BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH

DEPARTMENT OF BIOMEDICAL ENGINEERING

CURRICULUM AND SYLLABUS

(R2018)

B – FACT

Bharath - **F**lexible **A**ccommodative choice based **C**redit system for **T**echnology

(Applicable to the batches admitted from July 2018)

B.Tech - BIOMEDICAL ENGINEERING-R2018

DEPARTMENT VISION

To create highly motivated, technologically competent engineers, be a benchmark and trend setter in Biomedical Engineering by imparting quality education with interwoven input from academic institutions, research organizations and industries to improve healthcare delivery to human in association with physicians and surgeons

MISSION STATEMENTS

MS1: Providing good academic ambience by adopting best teaching and learning practices through flexible student centric curriculum evolved continuously for student of BME with diverse backgrounds.

MS2: Providing congenial ambience both for faculty members and students in inculcating critical thinking with a quest for creativity, innovation, research and development activities.

MS3: Enhancing collaborative activities with academia, research institutions and industries by nurturing ethical entrepreneurship and leadership qualities.

MS4: Nurturing continuous learning in the state-of-the art technologies and global outreach programmes resulting in competent world-class biomedical engineers

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO1: PREPARATION:

To provide students with sound fundamental in Mathematical, Scientific and Engineering fundamentals necessary to formulate, analyse, and comprehend the fundamental concepts in Bio Medical Engineering.

PEO2: CORE COMPETENCE:

To apply critical reasoning, quantitative, qualitative, designing and programming skills, to identify, solve problems and to analyze the experimental evaluations, and finally making appropriate decisions, and to enhance the techniques in the field of biomedical Engineering.

PEO3: PROFESSIONALISM:

To broaden knowledge to establish themselves as creative practicing professionals, locally and globally, in fields such as design, research, testing and manufacturing of Medical Electronics and Instrumentation Systems

PEO4: SKILL:

To provide Industry based training for developing professional skills and soft skills such as proficiency in languages, technical communication, verbal, logical, analytical, comprehension, team building, inter personal relationship, group discussion and leadership skill to become a better professional.

PEO5: ETHICS:

To apply the ethical and social aspects of modern Engineering and Technology innovations to the design, development, and usage of new products, machines, gadgets, devices, etc.

MAPPING BETWEEN MISSION Vs PEOs

PEO'S	MISSION STATEMENTS			
	MS1	MS2	MS3	MS4
PEO1 To provide students with sound fundamental in Mathematical, Scientific and Engineering fundamentals necessary to formulate, analyse, and comprehend the fundamental concepts in Bio Medical Engineering	✓	✓	✓	✓
PEO2: To apply critical reasoning, quantitative, qualitative, designing and programming skills, to identify, solve problems and to analyze the experimental evaluations, and finally making appropriate decisions, and to enhance the techniques in the field of biomedical Engineering.	✓	✓	✓	
PEO3: To broaden knowledge to establish themselves as creative practicing professionals, locally and globally, in fields such as design, research, testing and manufacturing of Medical Electronics and Instrumentation Systems	✓	✓	✓	
PEO4: To provide Industry based training for developing professional skills and soft skills such as proficiency in languages, technical communication, verbal, logical, analytical, comprehension, team building, inter personal relationship, group discussion and leadership skill to become a better professional.	✓	✓		
PEO5: To apply the ethical and social aspects of modern Engineering and Technology innovations to the design, development, and usage of new products, machines, gadgets, devices, etc.			✓	✓

PROGRAMME OUTCOMES (POs)

On completion of B.Tech in Biomedical Engineering Programme, Graduates will have to

PO 1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem Analysis: Identify, formulate and analyze complex problems in the field of biomedical engineering using principles of mathematics, natural, biological and engineering sciences.

PO 3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems.

PO 5: Modern Tool Usage: Use the techniques, skills, and modern engineering tools necessary for biomedical engineering practice.

PO 6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the biomedical engineering practice.

PO 7: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PO 12: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PROGRAM SPECIFIC OUTCOME (PSO):

Biomedical Engineering Graduates will be able to

PSO 1: Handle various biomedical instruments in calibrations and conduct analytic task individually to facilitate the needs of patients, healthcare professional and health care industries.

PSO 2: Apply the knowledge and skills in a multidisciplinary environment to develop diagnostic and therapeutic or assistive devices for better healthcare.

MAPPING BETWEEN PROGRAMME EDUCATIONAL OBJECTIVES & PROGRAMME OUTCOMES (POs)

PEOs\POs	a	b	c	d	e	f	g	h	i	j	k	l
PEO1	✓	✓	✓	✓	✓		✓		✓	✓		
PEO2	✓	✓	✓	✓	✓	✓	✓		✓		✓	
PEO3		✓		✓								
PEO4		✓		✓								
PEO5		✓		✓								

MAPPING BETWEEN CORE COURSES OUTCOMES & PROGRAM OUTCOMES

Sem	Courses\POs	a	b	c	d	e	f	g	h	i	j	k	l
I	**THEORY**												
	Communicative English	✓					✓		✓	✓	✓	✓	
	Engineering Mathematics – I	✓	✓	✓	✓	✓						✓	
	Introduction to Mechanics	✓	✓		✓	✓		✓		✓			✓
	Engineering Chemistry	✓	✓		✓	✓		✓		✓		✓	✓
	Programming for problem solving	✓	✓	✓			✓		✓			✓	
	Engineering Graphics& Design	✓	✓		✓	✓		✓		✓			✓
	PRACTICAL												
	Programming for problem solving Lab	✓	✓	✓			✓		✓			✓	
	Physics Lab	✓	✓		✓	✓		✓		✓		✓	✓
	Chemistry Lab	✓	✓		✓	✓		✓		✓		✓	✓
II	**THEORY**												
	Technical English	✓					✓		✓	✓	✓	✓	
	Engineering Mathematics- II	✓	✓	✓	✓	✓						✓	
	Waves and Optics	✓		✓		✓		✓	✓			✓	✓
	Cytology and Genetics				✓	✓	✓			✓		✓	
	Basic Electrical and Electronics Engineering	✓	✓	✓	✓			✓				✓	✓
	Environmental Sciences			✓		✓			✓	✓	✓	✓	
	PRACTICAL												
	Physics Lab	✓	✓		✓	✓		✓		✓		✓	✓
	Chemistry Lab	✓	✓		✓	✓		✓		✓		✓	✓
	Workshop/Manufacturing Practices Lab	✓	✓		✓	✓		✓		✓			✓
	Basic Electrical and Electronics Engineering Practices Laboratory	✓	✓	✓	✓			✓				✓	✓
III	**THEORY**												
	Partial Differential Equation and Transformation	✓	✓	✓	✓	✓						✓	
	Anatomy and Physiology				✓	✓	✓	✓	✓		✓	✓	✓
	Analog and Digital Integrated Circuits	✓	✓	✓	✓	✓		✓		✓		✓	✓
	Microprocessor and Microcontrollers in Biomedical Applications	✓		✓	✓			✓		✓		✓	✓
	Electronic Devices and Circuits	✓	✓	✓	✓			✓	✓			✓	✓

Sem	Courses\POs	a	b	c	d	e	f	g	h	i	j	k	l
	Biosensors and Measurements	✓		✓	✓		✓	✓		✓		✓	✓
	PRACTICAL												
	Anatomy and Physiology Lab				✓	✓	✓	✓	✓		✓	✓	✓
	Microprocessors and Microcontrollers lab												
	Biosensors and Measurements lab	✓		✓	✓			✓		✓		✓	✓
IV	**THEORY**												
	Probability Statistics And Numerical Methods	✓	✓	✓	✓	✓						✓	
	Medical Instrumentation I	✓	✓	✓	✓	✓		✓		✓		✓	✓
	Fundamentals of Biochemistry	✓		✓	✓		✓	✓		✓		✓	✓
	Medical Physics				✓	✓	✓	✓	✓		✓	✓	✓
	Analog and Digital Communication System	✓	✓	✓	✓			✓	✓		✓	✓	✓
	Biomaterials and Artificial Organs	✓		✓	✓		✓	✓		✓		✓	✓
	Constitution of India						✓		✓		✓	✓	
	PRACTICAL												
	Biochemistry Lab				✓	✓	✓	✓	✓		✓	✓	✓
	Analog and Digital Communication System Lab	✓		✓	✓		✓	✓		✓		✓	✓
V	**THEORY**												
	Bio control System	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓
	Medical Instrumentation – II	✓	✓	✓	✓	✓		✓		✓		✓	✓
	Digital Signal Processing for Bio Engineers				✓	✓	✓	✓	✓		✓	✓	✓
	Organizational Behaviour		✓	✓	✓	✓	✓		✓	✓	✓	✓	
	Universal Human Values						✓		✓		✓	✓	
	PRACTICAL												
	Medical Instrumentation lab	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓
	Digital Signal Processing for Bio Engineers lab				✓	✓	✓	✓	✓		✓	✓	✓
VI	**THEORY**												
	Pathology and Microbiology	✓	✓	✓	✓	✓		✓		✓		✓	✓
	Diagnostic and Therapeutic Equipment	✓	✓		✓			✓		✓		✓	✓
	Radiological Equipments	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
	Telemedicine	✓	✓	✓	✓	✓						✓	
	Essence of Indian Knowledge Tradition						✓	✓	✓	✓		✓	✓

Sem	Courses\POs	a	b	c	d	e	f	g	h	i	j	k	l
	PRACTICAL												
	Pathology and microbiology Lab	✓	✓	✓	✓	✓		✓		✓		✓	✓
	Virtual modeling Lab	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
VII	**THEORY**												
	Digital and Medical Image Processing	✓	✓	✓	✓	✓		✓		✓		✓	✓
	Robotics and Nanotechnology in Medicine	✓		✓		✓			✓	✓		✓	
	Health, Hospital & Equipment Management	✓		✓		✓	✓		✓	✓		✓	
	PRACTICAL												
	Image Processing Lab	✓		✓		✓			✓	✓		✓	
	Inplant Training in Hospital	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
	Project Phase I	✓	✓	✓	✓	✓		✓		✓		✓	✓
VIII	**PRACTICAL**												
	Project Phase II	✓	✓	✓	✓	✓		✓		✓		✓	✓
	Comprehension		✓		✓	✓	✓	✓				✓	✓

MAPPING BETWEEN PROGRAMME ELECTIVES (PEs) AND PROGRAM OUTCOMES (POs)

PE	Courses\POs	a	b	c	d	e	f	g	h	i	j	k	l
I	Biofluids and Biomechanics	✓	✓	✓	✓	✓		✓		✓		✓	
	Human Assist Devices	✓		✓		✓			✓	✓		✓	✓
	Medical Informatics	✓		✓		✓	✓		✓	✓		✓	
II	Troubleshooting of Medical Instruments	✓	✓	✓	✓	✓		✓		✓		✓	
	Real Time Processor and Bio MEMS	✓	✓		✓			✓		✓		✓	✓
	Clinical Engineering	✓	✓	✓	✓	✓	✓	✓		✓	✓		
III	Nuclear Medicine	✓		✓		✓		✓	✓			✓	✓
	Modelling of Physiological Systems	✓			✓	✓	✓			✓		✓	
	Tissue Engineering	✓	✓	✓	✓			✓				✓	
IV	Neural Networks and Pattern Recognition			✓		✓			✓	✓	✓	✓	
	Rehabilitation Engineering	✓		✓		✓			✓	✓		✓	✓
	Brain Control Interface	✓		✓		✓	✓		✓	✓		✓	
V	Bioprocess Technology	✓	✓	✓	✓	✓		✓		✓		✓	
	VLSI Design	✓	✓		✓			✓		✓		✓	✓
	Virtual Instrumentation	✓	✓	✓	✓	✓	✓	✓		✓	✓		
VI	Biological Effects of Radiation	✓		✓		✓			✓	✓		✓	
	Biomedical laser Instrumentation	✓	✓	✓	✓	✓		✓		✓		✓	
	Bio-photonics	✓		✓		✓	✓		✓	✓		✓	

CURRICULUM AND SYLLABUS

(R2018)
B – FACT

(Applicable to the batches admitted from July 2018)

B.Tech – BIOMEDICAL ENGINEERING
(FULL TIME)
I – VIII SEMESTERS

SEMESTER I								
Sl. No.	**Course Code**	**Category**	**Course Title**	**Contact Period**	**L**	**T**	**P**	**C**
THEORY								
1	U18HSEN101	HS	Communicative English	4	2	0	2	3
2	U18BSMA101	BS	Engineering Mathematics - I	4	4	0	0	4
3	U18BSPH101	BS	Waves and Optics	3	3	0	0	3
4	U18BSCH101	BS	Engineering Chemistry	3	3	0	0	3
5	U18ESEE101	ES	Basic Electrical and Electronics Engineering	3	0	0	3	3
6	U18BSBT101	BS	Biology for Engineers	2	2	0	0	2
PRACTICAL								
7	*U18BSPH2L2	BS	Wave Optics and Semi Conductor Physics Lab	3	0	0	3	0
8	*U18BSCH2L4	BS	Chemistry Lab	3	0	0	3	0
9	U18ESME1L2	ES	Workshop/Manufacturing Practices Laboratory	5	1	0	4	3
10	U18ESEE1L3	ES	Basic Electrical and Electronics Engineering Practices Laboratory	3	0	0	3	1.5
ACTIVITY BASED COURSES								
11	U18MCAB203	MC	Yoga	2	0	0	2	0
12	U18MCAB204	MC	Physical health – NCC	2	0	0	2	0
Total				31	14	0	17	22.5

***Laboratory Classes will be conducted on alternative weeks for Physics and Chemistry. The Lab Practical Examinations will be held only in the second semester (including the first semester experiments).**

SEMESTER II								
Sl. No	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18HSEN201	HS	Technical English	3	2	1	0	3
2	U18BSMA201	BS	Engineering Mathematics II	4	4	0	0	4
3	U18BSPH202	BS	Semi-Conductor Physics	3	3	0	0	3
4	U18BSCH201	MC	Environmental Sciences	3	3	0	0	3
5	U18ESCS101	ES	Problem Solving and Python Programming	3	3	0	0	3
6	U18ESME101	ES	Engineering Graphics & Design	5	1	0	4	3
PRACTICAL								
7	*U18BSPH2L2	BS	Wave Optics and Semi-Conductor Physics Lab	3	0	0	3	1.5
8	*U18BSCH2L4	BS	Chemistry Lab	3	0	0	3	1.5
9	U18ESCS1L1	ES	Problem Solving and Python Programming Lab	3	0	0	3	1.5
ACTIVITY BASED COURSES								
10	U18MCAB101	MC	Physical health – Sports & Games	2	0	0	2	0
11	U18MCAB102	MC	Gardening & Tree Plantation -	2	0	0	2	0
			Total	34	16	1	12	23.5

***Laboratory Classes will be conducted on alternative weeks for Physics and Chemistry. The Lab Practical Examinations will be held only in the second semester (including the first semester experiments).**

SEMESTER III								
S. No	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18BSMA301	BS	Transforms and Partial Differential Equation	4	3	1	0	4
2	U18PCBM301	PC	Anatomy and Physiology	3	3	0	0	3
3	U18PCBM302	PC	Analog and Digital Integrated Circuits	3	3	0	0	3
4	U18PCBM303	PC	Microprocessor and Microcontrollers in Biomedical Applications	3	3	0	0	3
5	U18PCBM304	PC	Electronic Devices and Circuits	3	3	0	0	3
6	U18PCBM305	PC	Biosensors and Measurements	3	3	0	0	3
PRACTICAL								
7	U18PCBM3L1	PC	Anatomy and Physiology Lab	2	0	0	2	1
8	U18PCBM3L2	PC	Microprocessors and Microcontrollers lab	2	0	0	2	1
9	U18PCBM3L3	PC	Biosensors and Measurements lab	2	0	0	2	1
ACTIVITY BASED COURSES								
10	U18MCAB305	MC	Culture- Learning an art form	2	0	0	2	0
11	U18MCAB306	MC	Culture – Intangible Cultural, heritage(festivals, Food ways, Local games)	2	0	0	2	0
			Total	**29**	**16**	**1**	**10**	**22**

SEMESTER IV								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18BSMA402	BS	Probability Statistics And Numerical Methods	4	3	1	0	4
2	U18PCBM401	PC	Medical Instrumentation I	3	3	0	0	3
3	U18PCBM402	PC	Fundamentals of Biochemistry	3	3	0	0	3
4	U18PCBM403	PC	Medical Physics	3	3	0	0	3
5	U18PCBM404	PC	Analog and Digital Communication System	3	3	0	0	3
6	U18PCBM405	PC	Biomaterials and Artificial Organs	3	3	0	0	3
7	U18MCTH502	MC	Universal Human Values	2	2	0	0	0
PRACTICAL								
7	U18PCBM4L1	PC	Biochemistry Lab	2	0	0	2	1
8	U18PCBM4L2	PC	Analog and Digital Communication System Lab	2	0	0	2	1
ACTIVITY BASED COURSES								
10	U18MCAB407	MC	Literature & Media – Literature, Cinema & Media	2	0	0	2	0
11	U18MCAB408	MC	Literature & Media – Group Reading of Classics	2	0	0	2	0
			Total	**28**	**19**	**1**	**8**	**21**

SEMESTER V								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18PCBM501	PC	Bio Control System	3	3	0	0	3
2	U18PCBM502	PC	Medical Instrumentation - II	3	3	0	0	3
3	U18PCBM503	PC	Digital Signal Processing for Bio Engineers	3	3	0	0	3
4	U18HSBA401	HS	Organizational Behaviour	3	3	0	0	3
5		PE	Professional Elective –I	3	3	0	0	3
7		OE	Open Elective I	3	3	0	0	3
6	U18MCTH401	MC	Constitution of India	2	2	0	0	0
PRACTICAL								
7	U18PCBM5L1	PC	Medical Instrumentation lab	2	0	0	2	1
8	U18PCBM5L2	PC	Digital Signal Processing for Bio Engineers lab	2	0	0	2	1
ACTIVITY BASED COURSES								
9	U18MCAB509	MC	Social Services – Social Awareness	2	0	0	2	0
10	U18MCAB510	MC	Social Services – NSS	2	0	0	2	0
			Total	**28**	**20**	**0**	**8**	**20**

SEMESTER VI								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18PCBM601	PC	Pathology and Microbiology	3	3	0	0	3
2	U18PCBM602	PC	Diagnostic and Therapeutic Equipment	3	3	0	0	3
3	U18PCBM603	PC	Radiological Equipments	3	3	0	0	3
4	U18PCBM604	PC	Telemedicine	2	2	0	0	2
5.		PE	Professional Elective II	3	3	0	0	3
6		OE	Open Elective II	3	3	0	0	3
PRACTICAL								
7	U18PCBM6L1	PC	Pathology and microbiology Lab	2	0	0	2	1
8	U18PCBM6L2	PC	Virtual Modelling Lab	2	0	0	2	1
ACTIVITY BASED COURSES								
10	U18MCAB611	MC	Self-Development – Spiritual, Mindfulness & Meditation	2	0	0	2	0
11	U18MCAB612	MC	Self-Development - religion and Inter-faith	2	0	0	2	0
			Total	**25**	**17**	**0**	**8**	**19**

SEMESTER VII								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18PCBM701	PC	Digital and Medical Image Processing	3	3	0	0	3
2	U18PCBM702	PC	Robotics and Nanotechnology in Medicine	3	3	0	0	3
3	U18PCBM703	PC	Health, Hospital & Equipment Management	3	3	0	0	3
4		PE	Professional Elective III	3	3	0	0	3
5.		PE	Professional Elective IV	3	3	0	0	3
6		OE	Open Elective III	3	3	0	0	3
7	U18MCTH603	MC	Essence of Indian Knowledge Tradition	2	2	0	0	0
PRACTICAL								
7	U18PCBM7L1	PC	Image Processing Lab	2	0	0	2	1
8	U18EEBM7L2	EE	Inplant Training in Hospital	2	0	0	1	1
9	U18EEBM7P1	EE	Project Phase I	6	0	0	6	3
ACTIVITY BASED COURSES								
10	U18MCAB713	MC	Behavioural and interpersonal skills	2	0	0	2	0
11	U18MCAB714	MC	Nature – Nature club	2	0	0	2	0
			Total	**32**	**20**	**0**	**13**	**23**

SEMESTER VIII								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1		PE	Professional Elective V	3	3	0	0	3
2		PE	Professional Elective VI	3	3	0	0	3
3		OE	Open Elective IV	2	2	0	0	2
PRACTICAL								
7	U18EEBM8P2	EE	Project Phase II	18	0	0	18	9
8	U18EEBM8C1	EE	Comprehension	0	0	0	0	1
ACTIVITY BASED COURSES								
10	U18MCAB815	MC	Innovation – Project based – Sc., Tech, Social, Design & Innovation	2	0	0	2	0
			Total	**28**	**8**	**0**	**18**	**18**

