

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

CO 1	**Describe** various helicopter configurations and their working principles. **(Understand)**
CO 2	**Estimate** the rotor performance parameters for hover flight. **(Evaluate)**
CO 3	**Discuss** the forward flight dynamic performance parameters. **(Understand)**
CO 4	**Discuss** the power required for climb and descent. **(Understand)**
CO 5	**Discuss** the working principle and applications of hovercraft. **(Understand)**

Category	**Professional Elective (PE)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

UNIT I	INTRODUCTION TO ROTATING WING CONCEPT	9

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 Cyclic pitch – Lead – Lag and flapping hinges.

UNIT II	HOVERING FLIGHT DYNAMICS	9

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.

UNIT III	FORWARD FLIGHT DYNAMICS	9

Forward flight performance-Parasite drag and Power-Stall limitations-flapping-cyclic Pitch - Autorotation in hover and in forward flight-Dead man’s curve.

UNIT IV	CLIMB AND DESCENT PERFORMANCE	9
Vertical flight-flow patterns surrounding the rotor-Power required in climb and descent- Descent speed calculations-Take-off techniques.		
UNIT V	**GROUND EFFECT MACHINES**	**9**
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.		

Text Books:

1. Gupta. L "Helicopter Engineering", Himalayan Books, 1996
2. Seddon. J "Basic Helicopter Aerodynamics" AIAA education series, 1990.

References:

1. Gessow A & Myers G.C "Aerodynamics of Helicopter" Mac Millan& Co, 1987
2. Saunders "Dynamics of Helicopter flight", John Wiley, 1975
3. Newman. S "Foundation of Helicopter Flight" Halsted Press, 1994

BANE09	**AIRCRAFT ENGINE REPAIR AND MAINTENANCE**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aircraft Propulsion, Basic aircraft maintenance and repair				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To know about the hydraulic, pneumatic, brake and landing gear systems principle, function of components, types and operation of typical system.
2. To study and differentiate conventional and modern aircraft control systems and engine control systems
3. To study about layout, components, functions of fuel, lubrication, starting, ignition systems of piston and jet engines.
4. To understand air-conditioning, air cycle, vapor cycle, oxygen, deicing, anti icing and fire protection systems of aero plane.
5. To study construction and operation of flight, navigation instruments and engine instruments installed in the aero plane.

COURSE OUTCOMES

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

CO 1	**Describe** the inspection and troubleshooting procedure for piston engine components. **(Understand)**
CO 2	**Explain** the inspection and troubleshooting methods of aircraft propeller. **(Understand)**
CO 3	**Discuss** the overhauling and testing procedure for aircraft reciprocating engine. **(Understand)**
CO 4	**Describe** the checks and maintenance procedures followed in gas turbine engines and **select** appropriate trouble shooting technique. **(Understand)**
CO 5	**Discuss** the overhauling procedure of aircraft gas turbine engine. **(Understand)**

Category	**Professional Elective (PE)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

UNIT I	**INSPECTIONS AND TROUBLE SHOOTING OF PISTON ENGINES**	**9**

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.

UNIT II	**INSPECTION AND TROUBLE SHOOTING OF PROPELLER**	**9**

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.		
UNIT III	**OVERHAULING OF PISTON ENGINES**	**9**
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		
UNIT IV	**INSPECTION AND TROUBLE SHOOTING OF GAS TURBINE ENGINE**	**9**
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.		
UNIT V	**OVERHAULING OF GAS TURBINE ENGINES**	**9**
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.		
Text Books: 1. KROES & WILD, "Aircraft Power plants", 7th Edition – McGraw Hill, New York, 1994.		
References: 1. TURBOMECA, "Gas Turbine Engines", The English Book Store, New Delhi, 1995. 2. UNITED TECHNOLOGIES PRATT & WHITNEY, "The Aircraft Gas turbine Engine and its Operation", The English Book Store, New Delhi.		