Total No. of Credit: 169 **Total Contact Hour: 235**

LIST OF ELECTIVES PROFESSIONAL ELECTIVE

SUBJECT CODE	SPECIALIZATION	SUBJECT NAME	Contact Periods	L	T	P	C
PROFESSIONAL ELECTIVE (PE) - I							
U18PEBM011	Anatomy and Physiology	Biofluids and Biomechanics	3	3	0	0	3
U18PEBM012	Medical Instrumentation I	Human Assist Devices	3	3	0	0	3
U18PEBM013	Computer Programming	Medical Informatics	3	3	0	0	3
PROFESSIONAL ELECTIVE (PE) –II							
U18PEBM021	Electronic Devices and Circuits	Troubleshooting of Medical Instruments	3	3	0	0	3
U18PEBM022	Microprocessor and DSP	Real Time Processor and Bio MEMS	3	3	0	0	3
U18PEBM023	Hospital Management	Clinical Engineering	3	3	0	0	3
PROFESSIONAL ELECTIVE (PE) - III							
U18PEBM031	Radiological Equipments	Nuclear Medicine	3	3	0	0	3
U18PEBM032	Bio control systems	Modelling of Physiological Systems	3	3	0	0	3
U18PEBM033	Biomaterials	Tissue Engineering	3	3	0	0	3
PROFESSIONAL ELECTIVE (PE) - IV							
U18PEBM041	Image Processing	Neural Network and Pattern Recognition	3	3	0	0	3
U18PEBM042	Artificial Organs	Rehabilitation Engineering	3	3	0	0	3
U18PEBM043	Medical Instrumentation	Brain Control Interface	3	3	0	0	3
PROFESSIONAL ELECTIVE (PE) - V							
U18PEBM051	Biochemistry	Bioprocess Technology	3	3	0	0	3
U18PEBM052	Digital systems	VLSI Design	3	3	0	0	3
U18PEBM053	Medical Instrumentation	Virtual Instrumentation	3	3	0	0	3
PROFESSIONAL ELECTIVE (PE) - VI							
U18PEBM061	Radiological Equipments	Biological Effects of Radiation	3	3	0	0	3
U18PEBM062	Medical Physics	Biomedical laser Instrumentation	3	3	0	0	3
U18PEBM063	Physics	Bio-photonics	3	3	0	0	3

LIST OF OPEN ELECTIVES COMMON TO ALL B.Tech PROGRAMMES

ALL THE COURSES WITH L=3, T=0, P=0 & C=3

1. U18OEBA001 Sociology
2. U18OEBA002-Lean Six Sigma
3. U18OEBA003-Cyber Law and Ethics
4. U18OEBA004-Economic Policies in India
5. U18OEBA005-Management Information System
6. Total Engineering Quality Management
7. U18OEBA007-Industrial Psychology
8. U18OEBA008-Entrepreneurship Development and IPR
9. U18OEBA009-Intellectual Property Rights
10. U18OEBA010-Engineering Economics and Cost Analysis
11. U18OEEN001- Soft Skills and Interpersonal Communication
12. U18OEEN002-Indian Writing in English
13. U18OEEN003-Creative Writing
14. U18OEEN004- Proficiency in English and Accent Training
15. U18OEMA001-Cryptography
16. U18OEMA002-Finite Automata Theory / Formal Languages
17. U18OEMA003-Linear Programming
18. U18OECE001 - Metro Systems and Engineering
19. U18OECE002-Pollution Regulations
20 U18OECE003-Road Safety
21. U18OECE004- Infrastructure Development
22. U18OECE005- Project Safety Management
23. U18OECE006- Environment, Health and Safety in Industries
24. U18OEME001-Design for Manufacturing and Assembly
25. U18OEME002Industrial Safety
26. U18OEME003-Refrigeration and Cryogenics
27. U18OEME004- Product Design and Development
28. U18OEAU001-Electric and Hybrid Vehicles
29. U18OEAU002-Intelligent Transportation System
30. U18OEAU003-Vibration and Noise Control
31. U18OEAU004-Automotive Sensors and Applications
32. U18OEMT001-MEMS and Nano Technology
33. U18OEMT002-Non-Destructive Testing
34. U18OEMT003-Bio Mechatronics
35. U18OEMT004-Artificial Intelligence for Robotics
36. U18OEAE001-Industrial Aerodynamics
37. U18OEAE002- Elements of Aeronautics and Astronautics
38. U18OEAE003- Unmanned Aerial Vehicle
39. U18OEAE004- Introduction to Avionics
40. U18OEAE005-Rocket Propulsion
41. U18OEEE001-Green Technologies
42. U18OEEE002-Electrical Safety and Quality Assurance
43. U18OEEE003-Energy Conservation Techniques
44. U18OEEE004-PLC and SCADA for Industrial

45. U18OEEC-001-Communication Systems
46. U18OEEC-002-VLSI circuits
47. U18OEEC-003-Image Processing Techniques
48. U18OEEC-004-Communication Networks
49. U18OEEC-005-An Introduction to DSP
50. U18OEEC-006-Basics of IoT
51. U18OEBM001-Medical Radiation Safety Engineering
52. U18OEBM002-Medical Waste Management
53. U18OEBM003-Quality Control in Healthcare
54. U18OEBM004-Wearable Technology
55. U18OEEI001-Analytical Methods and Instrumentation
56. U18OEEI002-Introduction to process Data Analytics
57. U18OEEI003-Reliability and Safety in Process industries
58. U18OEEI004-Multi sensor data fusion
59. U18OEBT001- Bioprocess Economics & Plant Design
60. U18OEBT002-Brewing technology
61. U18OEBT003-Biomining
62. U18OEBT004-Industrial Safety Engineering
63. U18OEAC001-Geo- informatics for Precision Farming
64. U18OEAC002-Livestock and poultry management
65. U18OEAC003-Extension methodologies and transfer of Agricultural Technologies
66. U18OEAC004-Soil and Water Conservation Engineering
67. U18OEIT001-Block Chain Technology
68. U18OEIT002-Semantic Web
69. U18OEIT003-Entrepreneurship Development
70. U18OEIT004-Ethical Hacking Techniques
71. U18OECS004-Mobile Application Development
72. U18OECS005-System Modelling and Simulation
73. U18OECS006-Web Programming
74. U18OECS007-Virtual Reality
75. U18OECS008- E Commerce
76. U18OEGE001-Metagenomics and Epigenomics
77. U18OEGE002-Molecular Genetics and Genomics
78. U18OEGE003-Principles of Molecular cell biology

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HUMANITIES AND SOCIAL STUDIES INCLUDING MANAGEMENT COURSES (HS)

Sl. No.	Course Code	Category	Course Title	Contact Period	L	T	P	C
THEORY								
1	U18HSEN101	HS	Communicative English	4	2	0	2	3
2	U18HSEN201	HS	Technical English	2	1	1	0	2
3	U18HSBA401	HS	Organisational Behavior	3	3	0	0	3
TOTAL CREDITS								8

BASIC SCIENCE COURSES (BS)

Sl. No.	Course Code	Category	Course Title	Contact Period	L	T	P	C
THEORY								
1	U18BSMA101	BS	Engineering Mathematics - I	4	4	0	0	4
2	U18BSPH101	BS	Waves and Optics	3	3	0	0	3
3	U18BSCH101	BS	Engineering Chemistry	3	3	0	0	3
4	U18BSBT101	BS	Biology for Engineers	2	2	0	0	2
5	U18BSMA201	BS	Engineering Mathematics II	4	4	0	0	4
6	U18BSPH202	BS	Semi-Conductor Physics	3	3	0	0	3
7	U18BSMA301	BS	Transforms and Partial Differential Equation and	4	3	1	0	4
8	U18BSMA402	BS	Probability Statistics And Numerical Methods	4	3	1	0	4
PRACTICAL								
11	*U18BSPH2L2	BS	Wave Optics and Semi-Conductor Physics Lab	3	0	0	3	1.5
12	*U18BSCH2L4	BS	Chemistry Lab	3	0	0	3	1.5
TOTAL CREDITS								30

ENGINEERING SCIENCE COURSES (ES)

Sl. No.	Course Code	Category	Course Title	Contact Period	L	T	P	C
THEORY								
1	U18ESEE101	ES	Basic Electrical and Electronics Engineering Practices Laboratory	3	0	0	3	3
2	U18ESCS101	ES	Problem Solving and Python Programming	3	3	0	0	3

3	U18ESME101	ES	Engineering Graphics & Design	5	1	0	4	3
PRACTICAL								
4	U18LCME101	ES	Workshop/Manufacturing Practices Laboratory	5	1	0	4	3
5	U18LCEE101	ES	Basic Electrical and Electronics Engineering Practices Laboratory	3	0	0	3	1.5
6	U18LCCS101	ES	Problem Solving and Python Programming Lab	3	0	0	3	1.5
TOTAL CREDITS								15

PROFESSIONAL CORE COURSES

Sl. No.	Code No.	Category	Course Title	Contact Periods	L	T	P	C
THEORY								
1	U18PCBM301	PC	Anatomy and Physiology	3	3	0	0	3
2	U18PCBM302	PC	Analog and Digital Integrated Circuits	3	3	0	0	3
3	U18PCBM303	PC	Microprocessor and Microcontrollers in Biomedical Applications	3	3	0	0	3
4	U18PCBM304	PC	Electronic Devices and Circuits	3	3	0	0	3
5	U18PCBM305	PC	Biosensors and Measurements	3	3	0	0	3
6	U18PCBM401	PC	Medical Instrumentation I	3	3	0	0	3
7	U18PCBM402	PC	Fundamentals of Biochemistry	3	3	0	0	3
8	U18PCBM403	PC	Medical Physics	3	3	0	0	3
9	U18PCBM404	PC	Analog and Digital Communication System	3	3	0	0	3
10	U18PCBM405	PC	Biomaterials and Artificial Organs	3	3	0	0	3
11	U18PCBM501	PC	Bio Control System	3	3	0	0	3
12	U18PCBM502	PC	Medical Instrumentation - II	3	3	0	0	3
13	U18PCBM503	PC	Digital Signal Processing for Bio Engineers	3	3	0	0	3
14	U18PCBM601	PC	Pathology and Microbiology	3	3	0	0	3

15	U18PCBM602	PC	Diagnostic and Therapeutic Equipment	3	3	0	0	3
16	U18PCBM603	PC	Radiological Equipments	3	3	0	0	3
17	U18PCBM604	PC	Telemedicine	2	3	0	0	2
18	U18PCBM701	PC	Digital and Medical Image Processing	3	3	0	0	3
19	U18PCBM702	PC	Robotics and Nanotechnology in Medicine	3	3	0	0	3
20	U18PCBM703	PC	Health, Hospital & Equipment Management	3	3	0	0	3
PRACTICAL								
21	U18PCBM3L1	PC	Anatomy and Physiology Lab	2	0	0	2	1
22	U18PCBM3L2	PC	Microprocessors and Microcontrollers lab	2	0	0	2	1
23	U18PCBM3L3	PC	Biosensors and Measurements lab	2	0	0	2	1
24	U18PCBM4L1	PC	Biochemistry Lab	2	0	0	2	1
25	U18PCBM4L2	PC	Analog and Digital Communication System Lab	2	0	0	2	1
26	U18PCBM5L1	PC	Medical Instrumentation lab	2	0	0	2	1
27	U18PCBM5L2	PC	Digital Signal Processing for Bio Engineers lab	2	0	0	2	1
28	U18PCBM6L1	PC	Pathology and microbiology Lab	2	0	0	2	1
29	U18PCBM6L2	PC	Virtual Modelling Lab	2	0	0	2	1
30	U18PCBM7L1	PC	Image Processing Lab	2	0	0	2	1
TOTAL CREDITS								69

MANDATORY COURSES (MC)

Sl. No.	Code No.	Category	Course Title	Contact Periods	L	T	P	C
THEORY								
1	U18MCTH401	MC	Constitution of India	2	2	0	0	0
2	U18MCTH502	MC	Universal Human Values	2	2	0	0	0
3	U18MCTH603	MC	Essence of Indian Knowledge Tradition	2	2	0	0	0
ACTIVITY BASED COURSES								
1	U18MCAB101	MC	Physical health – Sports & Games	2	0	0	2	0
2	U18MCAB102	MC	Gardening & Tree Plantation -	2	0	0	2	0
3	18MCAB201	MC	Yoga	2	0	0	2	0
4	18MCAB202	MC	Physical health – NCC	2	0	0	2	0
5	U18MCAB301	MC	Culture- Learning an art form	2	0	0	2	0
6	U18MCAB302	MC	Culture – Intangible Cultural, heritage(festivals, Food ways, Local games)	2	0	0	2	0
7	U18MCAB401	MC	Literature & Media – Literature, Cinema & Media	2	0	0	2	0
8	U18MCAB402	MC	Literature & Media – Group Reading of Classics	2	0	0	2	0
9	U18MCAB501	MC	Social Services – Social Awareness	2	0	0	2	0
10	U18MCAB502	MC	Social Services – NSS	2	0	0	2	0
11	U18MCAB601	MC	Self-Development – Spiritual, Mindfulness & Meditation	2	0	0	2	0
12	U18MCAB602	MC	Self-Development - religion and Inter-faith	2	0	0	2	0
13	U18MCAB701	MC	Behavioural and interpersonal skills	2	0	0	2	0
14	U18MCAB702	MC	Nature – Nature club	2	0	0	2	0
15	U18MCAB801	MC	Innovation – Project based – Sc., Tech, Social, Design & Innovation	2	0	0	2	0
TOTAL CONTACT PERIODS = 36								

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)	3	3			3				9	5.33
2	Basic Sciences (BS)	12	13	4	4					33	19.52
3	Engineering Sciences (ES)	7.5	7.5							15	8.87
4	Professional Core (PC)			18	17	11	13	10		69	40.83
5	Professional Electives(PE)					3	3	6	6	18	10.65
6	Open Electives (OE)					3	3	3	2	11	6.51
7	Employability Enhancement Courses(EE)Project Work, Soft Skill etc.							4	10	14	8.28
	Total Credit	22.5	23.5	22	21	20	19	23	18	**169**	100
	Total Contact Hour	31	34	29	28	28	25	32	28	**235**	

U18HSEN101	**COMMUNICATIVE ENGLISH**	**L**	**T**	**P**	**C**
	Total Contact Periods – 60	2	0	2	3
	Prerequisite – School English				
	Dept Designed by: epartment of English				
OBJECTIVES	To gain fundamental knowledge of language and the uses in daily life.				

UNIT I SPEAKING 6 hours

Speaking- Pronunciation, Intonation, Stress and Rhythm -Common Everyday Situations: Conversations and Dialogues -Communication at Workplace -Interviews -Formal Presentations -introducing one self – exchanging personal information- narrating events, -incidents , speaking about one's friend/pet -Wh- Questions- asking and answering-yes or no questions- parts of speech. Vocabulary development– prefixes- suffixes- articles, prepositions.

UNIT II READING 6 hours

Reading – comprehension (multiple choice questions, short questions) - short narratives and descriptions from newspapers including dialogues and conversations also used as short reading texts-- and longer passages - understanding text structure- use of reference words and discourse markers-coherence-jumbled sentences vocabulary and structures- Vocabulary Building -The concept of Word Formation

UNIT III LISTENING 6 hours

Listening – listening to longer texts and filling in the table- product description- asking about routine actions and expressing opinions. –Listening to telephonic conversations -degrees of comparison- pronouns- direct vs indirect questions- Vocabulary development – single word substitutes- adverbs- Identifying Common Errors in Writing - Subject-verb agreement - Noun-pronoun agreement

UNIT IV WRITING 6hours

Writing- letter writing, formal and personal letters- after listening to dialogues or conversations and completing exercises based on them. Understanding text structure- use of reference words and discourse markers-coherence-jumbled sentences -Tenses- simple present-simple past- present continuous and past continuous- Vocabulary development-synonyms-antonyms- phrasal verbs- Articles - Prepositions.

UNIT V LANGUAGE DEVELOPMENT 6 hours

Writing short essays – developing an outline- identifying main and subordinate ideas-dialogue writing- listening to talks, conversations to complete the remaining, participating in conversations- short group conversations-Language development-modal verbs- present/ past perfect tense.– paragraph writing- topic sentence- main ideas short narrative descriptions . Synonyms, antonyms, and standard abbreviations- Basic Writing Skills- Sentence Structures-Use of phrases and clauses in sentences - Importance of proper punctuation - Creating coherence- Organizing principles of paragraphs in documents- Techniques for writing precisely.

SOFTSKILL LABORATORY **30hours**

LIST OF EXPERIMENTS / EXCERCISES

1. Group discussion
2. Making effective presentations
3. Watching interviews & conversations
4. Reading different genres of texts
5. International English Language Testing System (IELTS)
6. Test of English as a Foreign Language (TOEFL)
7. Mock interviews
8. Time management &stress management
9. Role play
10. Listening to lectures, discussions from TV/ Radio.
11. Articulation of sounds- intonation.
12. Creative and critical thinking.

TEXT BOOKS:

1. English A Course book for Under Graduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad: 2015
2. Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP, 2015.

REFERENCES

1. Bailey, Stephen. Academic Writing: A practical guide for students. New York: Rutledge, 2011.
2. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint 2011
3. Dutt P. Kiranmai and RajeevanGeeta. Basic Communication Skills, Foundation Books: 2013
4. Means,L. Thomas and Elaine Langlois. English & Communication for Colleges. Cengage Learning ,USA: 2007
5. Practical English Usage. Michael Swan. OUP. 2005.
6. Remedial English Grammar. F.T. Wood. Macmillan.2007
7. On Writing Well. William Zinsser. Harper Resource Book. 2001

COURSE OUTCOMES (COs)	
CO1	The student will be able to comprehend the text with clarity
CO2	The capacity to read and listen will improve
CO3	Writing technical report will be learnt properly
CO4	Speaking skills will be acquired
CO5	Overall communication skills will make them employable

Mapping of Course Outcomes with Program outcomes (POs)
(1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1				**M**			**H**		**M**					
	CO2				**M**			**H**		**M**					
	CO3				**M**			**H**		**M**			**H**		
	CO4				**M**			**H**		**M**			**M**		

	CO5				**M**			**H**		**M**			**H**		
3	Category	Humanities and Social Studies (HS)													
4	Approval	47th Meeting of Academic Council													

U18BSMA101	**ENGINEERING MATHEMATICS – I**	**L**	**T**	**P**	**C**
	Total Contact Periods – 60	4	1	0	4
	Prerequisite – School Level Mathematics				
	Course Designed by Department of Mathematics				
OBJECTIVES	➢ To familiarize the prospective engineers with techniques in calculus, multivariate integration analysis and linear algebra. ➢ To equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines				

UNIT I DIFFERENTIAL CALCULUS - One Variable (9+3)

Representation of functions – limit of a function – continuity – Derivatives – Differentiation rule – Maxima and minima of functions of one variable – Rolle's Theorem – Mean Value Theorem – Taylor's and Maclaurin's Theorem with remainders.

UNIT II INTEGRAL CALCULUS - One Variable (9+3)

Definite integrals – Substitution rule – Techniques of integration – Integration by parts – Trigonometric integrals – Trigonometric substitutions – Integrations of rational functions by partial fractions – Integrations of irrational functions- Integration of improper functions - Beta, Gamma functions and their properties.

UNIT III DIFFERENTIAL CALCULUS - Several Variables (9+3)

Partial derivatives –Euler's theorem on Homogeneous functions - directional derivatives – total derivative – Jacobian – Maxima and minima of two variables.

UNIT IV MULTIPLE INTEGRALS - Several Variables (9+3)

Double integrals in Cartesian co-ordinates – Change of order of integrations – Area as a double integral – Triple integrals in Cartesian co-ordinates –Volume as triple integrals – Double integrals in polar co-ordinates – simple problems.

UNIT V MATRICES (9+3)

Characteristic Equations – Eigenvalue and Eigenvectors of the real matrix– Properties–- Cayley-Hamilton Theorem – Diagonalization of matrices – Reduction of quadratic form to canonical form by orthogonal transformation – Nature of Quadratic form.

TEXT BOOKS

1. Grewal B. S, Higher Engineering Mathematics, Khanna Publisher, Delhi – 2014.
2. Kreyszig. E, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, Singapore, 2012.

REFERENCE BOOKS

1. Veerarajan T, Engineering Mathematics, II edition, Tata McGraw Hill Publishers, 2008.
2. Kandasamy P &co., Engineering Mathematics, 9th edition, S. Chand & co Pub., 2010.
3. N.P.Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
4. Narayanan S., Manicavachagam Pillai T.K., Ramanaiah G., Advanced Mathematics for Engineering students, Volume I (2nd edition), S.Viswanathan Printers and Publishers,
5. George B. Thomas ,Jr ,Maurice D.Weir, Joel Hass., Thomas' Calculus ,Twelfth Edition Addison-Wesley, Pearson.