BANE10	CRYOGENIC ROCKET PROPULSION	L	T	P	C

		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 1	**Discuss** the basic components of cryogenic systems. **(Understand)**
CO 2	**Explain** the types of cryogenic propellant used and their storage and handling. **(Understand)**
CO 3	**Discuss** cryo equipment and accessories of cryogenic engine system. **(Understand)**
CO 4	**Discuss** various subsystem involved in the operation of cryogenic engine and their design aspects. **(Understand)**
CO 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**

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

UNIT III	**CRYO EQUIPMENT AND ACCESSORIES**	**9**

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

UNIT IV	**CRYOGENIC ENGINES**	**9**

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.		
UNIT V	**CHALLENGES IN CRYOGENIC ROCKET TECHNOLOGY**	**9**
Problems in storage and handling of cryogenic propellants: safety aspects, Thermal protectionsystems for stage tanks, Thermal stratification- destratification, Geysering effect – geysering elemination, Zero "g" problems – restart mechanism.		
TEXTBOOKS: 1. "A text book of Cryogenics", "Valery V. Kostionk", Discovery Publishing House, 2010. (Units 1 to 3) 2. "Operation of a Cryogenic Rocket Engine", "Kitsche, Wolfgang", Springer Publications, 2011. (Units 4 & 5)		
REFERENCES: 1. "Rocket Propulsion Elements", "Sutton G. P., Bibliarz" **WEBLINKS:** https://nptel.ac.in/courses/112101004/		

BASE08	**SPACE MISSION DESIGN AND ANALYSIS**	**L**	**T**	**P**	**C**

	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Introduction to Aerospace Engineering				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To make the students learn basics of Space Mission design process					

UNIT I SPACE MISSION DESIGN PROCESS 9

Classification of space missions – Low earth, Medium altitude, Geo-stationary, deep space, space mission life cycle, Mission objectives, identification of mission needs, requirements and constraints, mission characterization, mission evaluation, orbit and constellation design - Space Environment – peculiarities, survivability, selection of spacecraft material - Selection of launch systeM

UNIT II SPACECRAFT SYSTEM ENGINEERING 9

Spacecraft design and sizing, spacecraft payload design, spacecraft subsystems, functional requirement - Propulsion, attitude determination and control, power systems, thermal control, navigation and guidance, telemetry, tracking and command systems, ground system design

UNIT III GENERAL N-BODY PROBLEM 9

Relative Motion in the N-body Problem, Two body problem, orbit determination techniques, Kepler’s equation, Lamberts problem - Restricted Three Body Problem – Lagrange points - Jacobi Integral, orbital perturbation

UNIT IV SATELLITE INJECTION AND REENTRY FLIGHT DYNAMICS 9

Launching of a satellite - General aspects of satellite Injections, launch vehicle ascent trajectories, injection parameters and orbital elements, launch vehicle performance, orbit deviations due to injection errors - Reentry flight dynamics – fundamentals of entry flight mechanics, fundamentals of entry heating, entry vehicle design, landing and recovery techniques

UNIT V INTERPLANETARY TRAJECTORIES 9

Patched Conic Approximation - Patched Conic Procedure - Sphere of Influence - Locating the Planets - Design of the Transfer Ellipse - Design of the Departure Trajectory - Design of the Arrival Trajectory - Gravity-Assist maneuver - Establishing Planetary Orbit – Motion of the Earth-Moon System - Time of Flight and Injection Velocity - Lunar Patched Conic

TEXTBOOKS:

1. Cornelisse, J.W, Schoyer H F R, and Wakker K F, "Rocket Propulsion and Space Dynamic", Pitman Publishing Co., 1979

REFERENCES:

1. Peter Fortescue, John Stark, Graham Swinerd, “Spacecraft systems engineering” Wiley 2004
2. Vincent N Pisacane, “Fundamentals of space system design” Oxford University Press, 2005
3. W J Larson and J R Wertz, “Space Mission Analysis and Design”, Kluwer Academic Publishers, 1999.
4. Michael Griffin, “Space Vehicle Design”, AIAA education series, 2004
5. Ashish Tewari, “Atmospheric and Space Flight Dynamics”, Birkhauser, Boston, 2007

WEBLINKS:
https://www.aticourses.com/space_mission_analysys.html

COURSE OUTCOMES	
CO 1	Describe the basic process of space mission design (understand)
CO 2	Classify the various spacecraft systems and their design (understand)
CO 3	Summarize orbit determination techniques and n body problems (understand)
CO 4	Identify the concepts of launching and reentry of vehicles (understand)
CO 5	Develop the trajectory and orbits for space vehicles (apply)

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.
2. To introduce students to real gas effects caused by high temperature conditions.
3. To study pressure and heat transfer phenomena at the stagnation point of a hypersonic vehicle.
4. To study the distribution of pressure around a general vehicle shape.

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**

Local surface inclination methods-Newtonian theory-modified Newtonian law-tangent wedge and tangent cone and shock expansion methods-approximate theory-thin shock layer theory.

UNIT III	**VISCOUS HYPERSONIC FLOW THEORY**	**9**

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.

UNIT IV	**VISCOUS INTERACTIONS IN HYPERSONIC FLOWS**	**9**

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.