COURSE OUTCOMES (COs)	
The student will be able	
CO1	To apply both the limit definition and rules of differentiation to differentiate functions. Also they will have a basic understanding of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
CO2	To apply definite integrals of algebraic and trigonometric functions using formulas and substitution. Also they will have a basic understanding of Beta and Gama functions.
CO3	To apply differential and integral calculus to notions of curvature. Also apply differentiation to find maxima and minima of functions.
CO4	To apply multiple integrals to compute area and volume over curves, surface and domain in two dimensional and three dimensional spaces.
CO5	Identify Eigenvalue problems from practical areas using transformations; Diagonalising the matrix would render the Eigen values.

Mapping of Course Outcomes with Program Outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	H				M		L			L		
	CO2	H		H	W	M			M				
	CO3	H				M				L			
	CO4	H	M			M				L			
	CO5	H		H		M				M	L		
3	Category	Basic Science (BS)											
4	Approval	47th Meeting of Academic Council											

U18BSPH101	**WAVES AND OPTICS**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite – Higher Secondary School Physics				
	Course designed by – Department of Physics				
OBJECTIVES: To develop Physics and Engineering strategies of Waves and Optics and to discuss their functionalities in modern optoelectronics.					

UNIT 1 NON-DISPERSIVE TRANSVERSE AND LONGITUDINAL WAVES IN ONE DIMENSION 9

Introduction - Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, standing waves, longitudinal waves and the wave equation for them, acoustics waves and speed of sound. Waves with dispersion, superposition of waves, wave groups and group velocity.

UNIT 2 ULTRASONIC WAVES 9

Production of ultrasonic by magnetostriction and piezoelectric methods - acoustic grating – etection - Non Destructive Testing – pulse echo system through transmission and reflection modes - A,B and C – scan displays, Industrial and Medical applications – Sonogram.

UNIT 3 THE PROPAGATION OF LIGHT AND GEOMETRIC OPTICS 9

Fermat's principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster's angle, total internal reflection, and evanescent wave. Mirrors and lenses and optical instruments based on them

UNIT 4 WAVE OPTICS 9

Huygens' principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer. Fraunhofer diffraction from a single slit and a circular aperture, Diffraction gratings and their resolving power

UNIT 5 LASERS 9

Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO2), solid-state lasers(Neodymium), Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, applications of lasers in science, engineering and medicine.

TEXT BOOKS

1. M.N. Avadhanulu and P.G. Kshirsagar, "A Textbook of Engineering Physics" S.Chand Publishers, 2016 (for Units 1,3,4 & 5)
2. G.Senthil Kumar, "Engineering Physics", VRB publishers, Chennai, 2015 (for Unit 2)

REFERENCE BOOKS

1. BrijLal and Subramanian, "Waves and Oscillation", Vikas Publishsing House, 2011
2. R.Murugesan,"Optics and Spectroscopy", S.Chand Publishers, 2015
3. BrijLal and Subramanian,"Optics", S.Chand Publishers 2006
4. Ian G. Main, "Vibration and waves in physics", Cambridge University Press, 1978
5. H.J. Pain, "The physics of vibrations and waves", 6th edition, Wiley 2006
6. Ajoy Ghatak, "Optics", Tata McGraw-Hill publishing company, New Delhi, 2009
7. O. Svelto, "Principles of Lasers", Springer, 2010
8. Online reference Wikipedia.org

COURSE OUTCOMES (COs)	
The student will be able	
CO1	Understand the basic concept of waves and lights
CO2	Understand the importance of Ultrasonic waves and Non-Destructive Testing
CO3	Understand the propagation of light and geometrical optics
CO4	Understand the optical phenomenon like interference, diffraction and superposition of waves
CO5	Understand the concept of laser and its applications

Mapping of Course Outcomes with Program Outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l

2	CO1	H	H	M	H	M			M	H	H		H
	CO2	L	H	M	M	H			M		L	H	L
	CO3	H	L			L			M	M		M	H
	CO4	H	L			L			M	M		M	H
	CO5	H	M	M	M				M		H	W	H
3	Category	Basic Sciences (BS)											
4	Approval	47th Meeting of Academic Council											

U18BSCH101	**ENGINEERING CHEMISTRY**	**L**	**T**	**P**	**C**
	Total Contact Periods – 45	3	0	0	3
	Prerequisite – School Level Chemistry				
	Course Designed by – Department of Chemistry				
OBJECTIVES: To gain fundamental knowledge of Engineering Chemistry and its applications					

UNIT I WATER TECHNOLOGY **9**

Introduction - Characteristics: Hardness of Water – Types - Temporary and Permanent Hardness - Estimation by EDTA method. Alkalinity – Types of Alkalinity - Phenolphthalein and Methyl Orange Alkalinity - Determination – Domestic Water Treatment – Disinfection methods (Chlorination, Ozonation, and UV Treatment). Boiler feed water – Requirements – Disadvantages of using hard water in boilers (Caustic embrittlement, Boiler corrosion, Priming and foaming) – Prevention of scale formation – softening of hard water - Internal treatment (Calgon treatment method) – External treatment – Demineralization process – Desalination and Reverse osmosis.

UNIT II PHASE RULE AND ALLOYS **9**

Introduction: Statement of Phase Rule and Explanation of terms involved – One component system – Water system – Construction of phase diagram by thermal analysis - Condensed phase rule - Two Component System : Simple eutectic systems (lead-silver system) – eutectic temperature – eutectic composition – Pattinson's Process of desilverisation of Lead.

Alloys: Importance, ferrous alloys – nichrome and stainless steel – 18/8 stainless steel -heat treatment of steel – annealing –hardening – tempering - normalizing – carburizing - nitriding. Non- ferrous alloys: Brass and Bronze.

UNIT III NON-CONVENTIONAL ENERGY SOURCES AND STORAGE DEVICES **9**

Introduction: Nuclear fission and nuclear fusion reactions – differences between nuclear fission and nuclear fusion reactions – nuclear chain reactions – nuclear energy critical mass - super critical mass - sub - critical mass Light water nuclear reactor for power generation – breeder reactor. Solar energy conversion – solar cells – wind energy. Fuel cells – hydrogen – oxygen fuel cell. Batteries: Primary and secondary Batteries – differences between Primary and secondary Batteries Secondary batteries: Lead–acid storage battery –working –uses. Nickel–cadmium battery -working –uses. Solid – state battery: Lithium battery.

UNIT IV FUELS **9**

Introduction: Calorific value – types of Calorific value - gross calorific value – net calorific value. Analysis of Coal – Proximate and ultimate analysis – hydrogenation of coal - Metallurgical coke –manufacture by Otto-Hoffmann method. Petroleum processing and fractions– cracking – catalytic cracking – types – fixed bed catalytic cracking method- Octane

number and Cetane number. Synthetic petrol – Bergius processes – Gaseous fuels- water gas, producer gas, CNG and LPG. Flue gas analysis – importance - Orsat apparatus.

UNIT V NANOCHEMISTRY 9

Introduction: Nanochemistry: Definition - Classification based on dimensions - Size dependent properties. Types of nanomaterials: Nanoparticles: Synthesis by Bottom-up and top-down approaches - Nanoporous materials: Synthesis by sol-gel method. Nanowires: Synthesis by VLS mechanism. Carbon Nanotubes (CNTs): Single walled and Multi walled nanotubes - Mechanical and electrical properties of CNTs - Applications of CNTs - Synthesis of CNTs by Electric arc discharge method and Laser ablation method. Nanochemistry in biology and medicines – nanocatalysis. Nanocomposites – sensors and electronic devices.

TEXT BOOKS:

1. P.C.Jain and Monica Jain, "Engineering Chemistry" Dhanpat Rai Pub, Co., New Delhi (2002).
2. S.S.Dara "A text book of Engineering Chemistry" S.Chand & Co.Ltd., New Delhi (2006).
3. P. J. Lucia, M. Subhashini, "Engineering Chemistry, Volume 1", Crystal Publications, Chennai, (2007).
4. S. Vairam, P. Kalyani and Suba Ramesh, ―Engineering Chemistry‖, Wiley India PVT, LTD, New Delhi, 2013.
5. G. B. Sergeev, Nano chemistry, Elsevier Science, New York, 2006.

REFERENCES:

1. B.K.Sharma "Engineering Chemistry" Krishna Prakasan Media (P) Ltd., Meerut (2001).
2. Sivasankar "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, New Delhi (2008).

COURSE OUTCOMES (COs)	
The student will be able	
CO1	To impart knowledge to the Students about the principles, water characterization, conversant with boiler feed water requirements and water treatment techniques.
CO2	To make them understand the industrial importance of Phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys
CO3	To make the students to be well versed with the principles of Conventional and non-conventional energy sources and energy storage devices.
CO4	To make the students to have a deep knowledge of the Chemistry of Fuels and calorific value, manufacture of solid, liquid and gaseous fuels.
CO5	To make them understand the Nanochemistry, Types of nanomaterials: Nanoparticles, Nanochemistry in biology and medicines.

Mapping of Course Outcomes with Program Outcomes (POs)

(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	H			M		H		H		L		H
	CO2		L	H		M		S		M		L	
	CO3		M		H		L				M		
	CO4	H		M	H			M			H		H
	CO5		H		L		M				H		
3	Category	Basic Science (BS)											
4	Approval	47th Meeting of Academic Council											

U18ESEE101	BASIC ELECTRICAL & ELECTRONICS ENGINEERING	L	T	P	C
	Total Contact Periods – 45	3	0	0	3
	Prerequisite – School Level Physics				
	Course Designed by – Department of Electrical & Electronics Engineering				
OBJECTIVES	To gain fundamental knowledge of Electrical and Electronics Engineering and its applications				

MODULE 1 : DC CIRCUITS **12**

Electrical circuit elements, voltage and current sources, Fundamental Relationship of VI for RLC circuit, Ohms Law, Source Transformation ,Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Basics of Superposition, Thevenin and Norton Theorems, Maximum Power Transfer Theorem.

MODULE 2: AC CIRCUITS **9**

Representation of sinusoidal waveforms, peak and RMS values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Time-domain analysis of first-order RL and RC circuits. Three-phase balanced circuits, voltage and current relations in star and delta connections.

MODULE 3: ELECTRICAL MACHINES & TRANSFORMERS **9**

Principles of operation and characteristics of; DC machines, Synchronous machines, three phase and single phase induction motors. Transformers (single and three phase) regulation and efficiency, all day efficiency and auto-transformer .

MODULE 4: SEMICONDUCTOR DEVICES AND APPLICATIONS **9**

Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulation. Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics – Elementary Treatment of Small Signal Amplifier and its applications, Introduction to OP-AMP.

MODULE 5: DIGITAL ELECTRONICS **6**

Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders – Flip-Flops – Registers and Counters – Fundamentals of A/D and D/A Conversion.

TEXT BOOKS:

1. John Bird, Electrical Circuit Theory & Technology, Taylor & Francis Ltd, 6th, edition. 2017.
2. Smarajit Ghosh, Fundamentals of Electrical and Electronics Engineering, Second Edition, PHI Learning, 2007.
3. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
4. E. Hughes, "Electrical and Electronics Technology", Pearson, 10th Edition, 2011.
5. V. D. Toro, "Electrical Engineering Fundamentals", Pearson, 2nd Edition, 2015.
6. Millman and Halkias, "Integrated Electronics", McGraw Higher Ed, 2nd Edition, 2011.
7. Vincent Del Toro, `Electrical Engineering Fundamental, Prentice Hall, 2nd Edition, 2015.
8. K.A.Krishnamurthy and M.R.Raghuveer, `Electrical and Electronics Engineering for Scientists', New Age International Pvt Ltd Publishers, 2011.

REFERENCES:

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, Third Reprint,2016.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", Mcgraw Higher Ed, 1st Edition, 2011.
3. Jacob Millman and Christos C-Halkias,"Electronic Devices and Circuits", Mcgraw Higher Ed, 4th Edition, 2015.

COURSE OUTCOMES (COs)	
The student will be able	
CO1	To gain knowledge regarding the various laws and principles associated with DC Circuits.
CO2	To gain knowledge regarding fundamentals of AC circuits.
CO3	To gain knowledge regarding electrical machines and transformers.
CO4	To gain knowledge regarding various types of semiconductor devices and small signal amplifiers.
CO5	To gain knowledge on principles of digital electronics systems.

Mapping of Course Outcomes with Program Outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	H	L			M				H		W	H
	CO2	H	L			M				H		W	H
	CO3	H	M			M				H		W	H
	CO4	H	L			M				H		W	H
	CO5	H	L			M				H		W	H
3	Category	Engg Sciences (ES)											
4	Approval	47th Meeting of Academic Council											

U18BSBT101	**BIOLOGY FOR ENGINEERS**	**L**	**T**	**P**	**C**
	Total Contact Hours - 30	2	0	0	2
	Prerequisite – Higher Secondary level in Physical & Life Sciences signaling				
	Course Designed by – Dept of Industrial Biotechnology				
OBJECTIVES: To provide a basic understanding of the biological systems and its applications in the industrial sector					

UNIT I INTRODUCTION TO LIFE 6

Characteristics of living organisms-Basic classification-cell theory-structure of prokaryotic and eukaryotic cell- Introduction to biomolecules - general classification and important functions of carbohydrates-lipids-proteins-nucleic acids – vitamins

UNIT II BIODIVERSITY 6

Plant System: basic concepts of plant growth-nutrition-photosynthesis-Animal System: elementary study of digestive-respiratory-circulatory-excretory systems and their functions. Microbial System -types of microbes-economic importance and control of microbes.

UNIT III GENETICS AND IMMUNE SYSTEM 6

Evolution: theories of evolution- evidence of laws of inheritance-variation and speciation- nucleic acids as a genetic material-central dogma - immunity- antigens - antibody-immune response.

UNIT IV HUMAN DISEASES 6

Definition- causes, symptoms, diagnosis, treatment and prevention of diabetes, cancer, hypertension, AIDS and Hepatitis

UNIT V BIOLOGY AND ITS INDUSTRIAL APPLICATION 6

Transgenic plants and animals-stem cell and tissue engineering-bioreactors-biopharming-recombinant vaccines -cloning- bioremediation-biofertilizer-biocontrol- biosensors-biopolymers-bioenergy-biomaterials-biochips

TEXT BOOKS:

1. A Text book of Biotechnology, R. C. Dubey, S. Chand Higher Academic Publications, 2013
2. Diseases of the Human Body, Carol D. Tamparo and Marcia A. Lewis, F.A. Davis Company, 2011.
3. Biomedical instrumentation, Technology and applications, R. Khandpur, McGraw Hill Professional, 2004

REFERENCE BOOKS

1. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
2. Cell Biology and Genetics (Biology: The unity and diversity of life Volume I), Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008
3. Biotechnology Expanding horizon, B.D. Singh, Kalyani Publishers, 2012

COURSE OUTCOMES (COs)													
The student will be able													
CO1	To understand the basic concepts of the cell and its structure												
CO2	To understand about biodiversity and its conservation												
CO3	To know the fundamentals of genetics and the immune system												
CO4	To create an awareness about human diseases												
CO5	To give a basic knowledge of the applications of transgenic												
Mapping of Course Outcomes with Program Outcomes (POs) (H/M/L indicates strength of correlation) H-High, M-Medium, L-Low													
1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	H					M	M			H	M	H
	CO2	H			M		H		M	M			H
	CO3	M		M			M						M
	CO4							H			M	M	
	CO5	H	H					H	M	M			H
3	Category	Basic Sciences (BS)											
4	Approval	47th Meeting of Academic Council											

U18BSPH2L2	WAVE OPTICS AND SEMI-CONDUCTOR PHYSICS LABORATORY	L	T	P	C
	Total Contact Hours - 45	**0**	**0**	**3**	**1.5**
	Prerequisite – Higher Secondary School Physics				
	Course designed by – Department of Physics				

OBJECTIVES: To impart knowledge of practical Physics to the students

Course Outcome (CO's)

The student will be able

CO1	Understand the fundamental concept of optics
CO2	Understand the concept of production of ultrasonic waves
CO3	Understand the functions of semiconductor

Mapping of Course Outcomes with Programme Outcomes (POs)
S – Strong, M – Medium, W – Weak

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	H		H	H				H	L	M		
	CO2	H	H	L					H	L	M		
	CO3	L	H	H					H	L	M		
3	Category	Basic Sciences (BS)											
4	Approval	47th Meeting of Academic Council held in Aug, 2018											

Physics Lab experiments for Semester I & II

List of Experiments for Waves and Optics – Common for all branches

1) Ultrasonic Interferometer
2) Air-wedge Experiment
3) Particle size determination
4) Determination of acceptance angle
5) Determination of Laser Wavelength
6) Spectrometer – Determination of wavelength using grating

List of Experiments for Semiconductor Physics – Circuit branches

1) Determination of Band Gap
2) Zener diode characteristics
3) p-n junction diode Characteristics
3) Transistor Characteristics
5) V-I characteristics using LDR circuit
6) Carey Foster's Bridge

U18BSCH2L4	CHEMISTRY LABORATORY	L	T	P	C
	Total Contact Hours – 45	0	0	3	1.5
	Prerequisite – Engineering Chemistry				
	Course Designed by – Department of Chemistry				

OBJECTIVES: To enhance the practical knowledge on Chemistry through Volumetric and circuit experiments

LIST OF EXPERIMENTS

1. Determination of Total Hardness, Temporary Hardness and Permanent hardness of Water by EDTA method
2. Estimation of Alkalinity - Titrimetry

3. Estimation of Dissolved Oxygen
4. Estimation of Chlorides in Water by Argentometric Method (MOHR'S Method)
5. Estimation of Copper by EDTA method
6. Estimation of Iron in Water by Spectrophotometry
7. Conductometric Titration of Strong Acid with Strong Base
8 Determination of Molecular weight of a polymer by Viscosity Average Method
9. pH measurements for Acid - alkali Titrations
10 Determination of rate of corrosion by weight loss method.
11. Conductometric Precipitation titration
12. Determination of Water Crystallization

REFERENCES

1. R. Jeyalakshmi, "Practical Chemistry", Devi Publications 2014.
2. S.S. Dara, A text book on experiments and calculation Engg.

COURSE OUTCOMES (COs)	
The student will be able	
CO1	Students will able to analyze - hardness, Alkalinity, Dissolved oxygen, Chlorides in Water by Argentometric Method, Determination of Water of Crystallization and as well as estimation of Copper by EDTA method using volumetric analysis.
CO2	Students will understand basic principle of spectrophotometric method
CO3	Students will learn Conductometric Titration of Strong Acid with Strong Base and Conductometric Precipitation titration.
CO4	Student will be able to analyze Determination of Molecular weight of a polymer by Viscosity Average Method
CO5	Student will understand about pH measurements for Acid - alkali Titrations and rate of corrosion by weight loss method

Mapping of Course Outcomes with Program Outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	H		M	M		H		H		L		H
	CO2	W	H			M		H		M		L	L
	CO3		M		M						M		
	CO4	H		M				M				H	H
	CO5		H		L		M				H		
3	Category	Basic Sciences (BS)											
4	Approval	47th Meeting of Academic Council											

U18ESME1L2	**WORKSHOP/MANUFACTURING PRACTICES LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Periods – 75	1	0	4	3
	Prerequisite – NIL				
	Course Designed by – Department of Mechanical Engineering				
OBJECTIVES	To educate the students on common manufacturing processes employed in Industries.				

SYLLABUS

Lectures & videos: (15 hours)

Detailed contents

- Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods **(3 lecture)**
- CNC machining, Additive manufacturing **(2 lecture)**
- Fitting operations & power tools **(2 lecture)**
- Carpentry **(2 lecture)**
- Plastic moulding, glass cutting **(2 lecture)**
- Metal casting **(2 lecture)**
- Welding (arc welding & gas welding), brazing **(2 lecture)**

WORKSHOP PRACTICE:

1. Machine shop **(6 hours)**
   a) Facing
   b) Turning
   c) Drilling Practice
2. Fitting shop **(6 hours)**
   a) Fitting Exercises–Preparation of square fitting
   b) Vee–fitting models.
3. Carpentry **(9 hours)**
   a) Preparation of Lap joints.
   b) Mortise and Tenon joints.
   c) Cross Half joints.
   d) Dove Tail joints.

4. Welding shop **(Arc welding 6 hrs + gas welding 3 hrs) (9 hours)**

Preparation of butt joints, lap joints and Tee joints

5. Sheet Metal working **(9 hours)**
   a) Forming &Bending:
   b) Model making–Trays, funnels, etc.
   c) Different type of joints

6. Demonstration **(6 Hours)**

Smithy operations, upsetting, swaging, setting down and bending. Example–Exercise–Production of hexagonal headed bolt.