UNIT V	**INTRODUCTION TO HIGH TEMPERATURE EFFECTS**	**9**

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.

TEXTBOOKS:

1. Ethirajan Rathakrishnan., "High Enthalpy Gas Dynamics", John Wiley and Sons, 2015

REFERENCES:

1. John. D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", AIAA Series, New York, 2006.

2. John. D. Anderson. Jr., "Modern compressible flow with historical perspective", McGraw Hill Publishing Company, New York, 1996.

3. John. T Bertin, “Hypersonic Aerothermodynamics”, published by AIAA Inc.,Washington. D.C., 1994.
WEBLINKS:
https://nptel.ac.in/courses/101103003/

BANE13	**AN INTRODUCTION TO COMBUSTION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Aerothermodynamics, Aircraft Propulsion				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES
1. To acquaint with the basics of combustion.
2. To understand the combustion process in aircraft piston engines.
3. To understand the combustion process in gas turbine engines.
4. To understand the combustion process in scramjet engines.

5. To understand the combustion process in rocket engines.

COURSE OUTCOMES

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

CO 1	**Explain** thermo chemical reaction associated with combustion process and the various parameters affecting burning velocity. **(Understand)**
CO 2	**Select** apt fuel for optimum combustion in piston engines. **(Analyze)**
CO 3	**Compare** the ramjet and gas turbine combustion chamber design. **(Understand)**
CO 4	**Analyze** the challenges associated with supersonic combustion. **(Analyze)**
CO 5	**Discuss** combustion process in solid, liquid propellant rockets and hybrid rockets. **(Understand)**

Category	**Professional Elective (PE)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

UNIT I	**INTRODUCTION TO COMBUSTION**	**9**

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

UNIT II	**COMBUSTION IN AIRCRAFT PISTON ENGINES**	**9**

Introduction to combustion in aircraft piston engines – various factors affecting the combustion efficiency - fuels used for combustion in aircraft piston engines and their selection – detonation in piston engine combustion and the methods to prevent the detonation

UNIT III	**COMBUSTION IN GAS TURBINE ENGINES**	**9**

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.

UNIT IV	**COMBUSTION IN SCRAMJET ENGINES**	**9**

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.

UNIT V	**COMBUSTION IN ROCKET ENGINES**	**9**

Solid propellant combustion - double and composite propellant combustion – various combustion models – combustion in liquid rocket engines – single fuel droplet combustion model – combustion hybrid rockets

Text Books: 1.Stephen R turns, ”An Introduction to Combustion”, Tata Mc. Graw Hill Publishing Co., Ltd., New Delhi, Reprint 2013. 2. Lefebvre AG and Dilip R ballal, “Gas Turbine Combustion”, CRC press ,Third Edition, 2010.
References: 1.Warnatz J, Maas U and Dibble RW,”Combustion”,Springer, Fourth Edition,2006. 2. Beer, J.M., and Chiger, N.A. “Combustion Aerodynamics”, Applied Science Publishers Ltd., London, 1981. 3. Sharma, S.P., and Chandra Mohan, “Fuels and Combustion”, Tata Mc. Graw Hill Publishing Co., Ltd., New Delhi, 1987

U18PEAS034	**SOLAR THERMAL ENERGY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Nil				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To learn the basics of solar thermal energy					

COURSE OUTCOMES	
CO 1	Describe the different techniques to extract energy form the sun (Understand)
CO 2	Discuss the modeling and analysis of solar collectors (Understand)
CO 3	Explain the principle , working methodology for solar concentrators and receivers (understand)
CO 4	Classify solar power generation systems based on efficiencies (understand)
CO 5	Identify the models for thermal storage and cooling systems (Understand)

UNIT I	**INTRODUCTION**	**9**

Introductory aspects of non-renewable and renewable energy sources – fundamentals of thermal radiation – resource assessment – solar radiation concepts – solar-earth geometry – models to predict global and daily and hourly irradiation.	
UNIT II SOLAR COLLECTION THEORY AND TECHNOLOGIES	**8**
Heat transfer in solar collectors – basic modeling aspects – steady and dynamic analysis – performance parameters.	
UNIT III SOLAR CONCENTRATION SYSTEMS AND RECEIVERS	**10**
Overview and introduction to concentration optics – concentration ratio and thermodynamic maximum – linear concentration: trough and linear Fresnel – point concentration: dish and tower (central receiver system).	
UNIT IV SOLAR POWER GENERATION SYSTEMS	**9**
Overview and types of systems – components and sub systems – aspects of design and performance prediction.	
UNIT V THERMAL STORAGE AND SOLAR COOLING	**9**
Need for thermal storage – methods – simple models for thermal storage - solar liquid absorption and solar solid sorption technologies	
TEXTBOOKS:	
1. Boyle, G., Renewable Energy: Power for a Sustainable Future, 3rd ed., Oxford Univ. Press (2012).	
REFERENCES:	
1. Duffie, J. A. and Beckman, W. A., Solar Engineering of Thermal Processes, John Wiley (1991).	
2. Sukhatme, S. P. and Nayak, J. K., Solar Energy: Principles of Thermal Collection and Storage, 3rd ed., McGraw-Hill (2009).	
WEBLINKS:	
https://solarenergytraining.org/	
https://www.edx.org/course/solar-energy	

BANE15	NANO SCIENCE TECHNOLOGY	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Engineering Physics, Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

COURSE OUTCOMES

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

CO 1	**Memorize** the fundamentals of nanoscale materials and the scope of nanoscience and technology. **(Remember)**
CO 2	**Describe** the types of nanostructures and quantum size effects in nanostructures. **(Understand)**
CO 3	**Discuss** the synthesis of nanomaterials and methods of nanomaterials preparation. **(Understand)**
CO 4	**Define** the Mechanical, optical, electronic, magnetic, thermal and chemical properties of nanomaterials. **(Understand)**
CO 5	**List** the physical properties of nanostructured materials. **(Apply)**

Category	**Professional Elective (PE)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9**
Introduction to nanoscale materials - atomic & molecular size. Scientific revolutions-nanotechnology application area. Scope of nanoscience and technology		
UNIT II	**NANOSTRUCTURES AND DIMENSIONS**	**9**
Classification of nanostructures-zero, one, two and three dimensional nanostructures. Size Dependency inNanostructures-quantum size effects in nanostructures.		
UNIT III	**NANOMATERIAL SYNTHESIS**	**9**
Synthesis of nanomaterials-top down and bottom up approach. Method of nanomaterials preparation – wet chemical synthesis-mechanical grinding-gas phase synthesis.		
UNIT IV	**NANOMATERIAL PROPERTIES**	**9**

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.		
UNIT V	**PHYSICAL PROPERTIES OF NANOSTRUCTURED MATERIALS**	**9**
Quantum dots-optical properties and applications. Carbon nanotubes-physical properties and applications. Magnetic behavior of nanomaterials. Electronic transport in quantum wires.		
TEXTBOOKS: 1. T. Pradeep, “Nano the Essential Nanoscience and Nanotechnology”, Tata McGraw hill, 2007.		
REFERENCES: 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 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. **WEBLINKS:** https://www.edx.org/learn/nanotechnology		

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**

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		
UNIT IV	**COMMUNICATIONS NAVIGATION**	**9**
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		
UNIT V	**CONTROL AND STABILITY**	**9**
HTOL Aircraft - Helicopters - OTE/OTE/SPH - Convertible Rotor Aircraft - Payload Control - Sensors –culmon filter- Autonomy		

Text Books:

1. Reg Austin., Unmanned Aircraft Systems, John Wiley and Sons., 2010

References:

1. Milman & Halkias, "Integrated Electronics", McGraw Hill, 1999.
2. Malvino & Leach, "Digital Principles & Applications", McGraw Hill, 1986
3. Collinson R.P.G, "Introduction to Avionics", Chapman and Hall, India, 1996
4.BernadEtikin,"Dynamic of flight stability and control"", John Wiley, 1972

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.
2. To learn the different regime of viscous flow and its solution.
3. To understand the concept of laminar boundary layer.
4. To understand the concept of turbulent boundary layer.
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** theequations 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 VICOUS 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

considerations, creeping flow, boundary layer flow		
UNIT II	**SOLUTIONS OF VICOUS FLOW EQUATIONS**	**9**
Solutions of viscous flow equations, Couette flows, Hagen-Poisuelle 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.		
UNIT III	**LAMINAR BOUNDARY LAYER EQUATIONS**	**9**
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		
UNIT IV	**TURBULENT BOUNDARY LAYEREQUATIONS**	**9**
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		
UNIT V	**COMPRESSIBLE BOUNDARY LAYERSEQUATIONS**	**9**
Compressible boundary layer equations, Recovery factor, similarity solutions, laminar supersonic Cone rule, shock-boundary layer interaction		
Text Books: 1. White, F. M., Viscous Fluid Flow, McGraw-Hill & Co., Inc., New York, 2005.		
References: 1. Schlicting, H., Boundary Layer Theory, McGraw-Hill, New York, 2000. 2. Reynolds, A, J., Turbulent Flows Engineering, John Wiley and Sons, 1980.		