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

SUGGESTED TEXT/REFERENCE BOOKS:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers Private Limited, Mumbai.
1. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology",4th edition, Pearson Education India Edition, 2002.
2. Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.
3. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
4. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

COURSE OUTCOMES (COs)	
The student will be able	
CO1	Students will gain knowledge of the different manufacturing processes.
CO2	Students will be able to fabricate components with their own hands.
CO3	Students will gain practical knowledge of the dimensional accuracies and dimensional tolerances.
CO4	Students will be able to produce small devices of their interest.

Mapping of Course Outcomes with Program Outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1											H	
	CO2			H	M							H	
	CO3		M										
	CO4	H			L							H	H
	CO5											H	
3	Category	Engg Sciences (ES)											
4	Approval	47th Meeting of Academic Council											

U18ESEE1L3	**BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	0	0	3	1.5
	Prerequisite – School Level Physics & Basic Electrical and Electronics Engineering				
	Course Designed by – Department of Electrical & Electronics Engineering				
OBJECTIVES: To enhance the practical knowledge on basics of electrical and electronics components and circuits.					

LIST OF EXPERIMENTS FOR BASIC ELECTRICAL ENGINEERING LAB

1. Verification of Ohms and Kirchoff's Voltage and Current Laws
2. Measurement of the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification.
3. Fluorescent lamp wiring
4. Staircase wiring
5. Measurement of energy using single phase energy meter
6. Observation of the no-load current waveform on an oscilloscope and Measurement of Primary and secondary voltages and currents of a Transformer
7. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
8. Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform (c) the use of dc-ac converter for speed control of an induction motor and (d) Components of LT switchgear.

LIST OF EXPERIMENTS FOR BASIC ELECTRONICS ENGINEERING LAB

1. Measurement of ac signal parameters using cathode ray oscilloscope and function generator.
2. Characteristics – Half wave and Full wave Rectifiers
3. Characteristics – Common Base transistor configuration
4. Verification of truth tables of OR, AND, NOT, NAND, NOR gates and Flip-flops - JK and RS
5. Applications of Operational Amplifier

REFERENCE BOOKS:

1. S. K. Bhattacharya, "Basic Electrical and Electronics Engineeing", Pearson Education India,2011

COURSE OUTCOMES (COs)	
The student will be able	
CO1	To handle basic electrical equipment and verify current and voltage law
CO2	To understand the steady-state and transient time-response of R-L, R-C, and R-L-C circuits .
CO3	To understand domestic wiring procedures practically.
CO4	To analyze ac signal parameters using cathode ray oscilloscope and function generator
CO5	To understand all the fundamental concepts semiconductor Diode and Transistor
CO6	To understand all the fundamental concepts of logic Gates and Flip-Flaps

Mapping of Course Outcomes with Program Outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	H	H			H				H		M	H
	CO2	H	H			H				H		M	H
	CO3	H	H			H				H		M	H
	CO4	H	H			H				H		M	H
	CO5	H	H			H				H		M	H
	CO6	H	H			H				H		M	H
3	Category	Engg Sciences (ES)											
4	Approval	47th Meeting of Academic Council											

U18HSEN201	**TECHNICAL ENGLISH**	**L**	**T**	**P**	**C**
	Total Contact Periods – 45	2	1	0	3
	Prerequisite – I semester English				
	Course Designed by – Department of English				
OBJECTIVES	To gain fundamental knowledge of English language and its usage in day to day life.				

UNIT I LISTENING 9

Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises- Speaking –Asking for and giving directions- extended definitions –listening to daily issue- -Vocabulary Development- technical vocabulary - Language Development –subject verb agreement – compound words.

UNIT II READING 9

Reading – reading longer technical texts- identifying the various transitions in a text- interpreting charts, graphs after reading the, practice in speed reading- vocabulary Development-vocabulary used in formal letters/emails and reports -Language Development personal passive voice, numerical adjectives.

UNIT III TECHNICAL WRITING 9

Writing after listening to classroom lectures- talk should be on engineering /technology– introduction to technical presentations- longer texts both general and technical, Describing a process, use of sequence words- Vocabulary Development- sequence words- Misspelled words.

UNIT IV FORMAL WRITING 9

Writing- email etiquette- job application – cover letter –Resume preparation (via email and hard copy)- analytical essays and issue based essays–Vocabulary Development- finding suitable synonyms-paraphrasing-. Language Development- clauses- dependant, independent, if conditionals.

UNIT V LANGUAGE DEVELOPMENT 9

Speaking –participating in a group discussion – role play, Writing– Writing reports- minutes of a meeting- accident and survey-Vocabulary Development- transitive, intransitive verbs, Language Development- reported speech.

TEXT BOOKS:

1. Fluency in English A Course book for Engineering and Technology. Orient Blackswan, Hyderabad: 2016
2. Sudharshana.N.P and Saveetha. C. English for Technical Communication. Cambridge University Press: New Delhi, 2016.

REFERENCES

1. Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014.
2. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007
3. Kumar, Suresh. E. Engineering English. Orient Blackswan: Hyderabad,2015
4. Means, L. Thomas and Elaine Langlois, English & Communication For Colleges Cengage Learning, USA: 2007

COURSE OUTCOMES (COs)	
The student will be able	
CO1	The student will acquire basic proficiency in English
CO2	Reading and listening ability will improve.
CO3	Comprehension techniques will develop.
CO4	writing and speaking skills will be acquired
CO5	Overall communication skills will make them employable.

Mapping of Course Outcomes with Program Outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	L			M		H		H		L		H
	CO2	L	H	H		M		H		M		L	L
	CO3		M				L			H	M		
	CO4	L		M	L			M				M	H

	CO5		H		L		M				H		
3	Category	Humanities and Social Studies (HS)											
4	Approval	47th Meeting of Academic Council											

U18BSMA201	**ENGINEERING MATHEMATICS II**	**L**	**T**	**P**	**C**
	Total Contact Periods - 60	**3**	**1**	**0**	**4**
	Prerequisite – School Level Mathematics				
	Course Designed by Department of Mathematics				
OBJECTIVES	The objectives of this course are to equip the students of Engineering and Technology with techniques in ➢ Ordinary equations, vector calculus, complex variables. ➢ Laplace transform with advanced level of mathematics and applications that would be essential to formulate problems in engineering environment.				

UNIT I ORDINARY DIFFERENTIAL EQUATIONS (9+3)

Higher order linear differential equations with constant coefficients – linear differential equations with variable coefficients– Euler's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients- Method of variation of parameters.

UNIT II VECTOR CALCULUS (9+3)

Scalar and vector point function - Gradient, Divergence and curl – Directional derivatives – Angle between two surfaces - Irrotational and Solenoidal vector fields – Line Integral - Green's theorem – Gauss divergence theorem and Stokes' theorem – Simple applications involving cubes and rectangular parallelepipeds.

UNIT III ANALYTIC FUNCTIONS (9+3)

Functions of complex variable - Analytic functions – Necessary and sufficient conditions (without proof), Cauchy Riemann Equations in Cartesian and polar form – Harmonic functions – properties of analytic functions – Construction of analytic functions using Milne Thomson method –Conformal mapping : and Bilinear Transformation.

UNIT IV COMPLEX INTEGRATION (9+3)

Cauchy integral theorem – Cauchy's integral formula – problems – Taylor's and Laurent's Series – classification of Singularities – Poles and Residues – method of finding residues - Cauchy's residue theorem and its applications to evaluate real integrals – contour integration.

UNIT V LAPLACE TRANSFORMS (9+3)

Transforms of elementary functions – Basic properties – Shifting theorem- Transforms of derivatives and integrals – Initial and final value theorem – Laplace transform of Periodic Functions – Inverse Laplace transform – Convolution theorem – Periodic Functions – Applications of Laplace transform for solving linear ordinary differential equations up to second order with constant coefficient.

TEXT BOOKS

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Willie & Sons, 2006.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.

REFERENCE BOOKS

1. Venkataraman. M. K, Engineering Mathematics, National Publishing Company, 2000.
2. Bali .N.P and Manish Goyal, A Text book of Engineering Mathematics, Eighth Edition, Laxmi Publications Pvt Ltd., 2011.
3. Veerarajan T, Engineering Mathematics, II edition, Tata McGraw Hill Publishers, 2008.
4. George B. Thomas Jr., Maurice D. Weir, Joel R. Hass., Thomas' Calculus, 12th Edition, Addison-Wesley, Pearson.

COURSE OUTCOMES (COs)	
The student will be able	
CO1	The mathematical tools for solution of differential equation that model physical process.
CO2	To evaluate the line, surface and volume integrals using Green's, Stoke's and Gauss Theorems and their verification.
CO3	To understand the analytic functions, conformal mapping and complex integration and their applications.
CO4	To evaluate real and complex integrals using the Cauchy's integral formula and Residue theorem.
CO5	To apply the concept of Laplace Transformation in analysis and solve differential equations.

Mapping of Course Outcomes with Program Outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	L			M		H		H		L		H
	CO2	L	H	H		M		H		M		L	L
	CO3		M				L			H	M		
	CO4	L		M	L			M				M	H
	CO5		H		L		M				H		
3	Category	Basic Science (BS)											
4	Approval	47th Meeting of Academic Council											

U18BSPH202	**SEMICONDUCTOR PHYSICS**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite – Higher Secondary School Physics				
	Course designed by – Department of Physics				

OBJECTIVES

- To develop physics and engineering strategies of semiconductor materials and to discuss their functionalities in modern electronic and optoelectronic devices

UNIT 1 INTRODUCTION AND ELECTRONIC STATES OF SEMICONDUCTORS 9

Introduction to solid state materials - crystal structure - Reciprocal lattice - Brillouin zone and rules for band (k - space) representation. Dynamics of electrons in periodic potential:Kronig - penny and nearly free electron models - Real methods for band structure calculations; Band gaps in semiconductors - Holes and effective mass concept - Properties of conduction and valance bands

UNIT 2 CARRIERS AND DOPING 9

Fermi distribution and energy - Density of states - Valance and conduction band density of states - intrinsic carrier concentration – intrinsic Fermi level. Extrinsic semiconductors: n and p type doping - Densities of carriers in extrinsic semiconductors and their temperature dependence - extrinsic semiconductor Fermi energy level - Degenerate and non - degenerate semiconductors - Band gap engineering

UNIT 3 ELECTRICAL TRANSSORT 9

Scattering Mechanism: electron - electron and electron – phonon scattering. Macroscopic transport: Carrier transport by Diffusion - Carrier transport by Drift: Low field, High field and very high field.

UNIT 4 OPTICAL TRANSSORT 9

Electron - hole pair generation and recombination: band to band (direct and indirect band gap transitions) and intra band (impurity related) transitions, free - carrier & phonon transitions. Excitons: Origin, electronic levels and properties. Carrier transport - continuity equations. Optical constants: Kramers - Kronig relations.

UNIT 5 SEMICONDUCTOR AS DEVICES AND RECENT ADVANCES 9

Processing of Semiconductor devices (Brief), p - n Semiconductor as device and Semiconductor junctions - Homo and hetero Junctions. Active and passive optoelectronic devices: performance and response enhancement (photo processes)**.**

TEXT BOOK:

1. M.N. Avadhanulu and P.G. Kshirsagar, “A Textbook of Engineering Physics” S.Chand Publishers, 2014 **(for units 1 and 2)**
2. G.Senthil Kumar, “Engineering Physics”, VRB publishers, Chennai, 2015 (for Unit 5)

REFERENCES BOOKS:

1. Kevin F Brennan, "The Physics of Semiconductors", Cambridge Univ.Press 1999.
2. Peter Y Yu and Manuel Cardona, "Fundamentals of Semiconductors",Spriger, 1996.
3. Charles Kittel, "Introduction to Solid State Physics", 6th edition, Willey, 1991.
4. D.A. Neamen, "Semiconductor Physics and Devices", 3 rdEd.,Tata McGraw-Hill,2002.
5. Jasprit Singh, "Semiconductor Optoelectronics (Physics and Technology)", McGraw-Hill, 1995.
6. Online reference: Wikipedia, NPTEL

COURSE OUTCOMES (COs)	
The student will be able	
CO1	Understand the difference between metals, semiconductors and insulators
CO2	Understand the importance of doping to charge carrier density
CO3	Understand the electrical transport in semiconductors
CO4	Understand the difference between direct and indirect semiconductors
CO5	Understand the concept of semiconductor optoelectronic devices.

Mapping of Course Outcomes with Program Outcomes (POs)

(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	L			M		H		H		L		H
	CO2	L	H	H		M		H		M		L	L
	CO3		M				L			H	M		

	CO4	L		M	L			M				M	H
	CO5		H		L		M				H		
3	Category	Basic Sciences (BS)											
4	Approval	47th Meeting of Academic Council											

U18BSCH201	**ENVIRONMENTAL SCIENCE**	**L**	**T**	**P**	**C**
	Total Contact Periods – 45	3	0	0	3
	Prerequisite – NIL				
	Course Designed by – Department of Chemistry				
OBJECTIVES	• To study the interrelationship between living organism and environment. • To study of the nature and concepts of ecosystem. • To learn about the integrated themes and biodiversity of an environment. • To study of pollution control and waste management. • To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.				

UNIT I -NATURAL RESOURCES **9**

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people –Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems - Food resources: World food problems, changes caused by agriculture and overgrazing, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification - Equitable use of resources for sustainable lifestyles.

UNIT II -ECOSYSTEMS **9**

Introduction: concepts of an ecosystem. Structure and function of an ecosystem, producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids - Introduction, types, characteristic features, structure and function of the following ecosystem :- Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, (ponds, streams, lakes, rivers, oceans, estuaries)- Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation - Ethics : Issues and Possible Solutions, Climate change, global warming, acid rain, ozone layer depletion.

UNIT III -BIODIVERSITY AND ITS CONSERVATION **9**

Introduction and Definition - genetic, species and ecosystems diversity, Biogeographical classification of India - Value 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, habitat, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation biodiversity - In-situ and Ex-situ conservation of biodiversity.

UNIT IV-ENVIRONMENTAL POLLUTION 9

Definition, Causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution - pollution case studies - Disaster Management: floods earthquake, cyclone and landslides.

UNIT V- SOCIAL ISSUES AND HUMAN POPULATION 9

Social issues: Environmental Protection Act, Air (Prevention and Control of pollution) Act, Water (Prevention and Control of pollution) Act, Wildlife protection Act, Forest Conservation Act, Public awareness – Fireworks and its impact on the Environment – Chemicals used in Fireworks – (Fuel –oxidizing Agent – Reducing Agent –Toxic Materials – Fuel –Binder- Regulator) – Harmful nature of ingredients – chemical effects on health due to inhaling fumes.

Human population: population growth, variation among nations, Population explosion-Family Welfare programs, Environment and human health, Human Rights, Value Education, HIV and AIDS, Women and Child Welfare, Role of Information Technology in Environment and Human health - Case Studies.

TEXT BOOKS:

1. Gilbert M. Masters, Introduction to Environmental Engineering and Science‘, 2nd edition, Pearson Education 2004.
2. Benny Joseph, Environmental Science and Engineering‘, Tata McGraw-Hill, New Delhi, 2006.
3. R.K. Trivedi, Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards‘, Vol. I and II, Enviro Media.
4. Rajagopalan, R, Environmental Studies-From Crisis to Cure’, Oxford University Press 2005.
5. K.V.B. Raju and R.T. Ravichandran, “Basics of Civil Engineering”.

REFERENCES:

1. Cunningham, W.P. Cooper, T.H. Gorhani, Environmental Encyclopedia‘, Jaico Publ., House, Mumbai, 2001.
2. Dharmendra S. Sengar, Environmental law‘, Prentice hall of India PVT LTD, New Delhi, 2007.

COURSE OUTCOMES (COs)	
The student will be able to	
CO1	Master core concepts and methods from ecological and physical sciences and their application in environmental problem solving
CO2	Appreciate concepts and methods from ecological and physical sciences and their application in environmental problem solving.
CO3	Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems
CO4	Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales
CO5	Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes
Mapping of Course Outcomes with Program Outcomes (POs) (H/M/L indicates strength of correlation) H-High, M-Medium, L-Low	

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	L			M		H		H		L		H
	CO2	L	H	H		M		H		M		L	L
	CO3		M				L			H	M		
	CO4	L		M	L			M				M	H
	CO5		H		L		M				H		
3	Category	Basic Sciences (BS)											
4	Approval	47th Meeting of Academic Council											

U18ESCS101	**PROBLEM SOLVING AND PYTHON PROGRAMMING**	**L**	**T**	**P**	**C**
	Total Contact Periods – 45	**3**	**0**	**0**	**3**
	Prerequisite – NIL				
	Course Designed by – Department of Computer Science & Engineering				
OBJECTIVES	To gain fundamental knowledge of algorithmic problem solving and python programming				

MODULE 1 : ALGORITHMIC PROBLEM SOLVING **9**

Introduction to components of a computer system - disks, memory, processor, operating system, compilers – Problems, Solutions, Idea of Algorithm –Representation of Algorithm. Building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Problem Illustrations

MODULE 2: DATA, EXPRESSIONS, STATEMENTS **9**

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two Points.

MODULE 3: CONTROL FLOW, FUNCTIONS **9**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

MODULE 4: LISTS, TUPLES, DICTIONARIES **9**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list, Processing list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

MODULE 5: FILES, PACKAGES **9**

Files and exception: text files, reading and writing files, errors and exceptions, handling exceptions, packages: NumPy, SciPy, Matplotlib, Scikit-learn, Scilab Interface.

TEXT BOOKS:

1. Allen B. Downey, 'Think Python: How to Think Like a Computer Scientist', 2nd edition, Updated for Python3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Guido van Rossum and Fred L. Drake Jr, – An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES

1. John V Guttag, ―Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, ―Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3. Timothy A. Budd, ―Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd.,, 2015.
4. Kenneth A. Lambert, ―Fundamentals of Python: First Programs‖, CENGAGE Learning, 2012.
5. Charles Dierbach, ―Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
6. Paul Gries, Jennifer Campbell and Jason Montojo, ―Practical Programming: An Introduction to Computer Science using Python 3‖, Second edition, Pragmatic Programmers, LLC, 2013

COURSE OUTCOMES (COs)	
The student will be able to	
CO1	Develop algorithmic solutions to simple computational problems
CO2	Demonstrate programs using simple Python statements and expressions.
CO3	Gain knowledge regarding control flow and functions associated with python
CO4	Use Python data structures – lists, tuples & dictionaries for representing compound data
CO5	Ggain knowledge on files, exception, modules and packages in Python for solving problems

Mapping of Course Outcomes with Program Outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	H	H	H	M	H	M	L		M	L	M	H
	CO2	H	H	M	M		M		L			M	H
	CO3	M	M	L	H	M		L		L		M	M
	CO4	M	M	L	M	S	M	L	M	L		M	M
	CO5	M	S	W	M	M			M	M	L		M
3	Category	Engg Sciences (ES)											
4	Approval	47th Meeting of Academic Council											

U18ESME101	**ENGINEERING GRAPHICS&DESIGN(Theory&Lab)**	**L**	**T**	**P**	**C**
	Total Contact Periods – 75	1	0	4	3
	Prerequisite – +12 Level Maths and Physical Science				
	Course Designed by – Department of Mechanical Engineering				

OBJECTIVES	To Prepare students to design a system, component, or process to meet desired needs, using the techniques, skills, and modern engineering tools necessary for engineering practice

SYLLABUS

Detailed contents

Traditional Engineering Graphics:

Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Computer Graphics:

Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modelling; Solid Modelling; Introduction to Building Information Modelling (BIM).

(Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory)

MODULE 1: INTRODUCTION TO ENGINEERING DRAWING (9+2)

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Scales – Plain, Diagonal and Vernier Scales; Draw simple annotation, dimensioning and scale. Construction of Conic sections; Cycloid, Epicycloid, Hypo cycloid and Involute of circle.

MODULE 2: ORTHOGRAPHIC PROJECTIONS (10+2)

Principles of Orthographic Projections; Conventions; Projections of points and Orthographic projection of lines in first quadrant - Parallel to both the planes – Perpendicular to one plane – Parallel to one plane and inclined to other plane – Inclined to both the planes; Projections of planes inclined to either HP or VP.

MODULE3: PROJECTIONS OF REGULAR SOLIDS& ISOMETRIC PROJECTIONS (10+3)

Projection of solids in first quadrant – Prism, Pyramid, Cone and Cylinder inclined to one plane; Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions - Isometric Views of Simple Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa;

MODULE4: SECTIONSOF SOLIDS AND DEVELOPMENT OF SURFACE (10+3)

Sectional view of Prism, Cylinder, Pyramid, Cone (simple position in first quadrant) with cutting planes perpendicular to one plane and parallel or inclined to another plane– True shape of sections; Development of lateral surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone.