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 1	**Calculate** the stress concentration in structures subjected to fatigue loads. (**Analyze**)
CO 2	**Describe** statistical methods to determine the strain in structures under fatigue loading. (**Understand**)
CO 3	**Describe** various stages of failures due to fatigue load. (**Understand**)
CO 4	**Determine** stress in cracked structures. (**Apply**)
CO 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		

softening - Analysis of load histories - Cycle counting techniques -Cumulative damage - Miner's theory - Other theories.		
UNIT III	**PHYSICAL ASPECTS OF FATIGUE**	**9**
Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces.		
UNIT IV	**FRACTURE MECHANICS**	**9**
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.		
UNIT V	**FATIGUE DESIGN AND TESTING**	**9**
Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures.		

TEXTBOOKS:

1. Matej Billy, "Cyclic Deformation and Fatigue of Metals", Elsevier Science Ltd., 1993. (Units 1 to 3)
2. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India, 2009. (Unit 4)
3. Barrois W, Ripely, E.L., "Fatigue of aircraft structure", Pergamon press. Oxford, 1983 (Unit 5)

REFERENCES:

1. K. R.Y. Simha, Fracture Mechanics for Modern Engineering Design, Universities Press (India) Limited, 2001
2. D. Broek, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, Dordrecht, 1986.
3. T.L. Anderson, Fracture Mechanics - Fundamentals and Applications, 3rd Edition, Taylor and Francis Group, 2005

WEBLINKS:

https://ocw.mit.edu/courses/materials-science-and-engineering/3-35-fracture-and-fatigue-fall-2003/

BANE19	**HIGH TEMPERATURE MATERIALS**	**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 the student with the fundamentals of creep.
2. To make the student understand about design with creep resistance.
3. To familiarize the student about fracture, cracks and their mechanics.
4. To introduce to the student about oxidation and corrosion in hot environments.
5. To acquaint the student with various super alloys and other materials.

COURSE OUTCOMES

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

CO 1	**Discuss** the effect of creep on the functional life of components. **(Understand)**
CO 2	**Explain** the creep resistance of ductile and brittle materials. **(Understand)**
CO 3	**Describe** the effect of different alloys and oxidesmaterials behaviour from low temperature to high temperature **. (Understand)**
CO 4	**Discuss** the fracture mechanism maps for different alloys and oxides**. (Understand)**
CO 5	**Describe** the process of oxidation and different oxidations prevention techniques. **(Understand)**
CO 6	**Discuss** the various types of super alloys and its strengthening mechanisms. **(Understand)**

Category	**Professional Elective (PE)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

UNIT I	**CREEP**	**9**

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.

UNIT II	DESIGN FOR CREEP RESISTANCE	9
Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monkman-Grant relationship.		
UNIT III	**FRACTURE**	**9**
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.		
UNIT IV	**OXIDATION AND HOT CORROSION**	**9**
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.		
UNIT V	**SUPER ALLOYS AND OTHER MATERIALS**	**9**
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.		

Text Books:

1. Raj. R., "Flow and Fracture at Elevated Temperatures", American Society for Metals, USA, 1985.
2. Hertzberg R. W., "Deformation and Fracture Mechanics of Engineering materials", 4th Edition, John Wiley, USA, 1996.
3. Courtney T.H, "Mechanical Behavior of Materials", McGraw-Hill, USA, 1990.

References:

1. Boyle J.T, Spencer J, "Stress Analysis for Creep", Butterworths, UK, 1983.
2. Bressers. J., "Creep and Fatigue in High Temperature Alloys", Applied Science, 1981.
3. McLean D., "Directionally Solidified Materials for High Temperature Service", The Metals Society, USA, 1985.

BASE10	HIGH TEMPERATURE GAS DYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Compressible Flow				
	Cou10rse Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To enable the student to understand about the basics of high temperature gas flows	
COURSE OUTCOMES	
CO 1	**Review** the types of compressible flow. (**Understand**)
CO 2	**Explain** the relevance of statistical thermodynamics to high temperature flows(**Understand**)
CO 3	**Determine the collision frequencies of molecules at high temeprature**. (**Apply**)
CO 4	**Describe** the governing equations of the inviscid and viscid high temperature flows. (**Understand**)
CO 5	**Discuss** the diffusion and radiative properties in high temperature flows. (**Understand**)

UNIT I INTRODUCTION 8

Nature of high temperature flows – Chemical effects in air – Real perfect gases – Gibb's free energy and entropy by chemical and non-equilibrium – Chemically reacting mixtures and boundary layers.