MODULE 5: BUILDING DRAWING (9+2)

Introduction to building drawing; Types of Projection adopted in Building Drawing; Scales for various types of Drawings, Symbols, Conventions and Abbreviations. Drawing of residential single and two storied buildings with detail of Line plan, Foundation Plan, Ground floor Plan, First floor plan, Elevation and Sections.

MODULE 6: OVERVIEW OF COMPUTER GRAPHICS (12+3)

Introduction to CAD; Basic commands; Coordinate systems; Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects manually and automatically; Setup a drawing with proper scale – Dimensioning commands, Editing Dimensions and Dimension text; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles; Create basic drawing of objects such as polygon and general multi-line figures; Creating orthographic views of simple solids like prism, pyramid, cylinder, cone. Drawing sectional views of prism, pyramid, cylinder and cone; Preparation of fabrication drawing (Development of surfaces); Drawing front view, top view and side view of objects from the given pictorial view; Creation of 3-D models of simple objects.

TEXT BOOKS:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
2. Shah, M.B. &Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
3. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
5. (Corresponding set of) CAD Software Theory and User Manuals

COURSE OUTCOMES (COs)	
The student will be able	
CO1	Students will gain Exposure to engineering communication.
CO2	Students will learn standards of engineering graphics.
CO3	Students will get Exposure to basics of building construction
CO4	Students will get Exposure to computer-aided geometric design
CO5	Student will gain basic knowledge and Exposure to the visual aspects of Engineering Design.

Mapping of Course Outcomes with Program Outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	H			M			H					H
	CO2	H	H	L		H	M						H
	CO3			H									
	CO4											H	
	CO5	H						L					H
3	Category	Engg Sciences (ES)											
4	Approval	47th Meeting of Academic Council											

U18ESCS1L1	**PROBLEM SOLVING AND PYTHON PROGRAMMINGLABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	0	0	3	1.5
	Prerequisite – School Level Maths and Physical Science				
	Course Designed by – Department of Computer Science & Engineering				
OBJECTIVES: To enhance the practical knowledge on writing programs using Python					

LIST OF EXPERIMENTS FOR PROBLEM SOLVING AND PYTHON PROGRAMMING LAB

1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton‘s method)
3. Exponentiation (Power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers
9. Multiply matrices
10. Find the most frequent words in a text read from a file
11. Simulate elliptical orbits in Pygame
12. Simulate bouncing ball using Pygame
13. Simulate matrix operations with Scilab
14. Simulate fitting curve with NumPy and Matplotlib

COURSE OUTCOMES (COs)													
The student will be able													
CO1	Write, test, and debug simple Python programs.												
CO2	Implement Python programs with conditionals and loops												
CO3	Develop Python programs step-wise by defining functions and calling them												
CO4	Use Python lists, tuples, dictionaries for representing compound data												
CO5	Read and write data from/to files in Python and to simulate using the packages Scilab,NumPy and Matplotlib												
Mapping of Course Outcomes with Program Outcomes (POs) (H/M/L indicates strength of correlation) H-High, M-Medium, L-Low													
1	COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
2	CO1	H	H	M	H	H	M	M	M	M		M	H
	CO2	H	H	L	H	H	M	L	M	M	M	M	H
	CO3	H	H	M	M	M	M		M	M	M	M	H
	CO4	H	M	H	H	H	M	M	M	M	L		H
	CO5	H	H	M	S	M	M		M	M	L	M	H
3	Category	Engg Sciences (ES)											
4	Approval	47th Meeting of Academic Council											

REFERENCES:

1. Kenneth A. Lambert, ―Fundamentals of Python: First Programs‖, CENGAGE Learning, 2012

2. Timothy A. Budd, ―Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd.,, 2015.

PLATFORM NEEDED

1. Python 3 interpreter for Windows/Linux and Scilab

U18BSMA301	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
	Total Contact Hours – 60	3	1	0	4
	Prerequisite course – Engineering Mathematics-II				
	Course Designed by:- Department of Mathematics				

COURSE OBJECTIVES:-

- Grasp the Fourier series expansion for given periodic function in specific intervals and their different forms.
- Learn techniques of solving the standard types of first order and second order partial differential equations.
- Learn solving wave and heat equation using Fourier series.
- Understand the problems using Fourier transform and their properties. Understand the problems using Z - transform and their properties

UNIT I FOURIER SERIES (9+3)

Dirichlet's conditions – General Fourier Series – Half range Sine and Cosine series – Parseval's Identity – Harmonic Analysis.

UNIT II PARTIAL DIFFERENTIAL EQUATIONS (9+3)

Formation – Solutions of standard types of first order equations – Lagrange's linear equations – Linear partial differential equation of second and higher order with constant coefficients.

UNIT III BOUNDARY VALUE PROBLEMS FOR PARTIAL DIFFERENTIAL EQUATIONS (9+3)

Classifications second order linear partial differential equations – Solution of one-dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation – Fourier Series solutions in Cartesian coordinates.

UNIT IV FOURIER TRANSFORM (9+3)

Fourier integral theorem (without proof) – Fourier transform pairs – Fourier sine and cosine transform – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS (9+3)

Z – Transform – Elementary properties – Inverse Z – Transform – Convolution theorem – Formation of difference equations – Solution of difference equations using Z – Transform.

TEXT BOOKS

1. S. J. Farlow, Partial Differential Equations for Scientist and Engineers, Dover Publications 1993.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Willie & Sons, 2006.

REFERENCE BOOKS

1. R. Haberman, Elementary Applied partial differential equations with Fourier Series and Boundary Value Problems, 4th Ed., Prentice Hall, 1998.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2001.
3. Manish Goya and .N.P Bali l, Transforms and Partial Differential Equations, University Science Press, Second Edition, 2010.

COURSE OUTCOMES	
CO1	To Solve PDE and higher order with constant coefficients and physically interpret the results.
CO2	To Expand given function using the knowledge of Fourier Series and frequently needed practical harmonic analysis that an engineer July have to make from discrete data.
CO3	To Boundary Value Problems and Differential Equations will be knowledgeable about and will be able to analyze solutions to two-point boundary value problems, boundary value problems for partial differential equations.
CO4	To Solve many problems in automobile, medicine, electronic engineering by applying Fourier transform with the possible special cases with attention to their applications.
CO5	To Apply the basics of Z – Transform in its applicability to discretely varying functions.
CO6	To Gain the skill of formulate certain problems in terms of difference equations and solve them using the Z – Transform techniques.

Mapping of Course Outcomes with Program outcomes (POs)
(1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

COs\POs	1	2	3	4	5	6	7	8	9	10	11	12	PS01	PS02
1	3	2		3	3			3	3	3	3			
2	3	3	3	3	3			3	3	3	3			
3	3	3	3	3	3			3	3	3	3			3
4	3	3	3	3	3			2	3	3	3			
5	3	3	3	3	3			3	3	3	3			
6	3	3	3	3	3			3	3	3	3			
Category	Professional Core (PC)													
Approval	47th Meeting of Academic Council													

U18PCBM301	ANATOMY AND PHYSIOLOGY	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Biology for Engineers				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To recall the basic terminologies, cells, tissues and organs of human body.
- To explain about the positioning and functioning of the various organ systems.
- To differentiate the relation between the various physiological processes.
- To outline the various sense organs and relate the functions of hormones with physiological process.

UNIT I BASIC ELEMENTS OF HUMAN BODY 9

Anatomical terms of Location, Position and Planes. Structure and functions of Cell and organelles. Tissues of the human body: epithelial, connective, muscular and nervous tissues. Overview of organ systems. Membrane-Transport across membrane, Origin of cell membrane potential, Action potential. Blood-Properties and functions, Cellular Components: RBC, WBC, platelets, Blood Groups.

UNIT II CARDIOVASCULAR AND RESPIRATORY SYSTEMS 9

Structure of heart, Blood vessels, Conduction system of heart, Physiology of Cardiac Muscle, Cardiac cycle, Heart Sound, Cardiac output – Coronary and Peripheral Circulation, Blood pressure and its regulation. Respiratory Organs, Mechanism of respiration, Carbon dioxide and oxygen transport, Regulation of respiration, Volumes and capacities of lung.

UNIT III NERVOUS SYSTEM AND MUSCULOSKELETAL SYSTEM: 9

Neurons, Synapse and neurotransmitters, Central nervous system: Structure and functions of brain, Meninges, ventricles of brain and cerebrospinal fluid, Spinal cord anatomy. Peripheral nervous system: Classification of peripheral nervous system, Autonomic nervous system, Reflex action. Muscular System: Classification of muscles, Anatomy and Physiology of skeletal muscle. Bone: Types, Functions, Anatomy of long bone – Formation, growth and repair, Structural and functional classification of joints.

UNIT IV DIGESTIVE AND EXCRETORY SYSTEM 9

Anatomy of the gastro-intestinal tract, Accessory organs of Digestion - Salivary glands, Liver, Pancreas, Gall Bladder. Movement of gastrointestinal tract, Digestion and absorption at various parts of the system, Defecation. Anatomy of Urinary System, Physiology of urine formation, physiology of micturition, Composition of Urine. Skin and Sweat Gland – Temperature regulation.

UNIT V SPECIAL ORGANS AND ENDOCRINE GLANDS 9

Anatomy of Eye and Physiology of Vision, Structure of Ear and Physiology of Hearing, Sense of Smell, Sense of Taste. **Endocrine system:** Structure and functions of Pituitary gland, Thyroid gland, Parathyroid gland, Adrenal gland, Pancreas, Pineal gland, Thymus, Ovaries and Testes.

TEXT BOOKS:

1. Arthur C. Guyton, John E. Hall, "Textbook of Medical Physiology", W.B. Saunders Company, Twelfth Edition, 2006.
2. Stuart I. Fox, "Human Physiology", Tata McGraw Hill, 9th Edition,2006.

REFERENCES:

1. Ross & Wilson, "Anatomy & Physiology for Health and Illness", Elsevier, 11thEdition,2010.
2. Ranganathan, T.S. "Text Book of Human Anatomy", S.Chand & Co. Ltd., Delhi,1996.

COURSE OUTCOMES (COs)	
CO1	To Define the basic terminologies and outline the different tissues and organ systems.
CO2	To Describe the various organ systems and their functions
CO3	To Illustrate the cardiovascular, respiratory, digestive, excretory and other organ systems
CO4	To Explain the nervous and musculoskeletol system
CO5	To Compare and identify the relation between cardiovascular and respiratory, digestive and excretory system.
CO6	To Demonstrate the special organs and functions of endocrine glands

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**

2	CO1	2				3	2	3			1	2			
	CO2	2	3	2	3	3	2				1	2			
	CO3			2				3			1	2			
	CO4	2	3	2	3	3	2				1	2			
	CO5	2		2			2	3				2			
	CO6	2				3	2	3			1	2			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM302	ANALOG AND DIGITAL INTEGRATED CIRCUITS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic Electrical and Electronics Engineering				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To understand the number systems and their conversions, Boolean expressions, Boolean postulates and Karnaugh map method.
- To impart the design knowledge of various combinational logic circuits and sequential circuits.
- To bring out the analysis and design procedures for synchronous and asynchronous Sequential circuits.
- To get familiarized with operational amplifiers and its characteristics design and the working of waveform generators, regulators, filters and timers circuits.
- To design and the working of waveform generators, regulators, filters and timers circuits

UNIT I NUMBER SYSTEMS AND LOGIC GATES 9

Decimal, Binary, Octal and Hexadecimal Numbers.-Conversion between these number systems- 1's and 2's complements - subtraction using complements – Encoding numbers and characters using Binary digits. –Binary coded Decimal –Gray code - Binary to Gray code conversion –ASCII Code. Logic gates – Truth tables – NOT, AND, OR, NOR, NAND, XOR, XNOR - Boolean Laws and theorems – Solving Boolean expressions, Truth Tables and Logic circuits – The Karnaugh Map – half adder, full adder, Multiplexers and Demultiplexers - Decoders and encoders.

UNIT II REGISTERS AND COUNTERS 9

Flip Flops – RS, D, T, JK Flip Flops – Characteristic equations, exciting tables – JK Master – Slave flip-flop – Universal shift register, ripple counters, synchronous counters.

UNIT III OPERATIONAL AMPLIFIERS 9

The characteristics of Ideal Operation – slew rate, offset voltage, bias current, CMRR, bandwidth - equivalent circuit of an op-Amp – virtual ground concept – inverting and noninverting amplifier, adder, Subtracter, Instrumentation Amplifier, voltage to current converter – current to voltage converter — differentiator and integrator.

UNIT IV ACTIVE FILTERS AND SIGNAL GENERATOR 9

Active filters (first and second order) – Low pass, high pass, band pass filters, band reject filters (notch filters), Oscillators - RC Phase shift and Wein-bridge, Waveform generators - Triangular and Saw tooth.

UNIT V TIMER, PLL, A/D AND D/A CONVERTERS 9

555 Timer-Functional Block Diagram) – monostable multivibrator, astable multivibrator. Phase locked Loop (565 - block diagram approach), DAC – Binary weighted DAC and R-2R DAC, ADC – single slope and dual slope ADCs, successive approximation ADC.

TEXT BOOK:

1. M. Morris Mano, "Digital Design", 4th Edition, Prentice Hall of India Pvt. Ltd., 2008 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003.
2. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2000.

REFERENCES:

1. John F.Wakerly, "Digital Design", Fourth Edition, Pearson/PHI, 2008
2. John.M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.
3. Charles H.Roth. "Fundamentals of Logic Design", 6th Edition, Thomson Learning, 2013.
4. Ramakant A. Gayakwad, "OP-AMP and Linear ICs", 4th Edition, Prentice Hall / Pearson Education, 2001.
5. Robert F.Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Sixth Edition, PHI, 2001.

COURSE OUTCOMES (COs)	
CO1	To define the principles of Boolean algebra to manipulate and minimize logic Expressions
CO2	To Design various sequential circuits using flip flops (counters, shift registers, etc.,)
CO3	To illustrate the Operational Amplifier with its characteristics
CO4	To outline the functions of filters and waveform generators
CO5	To relate the concepts of PLL and its applications
CO6	To extend the knowledge in the operation of ADC,DAC and its applications

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	2	3	2	3		2	3	2		1	2	2		
	CO2		3	2	3	3	2	3			1	2			
	CO3	2	3	2	3	3	2	3	1		1	2	1		
	CO4	2	3		3	3		3			1				
	CO5		3		3	3	2	3		2	1	2			
	CO6	2	3	2	3		2	3	2		1	2	2		
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM303	**MICROPROCESSOR AND MICROCONTROLLERS IN BIOMEDICAL APPLICATIONS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic Electrical and Electronics Engineering				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
- To study the architecture of 8086 and 8051
- To study the addressing modes and instruction set of 8086 and 8051
- To introduce the need and use of interrupt structure in 8086 8051.
- To develop skill in simple program writing for 8086 and 8051 applications.
- To introduce commonly used peripheral / interfacing ICs.

UNIT I: OVERVIEW OF 8086 MICROPROCESSOR 9

Evolution of Microprocessor and its importance in biomedical domain, Architecture and signal description of 8086, Minimum and maximum mode, addressing modes, Instruction set

UNIT II: 8086 SYSTEM BUS STRUCTURE 9

8086 signals – Basic configurations – System bus timing –System design using 8086 – IO programming – Introduction to Multiprogramming – System Bus Structure

UNITIII: 8051 Microcontroller 9

Introduction to 8 bit microcontroller, signal descriptions of 8051- Architecture of 8051 - Register set of 8051 - Instruction set - Addressing mode

UNITIV: I/O INTERFACING 9

Timer-serial communication-interrupts programming - Interfacing to external memory - Basic techniques for reading & writing from I/O port pins - Interfacing 8051 to ADC - Liquid crystal display (LCD), keyboard - Stepper motor

UNIT V: 8086 APPLICATIONS AND OVERVIEW OF HIGHER PROCESSORS 9

8086 applications-stepper motor speed control- keyboard and display interfacing-introduction to PIC processor- Design of pulse oximeter circuit using ARM microcontroller

TEXT BOOKS:

1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085".Sixth edition, Penram International Publishing 2012.
2. Douglas V. Hall, "Microprocessor and Interfacing, Programming and Hardware". Revised Second Edition 2006, eleventh reprint 2010.Tata McGraw Hill.

REFERENCES:

1. Muhammad Ali Mazidi, Janice GillispieMazidi and Rolin D. McKinley, "The 8051 Microcontroller and Embedded Systems", Second Edition, Pearson Education 2008.Fifth impression 2011.
2. Krishna Kant, ― Microprocessor and Microcontroller Architecture, programming and system design using 8085, 8086, 8051 and 8096, PHI, 2007, Seventh Reprint, 2011.
3. Kenneth J. Ayala., ―The 8051 Microcontroller, 3rd Edition, Thompson Delmar Learning, 2012.
4. A.K. Ray, K.M. Bhurchandi, ―Advanced Microprocessor and Peripherals‖, Second edition, Tata McGraw-Hill, 2010. 5. Barry B. Brey, ―The Intel Microprocessors Architecture, Programming and Interfacing‖, Pearson Education, 2007. Second impression 2010.

COURSE OUTCOMES (COs)	
CO1	To define the basics of microprocessor
CO2	To label the different addressing modes
CO3	To design and develop microprocessor architecture.
CO4	To develop microprocessor and microcontroller systems for entertainment, communication and medical applications.
CO5	To demonstrate the troubleshooting of microprocessor and microcontroller systems.
CO6	To recall the basics of microcontroller systems and its applications

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1			3		2		3	1	1	2	2		3	
	CO2	3	2		3					1	2	2	1		
	CO3			3	3	2		1	3	1	2				
	CO4	3					3			1	2				
	CO5	3	2	3	3	2	3		3	1	2	2			
	CO6			3		2		3	1	1	2	2			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM304	**ELECTRONIC DEVICES AND CIRCUITS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic Electrical and Electronics Engineering				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- Understand the structure of basic electronic devices.
- Be exposed to active and passive circuit elements.
- Familiarize the operation and applications of transistor like BJT and FET.
- Explore the characteristics of amplifier gain and frequency response.
- Learn the required functionality of positive and negative feedback systems.

UNIT I PN JUNCTION DEVICES **9**

Intrinsic and Extrinsic semiconductor - PN junction diode –structure, operation and V-I characteristics, diffusion and transient capacitance - Display devices- LED, Laser diodes, Zener diode-characteristics.

UNIT II TRANSISTORS **9**

BJT, JFET, MOSFET- structure, operation, characteristics and Biasing UJT, Thyristor and IGBT - Structure and characteristics.

UNIT III AMPLIFIERS **9**

BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response – MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response

UNIT IV RECTIFIERS **9**

Half and full wave, ripple factor calculations for C, L, L-C.

UNIT V POWER SUPPLIES **9**

SMPS, linear electronic voltage regulators, power control using SCR. voltage controlled oscillators and phase locked loop

TEXT BOOKS:

1. David A. Bell ,‖Electronic devices and circuits‖, Oxford University higher education, 5th edition 2008. 2. Sedra and smith, ―Microelectronic circuits‖,7th Ed., Oxford University Press

REFERENCES:

1. Balbir Kumar, Shail.B.Jain, ―Electronic devices and circuits‖ PHI learning private limited, 2nd edition 2014.
2. Thomas L.Floyd, ―Electronic devices‖ Conventional current version, Pearson prentice hall, 10th Edition, 2017.
3. Donald A Neamen, ―Electronic Circuit Analysis and Design‖ Tata McGraw Hill, 3rd Edition, 2003.
4. Robert L.Boylestad, ―Electronic Devices and Circuit Theory‖, 2002.
5. Robert B. Northrop, ―Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation‖, CRC Press, 2004.

COURSE OUTCOMES (COs)														
CO1	To Explain the structure and working operation of basic electronic devices.													
CO2	To classify and differentiate both active and passive elements													
CO3	To outline the characteristics of different electronic devices such as diodes and transistors													
CO4	To Choose and adapt the required components to construct an amplifier circuit.													
CO5	To apply the acquired knowledge in design and analysis of oscillators													
CO6	To define basics of power supply's and its applications													
Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low														
1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	3	2	3				1			3	1	3	
	CO2		3	2	3	3		3			1	3			
	CO3	2					2	3		3	1	3			
	CO4		3	2	3	3			2				3		
	CO5		3		3	3	2	3			1	3			
	CO6	3	3	2	3				1			3	1		
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM305	**BIOSENSORS AND MEASUREMENTS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic Electrical and Electronics Engineering				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
- To understand the purpose of measurement, the methods of measurements, errors associated with measurements.
- To know the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications.
- To know the different display and recording devices.

UNIT I SCIENCE OF MEASUREMENT 9

Measurement System – Instrumentation – Classification and Characteristics of Transducers – Static and Dynamic – Errors in Measurements – Calibration – Primary and secondary standards.

UNIT II TYPES OF TRANSDUCERS 9

Resistive Transducers - Potentiometer, Strain Gauge, Thermometer, Thermocouple, Inductive transducer – LVDT, Capacitive Transducer - Displacement & Pressure transducers, Piezoelectric transducer , Biomedical applications.

UNIT III PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS 9

Phototube, scintillation counter, Photo Multiplier Tube (PMT), photovoltaic, Photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers, spectrophotometric applications of photo electric transducers. Piezoelectric active transducer and biomedical applications as pressure & Ultrasound transducer

UNIT IV SIGNAL CONDITIONING & SIGNAL PROCESSOR 9

Digital voltmeter – Multi meter – CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder.

UNIT V BIOSENSORS APPLICATIONS 9

Biosensors - Working Principle and Types. Chemical Biosensor-ISFET, IMFET, electrochemical sensor, chemical fibro sensors. Bananatrode, Blood glucose sensors, UREASE Biosensor Applications.

TEXT BOOKS:

1. L.A Geddes and L.E.Baker , ‗Principles of Applied Biomedical Instrumentation' Third Edition, – John Wiley and sons, Reprint 2008.
2. Albert D.Helfrick and William D.Cooper.―Modern Electronic Instrumentation and Measurement Techniques‖, Prentice Hall of India, 2007.

REFERENCES:

1. A.K.Sawhney,―Electrical & Electronics Measurement and Instrumentation‖,10th Edition, Dhanpat Rai & Co, New Delhi,2000.
2. Ernest o Doebelin and dhanesh N manik, Measuremet systems, Application and design, 5th Edition, McGraw-Hill, 2007.
3. Khandpur R.S, ―Handbook of Biomedical Instrumentation‖, Tata McGraw Hill, New Delhi, 3rd Edition, 2014.

4. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, ―Biomedical Instrumentation and Measurement‖, Prentice Hall India Pvt. Ltd. , New Delhi, 2nd Edition, Reprint, 2013.
5 John G.Webster, 'Medical Instrumentation Application and Design', 4th edition, John Wiley and Sons, New York, 2009.

COURSE OUTCOMES (COs)	
CO1	To define the purpose and methods of measurements
CO2	To outline the characteristics of different sensor
CO3	To Interpret the characteristics of different transducers
CO4	To list different Piezo electric sensors
CO5	To classify different signal conditioners
CO6	To recall basics applications of the biosensors

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	3	2	3	3	2	3			1	3		3	
	CO2	3		2	3				1		1		2		
	CO3							2		1		3			
	CO4	3	3	2	3	3	2	3		2			1		
	CO5	3	3		3			3			1	3			
	CO6	3	3	2	3	3	2	3			1	3			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM3L1	**ANATOMY AND PHYSIOLOGY LAB**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	0	0	2	1
	Prerequisite course – Biology for Engineers				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To Provide exposure to the fundamentals of human anatomy and physiology.
- To Analyse the methods for measurement of blood pressure and ECG.
- To learn the methods for identification and estimation of blood components.

LIST OF EXPERIMENTS

1. Study on Upper Extremity of bone.
2. Study on Lower Extremity of bone
3. Study of ECG.
4. Study of Microscope
5. Study of Haemocytometer
6. Blood Pressure Monitoring.
7. RBC Count
8. WBC Count
9. Differential count of WBC'
10. Hemoglobin Estimation.

11. ESR Estimation.
12. Blood group identification
13. Separation of Plasma and Serum
14. Determination of CT and BT

COURSE OUTCOMES (COs)	
CO1	To outline the bones of upper and lower extremities
CO2	To Explain the working principle of Electrocardiogram
CO3	To Analyze the Total count of blood and Hemoglobin Estimation.
CO4	To Analyze the process of Blood Pressure Monitoring
CO5	To outline the haemocytometer and microscope
CO6	To identify the different Types of Blood groups.

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	2	3		3	3	2	3		3	1	M	M		3
	CO2		3						3						
	CO3		3	2			2	3		1	1	3			
	CO4	2									1		2		
	CO5	2	3	2	3	3	2	3		2		2	2		
	CO6	2	3		3	3	2	3		3	1	2	2		
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM3L2	**MICROPROCESSORS AND MICROCONTROLLERS LAB**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	0	0	2	1
	Prerequisite course – – Basic Electrical and Electronics Engineering Practices Laboratory				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- Study the Architecture of 8086 microprocessor
- Learn the design aspects of I/O and Memory Interfacing circuits
- Study about communication and bus interfacing
- Study the Architecture of 8051 microcontroller

LIST OF EXPERIMENTS:

1. Familiarization of 8086 microprocessor kit.
2. Familiarization of 8051 microcontroller kit
3. 8086 assembly language programming exercises
4. 8051 assembly language programming exercises
5. Interfacing of switches and display devices
6. Interfacing of D/A convertors
7. Interfacing of A/D converters
8. Interface of key board and display using programming controllers
9. Interface of programmable timer
10. Stepper motor control using microprocessor

COURSE OUTCOMES (COs)	
CO1	To explain 8086 microprocessor
CO2	To Design and implement programs on 8086 microprocessor
CO3	To Demonstrate Memory Interfacing circuits.
CO4	To Design and implement 8051 microcontroller based systems.
CO5	To infer the instruction sets and interfacing
CO6	To Demonstrate the instruction sets and programming for microprocessor

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	2	3		3	3	2	3		3	1	M	M		3
	CO2		3						3						
	CO3		3	2			2	3		1	1	3			
	CO4	2									1		2		
	CO5	2	3	2	3	3	2	3		2		2	2		
	CO6	2	3		3	3	2	3		3	1	2	2		
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM3L3	**BIOSENSORS AND MEASUREMENTS LAB**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	0	0	2	1
	Prerequisite course – – Basic Electrical and Electronics Engineering Practices Laboratory				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- Understand the purpose of measurement, the methods of measurements, errors associated with measurements.
- Know the principle of transduction, classifications and the characteristics of different transducers and study its Biomedical applications.
- Know the different display and recording devices.

LIST OF EXPERIMENTS:

1. Characteristics of Strain Gauge
2. Characteristics of LVDT.
3. Characteristics of LDR
4. Characteristics of Thermistor.
5. Characteristics of Potentiometric Transducer.
6. Characteristics of Photodiode.
7. Characteristics of Load cell
8. Characteristics of Phototransistor.
9. Study of Multimeter.
10. Study of Digital tachometer.

COURSE OUTCOMES (COs)	
CO1	To Analyze the characteristics of different sensor
CO2	To Analyze the characteristics of Potentiometric Transducer

CO3	To Analyze the characteristics of thermistor
CO4	To Analyze the characteristics of LVDT
CO5	To explain the working principle of Digital tachometer.
CO6	To demonstrate the Multimeter and usage

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	3		2	3		2	3		2	1	3	3	
	CO2			2			1								
	CO3	2			3				3		2	3			
	CO4		2			3	1	3		1		3			
	CO5	3									3	1	1		
	CO6	3			2		3		3		3				
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18MCAB305	**LEARNING AN ART FORM**	**L**	**T**	**P**	**C**
		2	0	0	0

Cultivation of arts is an integral part of the development of human beings since the arts are what make us most human, most complete as people. They offer us the experience of wholeness because they touch us at the deepest levels of mind and personality. They come into being not when we move beyond necessity but when we move to a deeper necessity, to the deeper human need to create order, beauty and meaning out of chaos. They are the expressions of deepest human urges, imperatives and aspirations.

While enriching the process of learning through enhanced perceptual and cognitive skills, learning of arts promotes self-esteem, motivation, aesthetic awareness, cultural exposure, creativity, improved emotional expression, as well as social harmony and appreciation of diversity. They promote an understanding and sharing of culture, and equip the learners with social skills that enhance the awareness and respect of others. Each institution will offer a range of introductory courses in different art forms: music, dance, theatre, painting, and other art forms. Care should be taken to give adequate representation to local and regional art forms in which our culture abounds. For example, Banaras has local traditions in vocal music like Chaiti, Hori, Kajri and Birha.

An institution in Banaras area can offer courses on these art forms apart from regular classical and semi-classical vocal music forms. Similar local art tradition can be utilized in different cities and regions. This will, in turn, also ensure wider community involvement/interaction with the institution. Students will be given an option to choose a particular art form, and learn and practice it under an artist -instructor. At the end of the course, a student should be able to demonstrate basic proficiency in that particular art form. Contact hours per week should be 3-4 hours.

Towards the end of the course, the institution can organize a function/program in which all the students publicly demonstrate their skills.

U18MCAB306	INTANGIBLE CULTURAL HERITAGE (FESTIVALS, FOOD WAYS, LOCAL GAMES)	L	T	P	C
		2	0	0	0

As part of our rich intangible cultural heritage, foodways, fares and festivals, local games and sports are important sources for discovering the social and cultural values of our people and understanding the inner dynamics of our society, as these are sites where we witness the most significant and intimate representations of our society's self-perception—how our society perceives itself. These traditions have shaped and strengthened our social and cultural identities, and also the notion of community at the local, regional, and national levels. They have played a significant role in the making of our social life, and through them we have constructed for ourselves, individually and collectively, a sense of shared lived past and group identity. They facilitate the transmission of a culture's most deeply held values, from one generation to another and their continuity or discontinuity helps us to understand the changing social structure and culture of a society. For example, each community has its own foodways, and their overall health, well-being and cultural continuity are directly related to their ability to eat traditional foods and continue their traditional food practices. These traditional foods and food practices are deeply intertwined with their cultures and value systems, and play an important role in religious ceremonies and spirituality. Similar is the case with fares and festivals, and local games and sports. These traditions are bound up with rituals, customs, beliefs, and often also with trade, craft and professions. They are not mere superstitious rituals often condemned and denounced as being regressive, stagnant and backward, but repositories of our indigenous knowledge and wisdom which have evolved over centuries, and they still continue to serve social and cultural functions. This knowledge has been the basis for agriculture, food preparation, health care, education, conservation and the wide range of other activities that sustain societies in many parts of the world.

Most of these traditions are either on the verge of extinction or undergoing drastic changes due to globalization, acculturation, migration, questions of identity related to social mobility to confirm to a higher social order or simply because the context in which these traditions originated or were conceived no longer exist and their effectiveness or need seems no longer relevant. For example, while the agro-ecological and food systems offer some signs of resilience and adaptation, a range of factors are increasingly threatening these systems and peoples' well-being. The knowledge and skills of elders concerning traditional food preparation, and the use of traditional herbs and plants for healing purposes have not been passed on to the next generation and is at risk of being lost and disappearing altogether from reservation life and culture.

The course aims at exposing students to these traditions, and making them aware of the veritable treasure house of indigenous knowledge which can be utilized as resource for realizing a vision of sustainable future.

Each locality/region our Indian sub-continent abounds in a rich variety of food-ways, fares and festivals, games and sports. Students should be asked to identify one of these traditions and study them in detail. For example, the following guidelines can be adopted in the study of food-ways:

To study and document the indigenous knowledge and wisdom of everyday food habits and food items consumed;

- To study and document the prevalent social practices and beliefs regarding traditional foods;

- To study and document the feasts on religious and social occasions of different communities;
- To identify and document the food items consumed by different communities and determine their nutritional values;
- To conduct chemical analysis of food ingredients;
- To identify and document the kitchen generated health ingredients used by different communities;
- To find out the uses of leftover food stuff of different communities;
- To develop hygienic food chart for people ailing and suffering from different metabolic disorders; and
- To develop suitable communication strategies to effectively disseminate traditional knowledge regarding food habits.

Similarly, in the case of fares and festivals, and games and sports one could study how these traditions create a sense of community bonding and lead to the rules of commensality and social interaction and behavior. Suitable guidelines along the lines of foodways can be developed and adopted for such a study.

At the end of the course, students will be required to submit a detailed project report. Options should be given to the students to make short documentaries and films on these traditions.

U18BSMA402	PROBABILITY STATISTICS AND NUMERICAL METHODS	L	T	P	C
	Total Contact Hours – 60	3	1	0	4
	Prerequisite course – Engineering Mathematics				
	Course Designed by:- Department of Mathematics				

COURSE OBJECTIVES:-

- Learn basics of probability, Baye's Theorem. Understand the concept of random variable, moment generating functions and their properties; learn standard distributions in discrete and continuous cases.
- Learn measures of central tendency and correlation and regressions, rank correlation, statistical intervals for single sample and test of hypothesis for a small and large sample.
- Ability to apply knowledge of mathematics, science and engineering.
- Ability to analyze and interpret data
- Identify, formulate and solve equations by various methods

UNIT 1 PROBABILITY DISTRIBUTION 12

Probability – Axioms of probability – Conditional probability – Baye's theorem Random variables – Binomial – Poisson – Geometric – Uniform – Exponential and normal distribution and their properties.

UNIT II STATISTICS AND TESTING OF HYPOTHESIS 12

Measures of central tendency – Moments – Skewness and kurtosis – Correlation and Regression – Rank correlation – Test of significance: Large sample test for single proportion, difference of proportions – Chi Square test for goodness fit and independence of attributes.

UNIT III SOLUTION OF POLYNOMIAL AND TRANSCENDENTAL EQUATIONS 12

Bisection method, Newton-Raphson method and Regula-Falsi method for single variable-solutions of linear system of equations by Gaussian, Gauss-Jordan, Jacobian and Gauss-Siedal methods.

UNIT IV FINITE DIFFERENCE AND INTERPOLATION 12

Finite differences -Relation between finite difference operators- Interpolation using Newton's forward and backward difference formulae, Interpolation with unequal intervals-Newton's Divided difference formula, Lagrange's Interpolation formula.

UNIT V NUMERICAL DIFFERNTIATION AND INTEGRATION 12

Numerical Differentiation with interpolation polynomials, Numerical integration by Trapezoidal and Simpson's both $1/3^{rd}$ and $3/8^{th}$ rules. Double integration using Trapezoidal rule and Simpson rule.

TEXT BOOKS

1. Sastry. S. S "Introductory Numerical Methods" PHI, 2010.
2. Jain K.K. Iyengar, S.R.K and Jain, R.K. "Numerical Methods for Scientific and Engineering Computation" 4rd edition, 2005.
3. S.C.Gupta & V.K.Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, New Delhi, 2003.

REFERENCE BOOKS

1. Grewal, B.S. "Higher Engineering Mathematics (42^{nd} edition)" Khanna Publication Delhi, 2016.
2. P.Kandasamy, K.Thilagavathy, K.Gunavathi- Numerical methods, S.Chand& Company, 2^{nd} Edition 2010.
3. Veerarajan T. "Probability Statistics and Random Process" Tata McGraw Hill, New Delhi 2003.

COURSE OUTCOMES (COs)	
CO1	To Evaluate the probability using addition and multiplication theorem. Apply Baye's Theorem for practical problems to find the probability. Apply the discrete and continuous distribution for solving practical problems. Evaluates the moments of distributions using moment generating functions.
CO2	To Know the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications.
CO3	To Know the different display and recording devices for various bio signals
CO4	To Know the measurement techniques for blood flow measurement and cell counting
CO5	To Learn the uses of pH, spectrometers and auto-analyzer
CO6	To learn numerical approximation of definite integrals

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			2	3		2			2	1			2
	CO2			2					3				2		
	CO3	2			3						2				

	CO4					3		3		1			1		
	CO5	3	3						2		3	2			
	CO6														
3	Category	Professional Course (PC)													
4	Approval	47th Meeting of Academic Council													

U18PCBM401	MEDICAL INSTRUMENTATION I	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Biosensors and Measurements				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- The students will be exposed to electrical and non-electrical physiological measurements and bio amplifiers.
- To know the various Bio potential amplifiers.
- To study about various Physiological measurements.
- To study about clinical laboratory instruments and blood cell counters.

UNIT I BIO POTENTIAL ELECTRODES 9

Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits.

UNIT II ELECTRODE CONFIGURATIONS 9

Bio signals characteristics – frequency and amplitude ranges- ECG – Einthoven's triangle. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG, ERG and EOG – unipolar and bipolar mode.

UNIT III BIO AMPLIFIER 9

Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier. Band pass filtering, isolation amplifiers - Chopper amplifier.

UNIT IV MEASUREMENT OF NON-ELECTRICAL PARAMETER 9

Temperature, respiration rate and pulse rate measurements. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.

UNIT V BIO-CHEMICAL MEASUREMENT 9

Biochemical sensors - pH, pO2 and pCo2, Blood glucose sensors - Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter.

TEXT BOOKS:

1. Arumugam.M, Textbook of Biomedical Instrumentation,2003.
2. Richard A. Norman "Principles of Biomedical Instrumentation" John Wiley and sons. New York.1988.

REFERENCE:.

1. Khanpur R.R., Handbook of Biomedical Instrumentation, Tata McGraw hill publishing company. New Delhi 1999.
2. Scott / Mathur "Textbook of Biomedical Instrumentation" CBS Publishers. Chennai 2007.

COURSE OUTCOMES (COs)	
CO1	To explain the purpose of measurement, the methods of measurements, errors associated with measurements.
CO2	To define the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications.
CO3	To classify the different display and recording devices for various bio signals
CO4	To Relate the measurement techniques for blood flow measurement and cell counting
CO5	To Demonstrate the uses of pH, spectrometers and auto-analyzer
CO6	To Explain non-invasive diagnostic parameters

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	3		2	3		2		3	2	2			
	CO2			2					2			3	1		3
	CO3	2	3		3					2	2				
	CO4		3			3		3	2			1			
	CO5	3									3		1		
	CO6	3	3		2	3		2		3	2	2			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM402	**FUNDAMENTALS OF BIOCHEMISTRY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Biology for Engineers				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To get a clear idea of biomolecules and their functions
- To know the significance of biomolecules in biological systems
- To understand the metabolic pathways in normal and pathological conditions.

UNIT-1 INTRODUCTION TO BIOCHEMISTRY 9

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, physiological buffers in living systems, Energy in living organism. Properties of water and their applications in biological systems. Introduction to Biomolecules, Biological membrane, Clinical application of Electrolytes and radioisotopes.

UNIT-II CARBOHYDRATE 9

Carbohydrate classification, Structure and Properties of Mono-di and Polysaccharides with its clinical importance .Biological importance of carbohydrates metabolism – Glycolysis, TCA cycle, Glycogenesis, ,Uronic acid pathway, metabolism of fructose, Sorbitol pathway, metabolism of galactose and its dysfunction.

UNIT-III PROTEIN 9

Classification of amino acids – characteristics of amino acids – Zwitterions, Iso-electric point. Protein classification. Structure of proteins, primary, secondary, tertiary and quaternary structure. Biological importance of polypeptides. Metabolism of ammonia, Urea cycle ,Metabolic disorders of glycine, Phenyl alanine, Tyrosine, Tryptophan. Metabolic defects of branched chain amino acids -maple syrup urine disease.

UNIT-IV LIPIDS 9

Classification of lipids. Structure and properties of compound lipids, Derived lipids - Biosynthesis of cholesterol ,Bile acids and its importance. β- oxidation of fatty acids. Ketogenesis .Disorder of lipid metabolism. Atherosclerosis, hypercholesterolemia and Fattyliver diseases.

UNIT-V ENZYMES, HARMONES AND NUCLEIC ACID 9

Enzymes – chemical nature. Classification of enzymes, apoenzyme, coenzyme, holoenzyme and cofactors. Factors affecting enzymatic activity: temperature, pH, substrate concentration and enzyme concentration. Hormones – chemical nature, properties of hormones and hormonal disorders. Structure of purines and pyrimidines, nucleoside, nucleotide, chargoffs rule. Watson and crick model of DNA. Structure of RNA and its types.

TEXT BOOKS:

1. RAFI MD ―Text book of biochemistry for Medical Student‖ Second Edition, University Press, 2014.
2. David.W.Martin, Peter.A.Mayes , Victor. W.Rodwell, ―Harper‘s Review of Biochemistry‖, LANGE Medical Publications, 1981.
3 Sathyanarayana, Textbook of Biochemistry, 2003.