UNIT II STATISTICAL THERMODYNAMICS 8

Introduction to statistical thermodynamics – Relevance to hypersonic flow - Microscopic description of gases – Boltzmann distribution – Cartesian function

UNIT III KINETIC THEORY AND HYPERSONIC FLOWS 9

Chemical equilibrium calculation of equilibrium composition of high temperature air – equilibrium properties of high temperature air – collision frequency and mean free path – velocity and speed distribution functions.

UNIT IV INVISCID HIGH TEMPERATURE FLOWS 10

Equilibrium and non – equilibrium flows – governing equations for inviscid high temperature equilibrium flows – equilibrium normal and oblique shock wave flows – frozen and equilibrium flows – equilibrium conical and blunt body flows – governing equations for non-equilibrium inviscid flows.

UNIT V TRANSPORT PROPERTIES IN HIGH TEMPERATURE GAS 10

Transport coefficients – mechanisms of diffusion – total thermal conductivity – transport characteristics for high temperature air – radiative transparent gases – radiative transfer equation for transport, absorbing and emitting and absorbing gases

TEXTBOOKS:

1. "Ethirajan Rathakrishnan", "High Enthalpy Gas Dynamics", John Wiley and Sons, 2017

REFERENCES:

1. John D. Anderson, Jr., Hypersonic and High Temperature Gas Dynamics, McGraw-Hill Series, New York, 1996.
2. John D. Anderson, Jr., Modern Compressible Flow with Historical perspective McGraw Hill Series, New York, 1996.
3. William H. Heiser and David T. Pratt, Hypersonic Air breathing propulsion, AIAA Education Series.
4. John T. Bertin, Hypersonic Aerothermodynamics publishers - AIAA Inc., Washington, D.C., 1994.
5. .K.Bose, High Temperature Gas Dynamics
WEBLINKS:
https://engineering.purdue.edu/ProEd/courses/molecular-gas-dynamics
https://www.iitk.ac.in/new/ae690a

<table>
<tr><td rowspan="4">BANE21</td><td colspan="2">SATELLITE TECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">Total Contact Hours – 45</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">Prerequisite – Basic Electrical and Electronics, Engineering Mechanics</td></tr>
<tr><td colspan="6">Course Designed by – Department of Aeronautical Engineering</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td colspan="7">COURSE OUTCOMES
At the end of Course, Students will be able to,</td></tr>
<tr><td>CO 1</td><td colspan="6">Discuss the basics of satellites and its system's functions. (Understand)</td></tr>
<tr><td>CO 2</td><td colspan="6">Describe the fundamentals of orbital mechanics and the coordinate systems. (Understand)</td></tr>
<tr><td>CO 3</td><td colspan="6">Analyze the satellite structures and thermal protection systems. (Analyze)</td></tr>
<tr><td>CO 4</td><td colspan="6">Express the attitude controls and its stabilization schemes. (Understand)</td></tr>
<tr><td>CO 5</td><td colspan="6">Summarize various types of power systems and bus electronics. (Understand)</td></tr>
<tr><td>Category</td><td colspan="6">Professional Elective (PE)</td></tr>
<tr><td>Approval</td><td colspan="6">37th Academic Council Meeting held in May 2015.</td></tr>
<tr><td colspan="7">COURSE CONTENT</td></tr>
<tr><td>UNIT I</td><td colspan="5">INTRODUCTION TO SATELLITE SYSTEMS</td><td>9</td></tr>
<tr><td colspan="7">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).</td></tr>
</table>

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**
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.		
UNIT IV	**SPACECRAFT CONTROL**	**9**
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		
UNIT V	**POWER SYSTEM AND BUS ELECTRONICS**	**9**
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.		

Text Books:

1. Spacecraft Thermal Control, Hand Book, Aerospace Press, 2002.
2. Introduction Space Flight, Francis J. Hale Prentice Hall, 1994.

References:

1. Analysis and Design of Flight Vehicle Structures, Tri-State off set company, USA, 1980.
2. Space Systems Engineering Rilay, FF, McGraw Hill, 1982.
3. Principles of Astronautics Vertregt. M., Elsevier Publishing Company, 1985
4.Space Communications Systems, Richard.F, Filipowsky Eugen I Muehllorf Prentice Hall, 1995
5. Space Vehicle Design, Michael D. Griffin and James R. French, AIAAEducation Series, 1991.

BBA001	PRINCIPALS OF MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Professional Courses				
	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	**Describe** the structure of management andthe functions of each department. **(Remember)**
CO 2	**Understand** business, trading, partnership and methods to overcome pitfalls. **(Understand)**
CO 3	**Analyze** the causes of accidents and the minimization methods. **(Analyze)**
CO 4	**Explain** Organizational behavior and factors influencing personality. **(Understand)**
CO 5	**Define** group, Communication, Barriers and factors contributing effective leadership. **(Understand)**
CO 6	**Summarize** the various ethics to be followed in different workplace. **(Understand)**

Category	**Professional Elective (PE)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

UNIT I	**MANAGEMENT FUNCTIONS & STRUCTURE**	**9**
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.		
UNIT II	**MANAGEMENT OF ORGANISATION**	**9**
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.		
UNIT III	**ORGANISATIONAL BEHAVIOUR**	**9**

OB – Definition – Nature & Scope – Contributing Disciplines – Importance of OB to Managers. Personality – Definition – Theories – Factors Influencing Personality. Motivation – Definition – Theories. Theory X & Y – Transactional Analysis. Morale & Job Satisfaction – Factors Influencing Job Satisfaction.

UNIT IV	GROUP DYNAMICS	9

Group – Definition – Types – Determinants of Group Cohesiveness – Communication – Process – Barriers – Effective Communication. Leadership Theories – Factors Contributing to Effective Leadership – Role of Trade Union in Organizations – Functions of Trade Union – Why Trade Union is required? – Types of Trade Union.

UNIT V	PROFESSIONAL ETHICS	9

Ethics in Workplace – Formulation of Ethics – Managerial Ethics – Managing Ethical Behaviour – Codes of Ethics – Encouraging Ethical Behaviour – Social Responsibility – Spirituality.

Text Books:

1. Gupta C.B., Management Theory and Practice, 14th Edition, Sultan Chand & Sons, 2009.
2. Dr. Prasad L.M., Principle & Practice of Management, 7th Edition, Sultan Chand & Sons, 2008.

References:

1. Aswathappa, Organizational Behaviour, 8th Edition, Himalaya Publishing House, 2010.
2. Dr. Prasad L.M., Organizational Behaviour, 4th Edition, Sultan Chand & Sons, 2008.
3. Harold Koontz, Principles of Management, 1st Edition, Tata McGraw Hill, 2004.

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**

Forecasting – Fleet size, Fleet planning, the aircraft selection process, operating cost, passenger capacity, load factor etc. – Passenger fare and tariffs – Influence of geographical, economic & political factors on routes and route selection.

Fleet Planning: The aircraft selection process – Fleet commonality, factors affecting choice of fleet, route selection and Capitol acquisition – Valuation & Depreciation – Budgeting, Cost planning – Aircrew evaluation – Route analysis – Aircraft evaluation.

UNIT III	PRINCIPLES OF AIRLINES SCHEDULING	9

Equipment maintenance, Flight operations and crew scheduling, Ground operations and facility limitations, equipments and types of schedule – hub & spoke scheduling, advantages / disadvantages & preparing flight plans – Aircraft scheduling in line with aircraft maintenance practices.

UNIT IV	AIRCRAFT RELIABILITY	9

Aircraft reliability – The maintenance schedule & its determinations – Condition monitoring maintenance – Extended range operations (EROPS) & ETOPS – Ageing aircraft maintenance production.

UNIT V	TECHNOLOGY IN AIRCRAFT MAINTENANCE	9

Airlines scheduling (with reference to engineering) – Product support and spares – Maintenance sharing – Equipments and tools for aircraft maintenance – Aircraft weight control – Budgetary control.

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.

Text Books:

1. FEDRIC J.H., "Airport Management", 2000.
2. C.H. FRIEND, "Aircraft Maintenance Management", 2000.

References:

1. Gene Kropf, "Airline Procedures".
2. Wilson & Bryon, "Air Transportation".
3. Philip Locklin D, "Economics Of Transportation".
4. "Indian Aircraft Manual" – Dgca Pub.
5. Alexander T Wells, "Air Transportation", Wadsworth Publishing Company, California, 1993

BANE24	AEROSPACE BIO – MEDICAL AND LIFE SUPPORT ENGINEERING	L	T	P	C
	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,

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

Category	**Professional Elective (PE)**
Approval	**37th Academic Council Meeting held in May 2015.**

COURSE CONTENT

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

Onboard environment control systems – waste product management and recycling system – bio – monitoring and control		
UNIT V	**EXTRA – VEHICULAR ACTIVITY**	**9**
Extra Vehicular activity – challenges – specialties of space suits – life support system for EVA		

Text Books:

1. “Space Physiology”, Beckers, Frank, Bart Verheyden, Andre E Aubert, Wiley Encylopaedia of Bio – medical engineering, John Wiley and Sons, Inc., 2006
2. “Fundamentals of Space Life Sciences”, Diamandis, Peter H. Edited by Susanne Churchill. Malabar, FL: Krieger Publishing Co., 1997.