REFERENCES:

1. Keith Wilson & John Walker, ―Practical Biochemistry - Principles & Techniques‖, Oxford University Press, 2009.
2. Pamela.C.Champe & Richard.A.Harvey, ―Lippincott Biochemistry Lippincott‘s Illustrated Reviews‖, Raven publishers,1994.
3 Harper's Illustrated Biochemistry - 26th edition Publisher: McGraw-Hill Medical; 26 edition 2003

COURSE OUTCOMES (COs)	
CO1	Classify the biomolecules according to their structure and applications.
CO2	Define the functions and properties of carbohydrates.
CO3	Distinguish different types of amino acids and proteins based on the biological aspects
CO4	Assess the significance of bio molecules in biological systems
CO5	To explain about all the enzyme activities.
CO6	Analyze the etiology and biological parameters in metabolic diseases

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1		3		3			3		2	1	2			
	CO2	2		2	3	1	2	3						2	
	CO3	2	3				2		1				1		

	CO4				3	3		3			1	2			
	CO5	2	3	2	3	3	2			3	1	2	1		
	CO6		3		3			3		2	1	2			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM403	MEDICAL PHYSICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Semi Conductor Physics				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To Study effects of sound and light in human body
- To study effects of radiation in matter and how isotopes are produced
- To examine the somatic effects of radiation
- To correlate the genetic effects of radiation

UNIT I ELECTROMAGNETIC SPECTRUM AND ITS MEDICAL APPLICATION 9

Light - Physics of light, Intensity of light, limits of Vision and color vision Sound – Physics of sound , Normal sound levels – Ultrasound fundamentals- Generation of ultrasound (Ultrasound Transducer) – Interaction of Ultrasound with Materials-Reflection and Refraction – Absorption and Scattering Non- ionizing Electromagnetic Radiation Tissue as a leaky dielectric – Relaxation Processes – Overview of non – ionizing radiation effects -Low Frequency Effect – Higher frequency effect.

UNIT II RADIOACTIVE DECAY 9

Radioactive Decay – Spontaneous Emission – Isometric Transition - Gamma ray emission, alpha, beta, positron decay, electron capture Principles of Nuclear Physics – Natural radioactivity, Decay series, Half life period, type of radiation and their applications. Production of radionuclides – Cyclotron produced Radionuclide - Reactor produced Radionuclide – fission and electron Capture reaction, Radionuclide Generator – Milking Process - Linear accelerator , Radionuclide used in Medicine and technology.

UNIT III INTERACTION OF RADIATION WITH MATTER 9

Interaction of charged particles with matter – Specific ionization , linear energy Transfer Range, Bremsstrahlung , Annihilation Interaction of Gamma radiations with matter – Photoelectric effect, Compton Scattering , pair Production, Attenuation of Gamma Radiation, Interaction of neuron with matter

UNIT IV PHYSICS OF CARDIOPULMONARY SYSTEM 9

The Airways, - blood and lung interaction – measurement of lung volume – pressure air flow volume relationships of lungs – physics of alveoli – the breathing mechanism – Major components of cardiovascular system – O2 and CO2 exchange in the capillary system – Physical activity of heart – transmural pressure – Bernolli's principles applied to cardiovascular system - Blood flow – laminar and turbulent

UNIT V RADIATION EFFECTS 9

Acute Radiation Effects - The concept of LD 50 – Radiation syndromes- Central nervous system syndrome - Gastro-intestinal syndrome –Bone Marrow syndrome Delayed Effects of Radiation - Stochastic and Deterministic effects – Late Deterministic effect in different organs and tissues.

TEXT BOOKS

1. B.H Brown , PV Law ford, R H Small wood , D R Hose , D C Barber , "Medical Physics and Biomedical Engineering", CRC Press, 1999.
2. Gopal B.Saha "Physics and Radiobiology of Nuclear Medicine" Springer, 3rd ed, 2006

REFERENCES:

1. John R. Cameron and James G. Skofronick, "Medical Physics", John–Wiley & Sons, 978.
2. RF Farr and PJ Allisy –Roberts, "Physics for Medical Imaging" Saunders, 1997.
3. P.Uma Devi, A. Nagarathnam, B S Satish Rao, "Introduction to Radiation Biology" B.I Churchill Livingstone pvt ltd, 2000.
4. S.Webb, "The Physics of Medical Imaging", Taylor and Francis, 1988.
5. https://www.iop.org/education/teacher/resources/teaching-medical-physics/page_54690.html

COURSE OUTCOMES (COs)	
CO1	To define about Ultrasound fundamentals.
CO2	To outline the Natural radioactivity, type of radiation and their applications.
CO3	To extend the knowledge of Interaction of charged particles with matter.
CO4	To list the Major components of cardiovascular system.
CO5	To define Photoelectric effect, Acute Radiation Effects.
CO6	To illustrate all the radiation effects and syndromes

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	2					2	1		2	1			
	CO2						1			1			3		
	CO3	2			3				2						
	CO4			3	1		2	3				2			
	CO5	3	2						2		3	3	2		
	CO6	3		3	2	2	1		2	3					
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM404	**ANALOG AND DIGITAL COMMUNICATION SYSTEM**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic Electrical and Electronics Engineering Analog and Digital Integrated Circuits				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
- To study the various analog and digital modulation techniques
- To study the principles behind information theory and coding
- To study the various digital communication techniques

UNIT I ANALOG COMMUNICATION 9

Introduction to Communication Systems: Modulation – Types - Need for Modulation. Theory of Amplitude Modulation - Theory of Frequency and Phase Modulation – Comparison of various Analog Communication System (AM – FM – PM).

UNIT II PULSE MODULATION 9

Low pass sampling theorem – Quantization – PAM,PWM,PPM – Line coding – PCM, DPCM, DM, and ADPCM And ADM, Channel Vocoder - Time Division Multiplexing, Frequency Division Multiplexing

UNIT III DIGITAL MODULATION AND TRANSMISSION 9

Phase shift keying – BPSK, DPSK, QPSK – Principles of M-array signalling M-array PSK & QAM – Comparison, ISI – Eye pattern, equalizers

UNIT IV INFORMATION CODING AND DECODING 9

Coding for error detection and correction, Block coding – coding, Hadamard code, Hamming code, Cyclic Codes, Convolution coding and decoding

UNIT V MULTIPLE ACCESS TECHNIQUES 9

Multiplexing: definition, purpose - Frequency division multiple access (FDMA) - Time division multiple access (TDMA) - Code-division multiple access (CDMA) - Comparison of multiple access techniques - Differences between multiple access and multiplexing - Wireless communication systems - Propagation issues in mobile radio

TEXT BOOKS:

1. H Taub, D L Schilling, G Saha, ―Principles of Communication Systems‖ 3/e, TMH 2007
2. S. Haykin ―Digital Communications‖ John Wiley 2005

REFERENCES:

1. B.P.Lathi, ―Modern Digital and Analog Communication Systems‖, 3rd edition, Oxford University Press, 2007
2. H P Hsu, Schaum Outline Series – ―Analog and Digital Communications‖ TMH 2006
3. B.Sklar, Digital Communications Fundamentals and Applications‖ 2/e Pearson Education 2007.

COURSE OUTCOMES (COs)	
CO1	To list the different analog modulation schemes.
CO2	To demonstrate different pulse modulation techniques.
CO3	To define the different Digital Modulation Techniques.
CO4	To identify the error detection and correction mechanism

CO5	To outline the various Multiple Access Techniques														
CO6	To Understand the wireless communication														
Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low															
1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1					3	2	3			1		2		
	CO2	2		2					3			2			
	CO3		3	2						3					
	CO4				3	3		3					2		
	CO5	2	3	2		3	2	3	3		1	2			
	CO6	2		2					3			2			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM405	**BIOMATERIALS AND ARTIFICIAL ORGANS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Human Anatomy and Physiology				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- Learn characteristics and classification of Biomaterials
- Understand different metals and ceramics used as biomaterials
- Learn polymeric materials and combinations that could be used as a tissue replacement implants
- Know the various artificial organs developed using these materials

UNIT I BIOMATERIALS AND BIOCOMPATIBILITY 9

Biocompatibility and hemo-compatibility, Overview of Biomaterials used as medical devices, Classification of biomaterials, Impact and future of biomaterials, performance of implants, Interfacial phenomena and tissue response to biomaterials. Electro kinetic factors. Types of orthopaedic fixation devices- pins, screws and plates, IM nails.

UNIT II ARTIFICIAL JOINTS 9

Bioelectric effect, Wolff's law. Interface problems with artificial joints and various fixation methods. Failure of implantation materials- metallic corrosion, wear, metallic implant fractures and their impact on biological systems. Hard tissue replacements- total hip and knee joint replacements.

UNIT III METALS AND POLYMERS 9

Metals and alloys for orthopaedic implants- Stainless steel, Cobalt chromium alloy, Titanium and its alloys .Polymers in biomedical use, Hydrogels, silicone rubber, biodegradable polymers, microorganisms in polymeric implants and polymer sterilization. Biopolymers, Synthetic polymers.Composites- Types and Applications.

UNIT IV BIOCERAMICS 9

Bioceramics, types – bioactive, resorbable, non-resorbable. Stoichiomety and Ca/P ratio of various forms calcium phosphates, bioceramic coatings on metallic implants and bone bonding reactions on implantation. Hydroxyapatite –properties and applications. Bone cements and bio glasses.Dental implants- materials, types and designs.

UNIT VBIOMATERIAL TESTING AND ARTIFICIAL ORGANS 9

Testing of biomaterials: In-vitro, in-vivo preclinical tests- Standards on biomaterials.- Biological Tests- biocompatibility methods for improvement, surface modification of materials -. Artificial Heart, eye and ear implants, artificial pancreas, ophthalmic implantation, extracorporeal artificial organs, neural prostheses.

TEXTBOOKS :

1. Joon Bu Park, Roderic S, Lakes, "Biomaterials", Springer-Verlag, New York Inc., 2010.
2. Ratner A, and S.Hoffman, B. D. "Biomaterials Science: An Introduction to Materials in Medicine", Academic Press; 3 edition,November 8, 2012.

REFERENCES:

1. "Biomaterials", Sujata V Bhat., Narosa Publishing House, New Delhi, 2002.
2. A.F. Von Recum, "Handbook of Biomaterials Evaluation - Scientific, Technical and Clinical Testing of Implant Materials", 2nd Edn., Taylor & Francis, Philadelphia, 1999.
3. F. Silver and C. Dillon, " Biocompatibility: Interactions of Biological and Implantable Materials" Vol.1, VCH Publishers, New York, 1989.
4. Park. J.B. "Biomaterials: An Introduction", CBS Publishers, 2007.

COURSE OUTCOMES (COs)															
CO1	To Analyze different types of Biomaterials and its classification**.**														
CO2	To experiment with combinations of materials that could be used as a tissue replacement implant.														
CO3	To label about the various polymeric materials used for medical applications														
CO4	To explain about bio-ceramics and its applications in medicine														
CO5	To interpret the applications and properties of materials in orthopaedics														
CO6	To Design biocompatible organs														
Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low															
1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	3		2	3		2		2	2	1			3
	CO2			2						3			2		
	CO3	2	2		3		2		1		2				
	CO4					3		3				1			
	CO5	3	3							2	3	3	3		
	CO6	3	3		2	3		2		2	2	1			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18MCTH502	UNIVERSAL HUMAN VALUES	L	T	P	C
		2	0	0	0

The objective of the course is four fold:

Sensitization of student towards self, family (relationship), society and nature.

Understanding (or developing clarity) of nature, society and larger systems, on the basis of human relationships and resolved individuals.

Strengthening of self reflection.

Development of commitment and courage to act.

At the end of the course, students are expected to become more aware of their surroundings, society, social problems and their sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability. They would also become sensitive to their commitment towards what they believe in (humane values. humane relationships and humane society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

U18PCBM4L1	BIOCHEMISTRY LAB	L	T	P	C
	Total Contact Hours – 45	0	0	2	1
	Prerequisite course – Human Anatomy and Physiology Lab				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To introduce the basics of Carbohydrates, Proteins and Amino acids.
- To identify the different Types of Carbohydrates-Monosaccharides, Disaccharides and Polysaccharides.
- To identify the Aminoacids.

LIST OF EXPERIMENTS:

1. Qualitative analysis of Carbohydrates.
2. Estimation of Glucose by Benedict's Method.
3. Estimation of Protein by Lowry's Method.
4. Estimation of Protein by Biuret's Method.
5. Estimation of DNA by Diphenyl amine method..
6. Isolation of Starch from Potato.
7. Estimation of Amino acid by Ninhydrin method.
8. Estimation of Creatinine by Jafe's method.
9. Abnormal Urine analysis (Glucose, Protein, Acetone, etc.)

COURSE OUTCOMES (COs)	
CO1	To Qualitative analysis of Carbohydrates
CO2	To Estimate the Biomolecules by different methods
CO3	To Isolate the Starch
CO4	To Estimate the DNA
CO5	To find the Abnormal constituents of blood
CO6	To find protein functions
Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low	

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1			3		3	2	3			1		1	2	
	CO2	2									1				
	CO3			2					3	3		2	1		
	CO4					3	2	3							
	CO5	2	3	2					L		1	2	3		
	CO6			3		3	2	3			1		1		
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM4L2	**ANALOG AND DIGITAL COMMUNICATION SYSTEM LAB**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	0	0	2	1
	Prerequisite course – Basic Electrical and Electronics Engineering Lab				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
- To learn various analog modulation techniques
- To understand various digital modulation techniques

List of Experiments

1. Signal Sampling and reconstruction
2. Amplitude modulation and demodulation
3. Frequency Modulation and Demodulation
4. PAM, PWM, PPM
5. Delta and Adaptive Delta Modulation
6. Pulse code modulation
7. BPSK Modulation and Demodulation
8. BFSK Modulation and Demodulation
9. QPSK Modulation and Demodulation
10. TDM, FDM

COURSE OUTCOMES (COs)	
CO1	To explain different analog modulation techniques.
CO2	To Demonstrate Knowledge on frequency shift keying
CO3	To illustrate the concept of digital transmission.
CO4	To compare analog and digital communication techniques.
CO5	To interpret the BPSK transmission techniques.
CO6	To illustrate the TDM and FDM techniques.

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**

2	CO1					3	2	3			1		3		2
	CO2	2		2					3			2			
	CO3		3	2						3			3		
	CO4				3	3		3							
	CO5	2	3	2		3	2	3	3		1	2			
	CO6					3	2	3			1		3		
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18MCAB407	LITERATURE, CINEMA AND MEDIA (WORKSHOP, READING MULTIPLE NEWS SOURCES,ANALYZE ADS)	L	T	P	C
		0	0	2	0

The objective is to inculcate the habit of active (or interactive) consumption of the best content available in literature, films and media, rather than passive consumption. Description.

Literature is perhaps as old as history or may be older and it is difficult to think of a fully educated person without any exposure to the best of the world literature (not just the literature of their own country or in their own language). Cinema is more recent and mass media is even more recent, but all these have a vital role in today's society. The problem is that the content available easily to most people (partly due to extensive promotion) caters to the lowest common denominator. Engineering students should be encouraged to read the best of the world literature and watch the best of the world cinema (regardless of their viewpoints). They should also be made aware that news is best collected from different sources, which don't necessarily agree, so that they can understand the true meaning of democracy and also learn to form educated opinions about various topics based on the information from diverse sources. They should learn that being opinionated without being properly informed (say, by relying only on one source of news on TV based on TRPs) is not the right way to be a good citizen. They should get the experience of their opinion being contradicted by the most reliable evidence, so that they realize that there is no shame in changing a wrong opinion in the light of overwhelming evidence. For that, they will also have to learn how to find out the degree of reliability of different sources. One way to achieve this is to conduct workshops where students, aided by invited experts, read news from different sources, watch the best cinema and read or watch different media sources. They can then discuss these with their peers and with the invited experts and learn to talk peacefully with people of different viewpoints, as well as learn to form their own opinions. They should then be encouraged to write about their takeaways from these discussions or their opinions and their reasons for forming those opinions. Such activities can counter the current culture of being 'trolls' on the social media, for example. Instead, we should have citizens who give due respect to their fellow citizens and learn to analyze, discuss and reach conclusions in an agreeable manner, without unnecessary feelings of bitterness and enmity.

Another related exercise could be to read or watch advertisements and then analyze them in terms of the biases they promote (such as the desirability of fair skin) or the deception they indulge in to psychologically compel consumers to buy things they don't really need. Some advertisements even promote the habit of treating fellow human beings with contempt for being different from them (even in terms of possessing the products they are promoting). A

well-educated citizen should be less susceptible to such practices in advertisements. Advertisements are just one example. Something similar could be done with all kinds of propaganda material

U18MCAB408	LITERATURE & MEDIA GROUP READING (SAAMUHIKVAACHAN) OF CLASSICS.	L	T	P	C
		2	0	0	0

This will make group to read one or two books during a semester.

Process: An hour may be fixed for a small group for a particular classic. Group sitsand each person reads aloud (if possible with proper modulation) taking turns. This if done properly for an hour one may complete 30-40 pages in an hour. A normal classic can be finished in 15 to 20 days. If serious books on philosophy etc. are taken up a discussion can be held after every idea is complete.

U18PCBM501	BIOCONTROL SYSTEMS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic Electrical and Electronics Engineering				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To design the physiological systems
- To analyze the systems in time and frequency domain and to understand the concept of stability.
- To apply mathematical modelling principles in understanding the various fundamental biological systems.

UNIT I: SYSTEM CONCEPTS 9

Basic structure of control system -Types of systems - Open loop systems, closed loop systems, Effects of feedback, Block diagram & Signal flow graph, conversion of block diagram to signal flow graph, reduction of block diagram and signal flow graph.

UNIT II: TIME RESPONSE ANALYSIS OF CONTROL SYSTEMS 9

Step and Impulse responses of first order and second order systems, Determination of time domain specifications of first and second order systems from its output responses.

UNIT III: THE CONCEPT OF STABILITY & ROOT LOCUS TECHNIQUE 9

Concept of stability, Routh stability criterion qualitative stability and conditional stability. The Root locus concept, Construction of root locus.

UNIT IV: FREQUENCY RESPONSE ANALYSIS 9

Frequency response, Nyquist stability criterion, Nyquist plot and determination of closed loop stability, definition of gain margin and phase margin, Bode plot, Determination of gain margin and phase margin using Bode plot.

UNIT V: BIOMEDICAL APPLICATIONS 9

Cardiovascular Control System, Endocrine Control Systems, Pupil Control System, Skeletal Muscle, Servomechanism, Neuro muscular system, Respiratory system, occulomotor system.

TEXT BOOKS:

1. M. Gopal "Control Systems Principles and design", Tata McGraw Hill ,2002
2. Benjamin C. Kuo, "Automatic control systems", Prentice Hall of India, 1995
3. Michael C K Khoo, "Physiological control systems", IEEE press, Prentice –Hall of India, 2001.

REFERENCES

1. John Enderle, Susan Blanchard, Joseph Bronzino "Introduction to Biomedical Engineering" second edition, Academic Press, 2005.
2. Richard C. Dorf, Robert H. Bishop," Modern control systems",Pearson, 2004

COURSE OUTCOMES (COs)	
CO1	To know about the process of neurophysiology.
CO2	To gain knowledge about the neural networking process such as back propagation
CO3	To have a fundamental knowledge of pattern recognition
CO4	To have skills about the manipulating, transforms using classifiers theorems.
CO5	To acquire the skills cluster analysis and feature extraction
CO6	To Learn about all the human control system

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			3	2			2			1			3
	CO2		3	2			3						1		
	CO3	2			3						3				
	CO4			3		3		2				1			
	CO5		3	2							3	3	2		
	CO6	3			3	2			2			1			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM502	**MEDICAL INSTRUMENTATION II**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Medical instrumentation- 1				
	Course Designed by:-Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- Gather basic knowledge about measurements of parameters related to respiratory system
- Learn measurement techniques of sensory responses
- Understand different types and uses of diathermy units.
- Know ultrasound imaging technique and its use in diagnosis
- Know the importance of patient safety against electrical hazard

UNIT-I HEART LUNG MACHINE AND CARDIAC ASSIST DEVICES 9

Condition to be satisfied by the H/L system, different type of Oxygenators, pumps- Blood handling system, Synchronous counter pulsation, right ventricular bypass pump, left ventricular bypass pump, Intra aortic balloon pumping and veno arterial pumping.

UNIT II RESPIRATORY MEASUREMENT STSTEM 9

Instrumentation for measuring the mechanics of breathing – Spiro meter, – Airway resistance measurement, Whole body plethysmography, Intra-Alveolar and Thoracic pressure measurements, Apnea Monitor. Types of Ventilators – Pressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.

UNIT-III ARTIFICIAL KIDNEY AND SENSORY MEASUREMENT 9

Indication and Principle of Hemodialysis, different types of dialysis, monitoring systems, artificial kidney,Psycho Physiological Measurements-for testing sensory Responses, Electro occulograph, Audiometer-Pure tone, Speech. EGG (Electrogastrograph), galvanic skin resistance (GSR), polygraph.

UNIT IV PATIENT MONITORING AND BIOTELEMETRY 9

Patient monitoring systems, ICU/CCU Equipment, Infusion pumps, bed side monitors, Central consoling controls. Radio Telemetry (single, multi), Portable and Landline Telemetry unit, Applications in ECG and EEG Transmission.