References:

1. “Human Anatomy Manual: The Skeleton”, Gatesville, TX, Medical Plastics Laboratory, Inc., 1997
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.
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.
4. Flash, T. "The Control of Hand Equilibrium Trajectories in Multi-joint Arm Movements." Biological Cybernetics 57 (1987): 257-274.
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.
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.
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.
8. Brubakk, A. "Man in Extreme Environments." Aviat. Space Env. Med. (September 2000): A126-A130.

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**

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.		
UNIT IV	**TQM TOOLS**	**9**
Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA –Stages of FMEA.		
UNIT V	**QUALITY SYSTEMS**	**9**
Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System –Elements, Implementation of Quality System, Documentation, Quality Auditing, TS16949, ISO 14000 – Concept, Requirements and Benefits.		

Text Books:

1. Dale H. Besterfiled, et al., “Total Quality Management”, Pearson Education, Inc.2003. (Indian reprint 2004). ISBN 81-297-0260-6.

References:

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).
2. Feigenbaum.A.V. “Total Quality Management”, McGraw-Hill, 1991.
3. Oakland.J.S. “Total Quality Management”, Butterworth Hcinemann Ltd., Oxford,1989.
4. Narayana V. and Sreenivasan, N.S. “Quality Management – Concepts and Tasks”,New Age International 1996.
5. Zeiri. “Total Quality Management for Engineers”, Wood Head Publishers, 1991.

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)**

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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**

Horizontal and vertical axis machines-energy density of different rotors-Power coefficient-Betz coefficient by momentum theory.		
UNIT IV	**BUILDING AERODYNAMICS**	**9**
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		
UNIT V	**FLOW INDUCED VIBRATIONS**	**9**
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.		

Text Books:

1. Blevins R.D “Flow Induced Vibrations”, Van Nostrand, 1990
2. Sovran, M(ed) “Aerodynamic drag mechanism of bluff bodies and road vehicles”,Plenum Press, N.Y, 1990

References:

1. Sachs P “Wind Forces in Engineering”, Pergamon Press, 1988
2. Scorer R.S “Environmental Aerodynamics”, Ellis Harwood Ltd, England, 1978
3. Calvert N.G “Wind Power Principles”, Charles Griffin & Co London, 1979.

BANE26	**MECHANICS OF HETEROGENEOUS**	**L**	**T**	**P**	**C**

	MATERIALS				
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Engineering Physics I, Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce to the student about the various heterogeneous materials.
2. To accustom the student to the mechanics of heterogeneous materials.
3. To acquaint the student to the structure of particulate, fibrous and cellular solids and their properties.
4. To familiarize the student about the hierarchical structure in heterogeneous materials.
5. To enable the student to understand various design considerations in application of heterogeneous materials.

COURSE OUTCOMES

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

CO 1	**Summarize** various material structures and different crystal properties. **(Understand)**
CO 2	**Predict** the stiffness and strength of different directions. **(Understand)**
CO 3	**Memorize** the properties of Particulate, fibrous and cellular solids. **(Remember)**
CO 4	**Define** the various aspects of hierarchical structure of heterogeneous materials. **(Remember)**
CO 5	**Explain** the eutectic structure and gradient effects. **(Understand)**

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COURSE CONTENT

UNIT I	**INTRODUCTION**	**9**
	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 nanotructures.	
UNIT II	**STRUCTURE OF HETEROGENEOUS MATERIALS**	**9**
	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.	
UNIT III	**PARTICULATE, FIBROUS AND CELLULAR SOLIDS**	**12**

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.		
UNIT IV	**HIERARCHICAL STRUCTURE**	**6**
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.		
UNIT V	**DESIGN CONSIDERATIONS**	**9**
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.		

Text Books:

1. L. J. Gibson, and M. F. Ashby, Cellular Solids, Cambridge, (1999).
2. M. F. Ashby and D. R. H. Jones, Engineering Materials, 2nd ed. Butterworth, (1998).

References:

1. J. F. Nye, Physical Properties of Crystals, Oxford, (1976).
2. B. D. Agarwal and L. J. Broutman, Analysis and Performance of Fiber Composites, J. Wiley, 2nd ed. (1990).