UNIT V - DIAGNOSTIC EQUIPMENTS 9

Endoscopy – Laparoscopy – thermograph- Lithotripsy -Cryogenic Equipment - Automated drug delivery system – Components of drug infusion system – Implantable infusion systems. Physiological effects of electricity – important susceptibility parameters – Macro shock, Micro shock hazards, Patient‘s electrical environment.

TEXTBOOKS:

1. Albert-N. Cook & Webster. J. G. Therapeutical medical devices, Prentice hall INC, New Jersey, 1982.
2. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 2003.
3. Leslie Cromwell, Fred Weibell J, Erich Pfeiffer. A, “Biomedical Instrumentation and Measurements”, Prentice-Hall India, 2nd Edition, 1997

COURSE OUTCOMES (COs)	
CO1	To describe about measurements of parameters related to respiratory system
CO2	To describe the measurement techniques of sensory responses
CO3	To list the different types of patient monitoring parameters
CO4	To understand the importance of patient safety against electrical hazard
CO5	To acquire knowledge about drug delivery systems
CO6	To describe about measurements of parameters related to respiratory system

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			2	3		2			2	3			3
	CO2		1	2			3	3	3				1		
	CO3	2			3						2	2			
	CO4					3	2	3	2			1			
	CO5	3	2	1				3	1		3	3	2		
	CO6	3			2	3		2			2	3			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM503	DIGITAL SIGNAL PROCESSING FOR BIO ENGINEERS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Partial Differential Equation and Transformation				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To learn discrete concepts of Signals and Systems
- To Understand Concepts of Z Transform and its properties
- To learn discrete Fourier transform and its properties
- To know the characteristics of FIR filters
- To know the characteristics of IIR filters

UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9

Continuous time signals (CT signals) - Discrete time signals (DT signals) - Step, Ramp, Pulse, Impulse, Sinusoidal, Exponential, Classification of CT and DT signals - Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - CT systems and DT systems Classification of systems – Static & Dynamic, Linear & Nonlinear, Time-variant & Time-invariant, Causal & Noncausal, Stable & Unstable.

UNIT II DISCRETE TIME SYSTEMS - Z TRANSFORM 9

Z transform and its properties-Convolution, Inverse Z transform-Discrete Fourier series Properties-Sampling the Z transform-Discrete Fourier transform-Properties for frequency domain analysis-Linear Convolution using discrete Fourier transform-Overlap save method.

UNIT III DISCRETE FOURIER TRANSFORMS 9

Discrete Signals and Systems- A Review – Introduction to DFT – Properties of DFT – Circular Convolution - Filtering methods based on DFT – FFT Algorithms –Decimation in time Algorithms, Decimation in frequency Algorithms – Use of FFT in Linear Filtering.

UNIT IV FIR FILTER DESIGN 9

FIR design-Fourier Series Method –Window function Method, triangular window, rectangular window, Hamming window, Hanning window functions, Kaiser window. Applications of Signal Processing in Biomedical Engineering.

UNIT V IIR FILTER DESIGN 9

Classification-Reliability constraints-IIR design-Butterworth and Chebyshev Filters, Bilinear Transform Method-Impulse Invariant Method-Step Invariance Method.

TEXT BOOK:

1. John G. Proakis & Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, Fourth Edition, Pearson Education / Prentice Hall, 2007.

REFERENCES:

1. Emmanuel C..Ifeachor, &Barrie.W.Jervis, “Digital Signal Processing”, Second Edition, Pearson Education / Prentice Hall, 2002.
2. Sanjit K. Mitra, “Digital Signal Processing – A Computer Based Approach”, Tata Mc Graw Hill, 2007.
3. A.V.Oppenheim, R.W. Schafer and J.R. Buck, “Discrete-Time Signal Processing”, 8th Indian Reprint, Pearson, 2004.
4. Andreas Antoniou, “Digital Signal Processing”, Tata Mc Graw Hill, 2006.

COURSE OUTCOMES (COs)	
CO1	To list the different types of signals and systems
CO2	To describe the discrete time systems and its properties
CO3	To apply Z transform for the analysis of digital signals & systems
CO4	To apply DFT for the analysis of digital signals & system
CO5	To design FIR and IIR filter
CO6	To apply various window functions in biomedical applications

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	2			3	3		3		3	1	1			3
	CO2		3	2			2	3	1				1		
	CO3				3	3					2	2			
	CO4	2					2	3	3	2	1				
	CO5	2	3	2	3	3		3					2		
	CO6	2			3	3		3		3	1	1			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18HSBA401	**ORGANIZATIONAL BEHAVIOR**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic Knowledge on Managements				
	Course Designed by:- Department of Management Studies				

COURSE OBJECTIVES:-

- Understanding the basic approaches in organization
- Knowledge on theories of Personality
- Clear sight on the Decision Making in Groups
- Analyse the behaviour of individuals and groups in organizations in terms of the key factors that influence organizational behaviour.
- Assess the potential effects of organizational - level factors (such as structure, culture and change) on organizational behaviour.

UNIT I **9 hours**

Orgnanizational Behavior – Definition, Need for studying Organizational Behavior, Disciplines involved in the study of Organizational Behavior, -Contributing disciplines and area - Application of Organizational Behavior in Business.

UNIT II **9 hours**

Individual behaviour – personality, perception, learning, attitudes inter-personal behavior – Group and inter-group behaviour.

UNIT III **9 hours**

Group Dynamics – Formal and Informal Group, Group Norms, Group Cohesiveness, Group Behaviour and Group Decision – Motivation – Need and Importance – Theories of Motivation

UNIT IV **9 hours**

leadership-nature, stles and approaches, development of leadership including laboratory training. Power and Authority – Definition of Power – Types of Power.

UNIT V **9 hours**

Management of change-conflict Management- Management of culture, Cross Cultural Management.

REFERENCES

1. Uma Sekaran, Organizational Behavior: Text and Cases TMH Publications
2. Ashwathappa K, Organizational Behavior: Text, cases and games, Himalaya Publishers
3. Chandhan JS, Organizational Behavior, Vikas Publishers
4. Stephen Robbins, Organizatonal Behavior, Pearson Education
5. RS Diwedi, Human Relations and Organizational Behavior, Mac Millan

COURSE OUTCOMES (COs)	
CO1	Familiarity with the knowledge of Frame work of Organizational Behaviour
CO2	Knowledge of the Interpersonal perception
CO3	Awareness of the Merits and Demerits of Group decision making.
CO4	Understanding of the Sources of power
CO5	Familiarity with the knowledge of types of Conflicts
CO6	Understanding the Concept of management Culture

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			3			3	3		1	3		1	
	CO2					3	2	3					1		
	CO3	2	3	3				3		3	1	2			
	CO4	2			3			3			1	3			
	CO5	2	3	2	3		2	3	3		1		2		
	CO6	3			3			3	3		1	3			
3	Category	Humanities and Social Science including Management Courses (HS)													
4	Approval	48th Meeting of the Academic Council													

U18MCTH401 CONSTITUTION OF INDIA – BASIC FEATURES AND FUNDAMENTAL PRINCIPLES

The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted

into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Course content

- Meaning of the constitution law and constitutionalism
- Historical perspective of the Constitution of India
- Salient features and characteristics of the Constitution of India
- Scheme of the fundamental rights
- The scheme of the Fundamental Duties and its legal status
- The Directive Principles of State Policy – Its importance and implementation
- Federal structure and distribution of legislative and financial powers between the Union and the States
- Parliamentary Form of Government in India – The constitution powers and status of the President of India
- Amendment of the Constitutional Powers and Procedure
- The historical perspectives of the constitutional amendments in India
- Emergency Provisions : National Emergency, President Rule, Financial Emergency
- Local Self Government – Constitutional Scheme in India
- Scheme of the Fundamental Right to Equality
- Scheme of the Fundamental Right to certain Freedom under Article 19
- Scope of the Right to Life and Personal Liberty under Article 21

U18PCBM5L1	MEDICAL INSTRUMENTATION LAB	L	T	P	C
	Total Contact Hours – 45	0	0	2	1
	Prerequisite course – Biosensors and Measurements lab				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- Gather basic knowledge about measurements of parameters related to respiratory system
- Learn measurement techniques of sensory responses
- Understand different types and uses of diathermy units.
- Know ultrasound imaging technique and its use in diagnosis
- Know the importance of patient safety against electrical hazard

LIST OF EXPERIMENTS:

1. ECG recording and Analysis.
2. EEG recording and analysis.
3. Respiratory Analysis.
4. Blood Pressure Measurement System.
5. Nerve Conduction Study.
6. Digital Heart Monitor.
7. EOG system
8. Study of ESU – cutting and coagulation modes
9. pH Measurement and conductivity test.
10. Spectrophotometer.
11. Flame photometer.
12. ELIZA.
13. Plotting of human auditory response using audiometer
14. Analysis of bio signals using FFT Spectrum Analyser
15. Ultra Sound Dopplers.
16. Defibrillators and Pacemakers (Demo)

COURSE OUTCOMES (COs)	
CO1	To learn recording systems of EEG and ECG
CO2	To Acquire knowledge on diathermy units
CO3	To determine concentration of certain metal ions in chemical components
CO4	To determine the quantitative analysis of molecules
CO5	Able to detect antibodies in our blood
CO6	Learns pH measurement

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			2	3		2			2	3			3
	CO2		1	2			3	3	3				1		
	CO3	2			3						2	2			
	CO4					3	2	3	2			1			
	CO5	3	2	1				3	1		3	3	2		
	CO6	3			2	3		2			2	3			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM5L2	**DIGITAL SIGNAL PROCESSING FOR BIO ENGINEERS LAB**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	0	0	2	1
	Prerequisite course – Partial Differential Equation and Transformation				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To gain the practical knowledge about the various bio signals and its characteristics

LIST OF EXPERIMENTS

1. Representation of basic discrete time signals
2. Computation of convolution –linear convolution
3. Response of a difference equation to initial conditions; stability
4. DFT and FFT computation
5. FIR filter design using windowing techniques
6. IIR filters design-digital Butterworth filter
7. IIR filters design-digital Chebyshev filter
8. Analysis of ECG signals.
9. Analysis of EEG signals
10. Analysis of EMG signals

COURSE OUTCOMES (COs)	
CO1	To represent the basic discrete time signals and analyze it
CO2	To represent time series signal and convolve them
CO3	To compute the DFT and FFT
CO4	To design the IIR and FIR filter
CO5	To analyze various types of bio signals and study its characteristics
CO6	To learn window techniques for filtering signals

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			2	3		2			2	1			3
	CO2	3							2		3		2		
	CO3	3		2				1							
	CO4			2			3			3			1		
	CO5	2			3		1		3		2				
	CO6	3				3		2			2	1			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18MCAB509	**SOCIAL AWARENESS (ARTISANS-RELATES TO ENGG., VISIT TO HOSPITALS, ORPHANAGES, POLICESTATION, COURTS, TRAUMA CENTERS, CONSUMER FORUMS)**	**L**	**T**	**P**	**C**
		0	0	2	0

Human beings live in relationship with their family members and with others in the society. As a society, mankind strives to achieve ordered and organized life through which an environment of cooperation and coexistence is expected. A healthy society creating an environment of fearlessness is a key for the mankind to achieve higher goals because it is society which makes us most human, most complete as people.

Although as a society, our expectation is fearlessness, but due to lack of understanding of our role in a society, we fail to fulfill the expectation. The social awareness activity shall promote an understanding and sharing of issues of societal problem through exposure to variety of artisans and different kind of organizations. It is expected that this exposure will enable the learners to appreciate social issues, problems and challenges.

Each institution will offer a range of introductory activity based courses focusing on local artisans related to engineering so that students are sensitized to appreciate their problems and can take up some of the problems to solve while they do their regular studies. This course shall also include visits to visit to hospitals, orphanages, police station, courts, trauma centers, consumer forums so that they get exposed to different facets of societal problems. Care should be taken to give adequate representation to local and regional organizations and artisans. For example, Banaras has local traditions in BanarasiSaari, Toy making, etc and has almost all types of organizations. An institution in Banaras area can offer courses on these artisans. This will, in turn, also ensure wider community involvement/interaction with the institution. At the end of the course/semester, a student should be able to identify a social issue, prepare project report and give presentation on the selected issues. Contact hours per week should be 3 -4 hours. Towards the end of the course, the institution can organize an exhibition in which all the students publicly demonstrate findings of their reports and their future plan of actions.

U18MCAB510	SOCIAL SERVICE / NSS	L	T	P	C
		0	0	2	0
(Teach in neighborhood, adopt an underprivileged school, village stay / visit (NSS), cleanliness drive, and skill transfer)					

U18PCBM601	PATHOLOGY AND MICROBIOLOGY	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Biology for Engineers				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- Gain a knowledge on the structural and functional aspects of living organisms.
- Know the etiology and remedy in treating the pathological diseases
- To learn about the cell structure and its disorders
- To gain knowledge about the fundamental structure of virus, bacteria and its causes
- Empower the importance of public health.

UNIT I CELL DEGENERATION, REPAIR AND NEOPLASIA 9

Cell injury - Reversible cell injury and Irreversible cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification- Dystrophic and Metastatic. Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours Autopsy and biopsy.

UNIT-II FLUID AND HAEMODYNAMIC DERANGEMENTS 9

Edema, Hyperemia/Ischemia, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock, Chronic venous congestion. Hematological disorders-Bleeding disorders, Leukaemias, Lymphomas, Haemorrhage.

UNIT V MICROBIOLOGY 9

Structure of Bacteria and Virus. Routes of infection and spread; endogenous and exogenous infections, Morphological features and structural organization of bacteria and virus, growth curve, identification of bacteria , culture media and its types , culture techniques and observation of culture. Disease caused by bacteria, fungi, protozoan, virus and helminthes.

UNIT V MICROSCOPES 9

Light microscope – bright field, dark field, phase contrast, fluorescence, Electron microscope (TEM & SEM). Preparation of samples for electron microscope. Staining methods – simple, gram staining and AFB staining

UNIT V IMMUNOPATHOLOGY 9

Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury: opsonization, phagocytosis, inflammation, Secondary immunodeficiency including HIV infection. Auto-immune disorders: Basic concepts and classification, SLE.Antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies.

TEXT BOOKS:

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, ―Pathologic Basis of Diseases‖, 7th edition,WB Saunders Co. 2005 (Units I & II).
2. Ananthanarayanan&Panicker, ―Microbiology‖ Orientblackswan, 2017 10th edition. (Units III,IV and V).

REFERENCES:

1. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
2. Dubey RC and Maheswari DK. ―A Text Book of Microbiology‖ Chand & Company Ltd, 2007 3. Prescott, Harley and Klein, ―Microbiology‖, 10th edition, McGraw Hill, 2017

COURSE OUTCOMES (COs)															
CO1	To have a Fundamental Knowledge about the cell and concepts of tumor.														
CO2	To have to learn about the fluid present in the body and hemodynamic derangement														
CO3	To discuss the importance of public health and describe methods involved in treating the pathological diseases														
CO4	To have knowledge about basic concepts of infection and immunity of the human body														
CO5	To acquire the fundamental knowledge of structure of Bacteria, virus and its causes.														
CO6	To know the uses of various microbiology based techniques														
Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low															
1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	1		2	3	3	2			2			2	
	CO2			2			2		3			3	2		
	CO3	2	2		3		2				2				
	CO4			3		3		3				3	3		
	CO5	3					3		2		3				
	CO6	3	1		2	3	3	2			2				
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM602	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Medical Instrumentation I & II				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- Gain knowledge about measurements of parameters related to respiratory system
- Learn measurement techniques of sensory responses
- Understand different types and uses of diathermy units.
- Know ultrasound imaging technique and its use in diagnosis
- Know the importance of patient safety against electrical hazard

UNIT I CARDIAC EQUIPMENT 9

Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor. Cardiac Pacemaker- Internal and External Pacemaker– Batteries, AC and DC Defibrillator- Internal and External.

UNIT II NEUROLOGICAL EQUIPMENT 9

Multi channel EEG recording system, Clinical significance of EEG- Epilepsy, Evoked Potential Signals–, EEG Bio Feedback Instrumentation, MEG (Magneto Encephalo Graph) - sensing principle and instrumentation (Block diagram)

UNIT III SKELETAL MUSCULAR EQUIPMENT 9

Generation of EMG, recording and analysis of EMG waveforms, fatigue characteristics, Muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation.

UNIT IV DIATHERMY 9

IR and UV lamp - application. Need for different diathermy units, Short wave diathermy, ultrasonic diathermy, Microwave diathermy. Electro surgery machine - Current waveforms, Tissue Responses, Electro surgical current level.

UNIT V ULTRASONIC TECHNIQUE & PATIENT SAFETY 9

Diagnosis: Tissue Reaction, Basic principles of Echo technique, display techniques A, B and M mode, B Scan, Application of ultrasound as diagnostic tool – Echocardiogram, Echoencephalogram, abdomen, obstetrics and gynecology, ophthalmology. Electrical safety codes and standards, Basic Approaches to protection against shock, Protection equipment design, Electrical safety analyzer – Testing the Electrical safety of medical equipment.

TEXT BOOKS:

1. Leslie Cromwell, Fred J. Seibel, Erich A. Pfeiffer, ―Biomedical Instrumentation and Measurement‖, Prentice Hall India Pvt. Ltd., New Delhi, 2nd Edition, Reprint, 2013.
2. Joseph J. Carr and John M. Brown, ―Introduction to Biomedical equipment technology, Pearson Education, 4th edition, 2008.

REFERENCES:

1. Khandpur R.S, ―Handbook of Biomedical Instrumentation‖, Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
2. Richard Aston ―Principles of Biomedical Instrumentation and Measurement‖ – Merril Publishing Company, 1990.

3. L.A Geddes and L.E.Baker, ―Principles of Applied Biomedical Instrumentation‖, John Wileyand Sons, Reprint 2008
4. John G.Webster, 'Medical Instrumentation Application and Design', 4th edition, John Wiley and Sons, New York, 2009.
5. Myer Kutz ―Standard Handbook of Biomedical Engineering & Design‖ – McGraw-Hill Publisher, 2003.
6. Antony Y.K.Chan,‟ Biomedical Device technology, Principles and design‟, Charles

COURSE OUTCOMES (COs)	
CO1	o apply different medical devices in the measurement of parameters related to cardiology
CO2	To explain the recording method of EEG
CO3	To measure and analyse signals generated by muscles
CO4	To analyse different types of diathermy units
CO5	To list the applications of ultrasound in medical field
CO6	To differentiate the diagnostic and therapeutic equipment's

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	2		2					3			2			3
	CO2	3			3	3	2				1		1		
	CO3		3	2			2	3		2	1		2		
	CO4	2			3	1									
	CO5		3	2	3		3	3	1		1				
	CO6	2		2					3			2			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM603	**RADIOLOGICAL EQUIPMENTS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Medical Instrumentation I& II				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To know the techniques used for visualizing various sections of the body.
- To learn the principles of different radio diagnostic equipment in Imaging
- To discuss the radiation therapy techniques and radiation safety

UNIT I: X – RAYS **9**

Principle and production of soft X – Rays, Selection of anodes, heel pattern, Scattered Radiation, Porter Bucky systems, Cooling System, Testing for various parameters of the unit, principles of Angiography and Fluoroscopic Techniques, Image Intensifiers, Single plane and bi plane recording units, digital subtraction angiography, dental X- ray units.

UNIT II: COMPUTER TOMOGRAPHY **9**

Principle, Plane of Movement, Multi section Radiography, Computerised Axial Tomography, Type of Detection, image reconstruction, Spiral CT, Transverse Tomography.

UNIT III: MAGNETIC RESONANCE IMAGING **9**

Principle of MRI, MRI instrumentation, Imaging Different Sections of the Body, Tissue Characterisation, MR Spectroscopy, Functional MRI.

UNIT IV: EMISSION IMAGING **9**

Alpha, Beta, Gamma Emission, different types of Radiation Detectors, G.M. & Proportional Counters, Pulse Height Analysers, Isotopic, Scanners, Isotopic Diagnosis of RBC Destruction Rate, GI Bleedings Iron Concentration, Liver Functions, Functions of Gamma Camera, PET, SPECT.

UNIT V: RADIATION THERAPY USING X – RAYS AND ISOTOPES **9**

Direct and Indirect effects of high energy radiation, Units for radiation Exposer, Depth Dose curves, Linear Accelerator Betatron, Cobalt and Cesium Therapy, Computation of Absorbed Dose Level, Automatic Treatment Planning, Hazardous Effects of Radiation, Radiation measuring units, Allowed Levels, ICRP regulation Protection Methods.

TEXT BOOKS:

1. Steve Webb, ―The Physics of Medical Imaging‖, Adam Hilger, Philadelpia, 1988 (Units I, II, III & IV).
2. R.Hendee and Russell Ritenour ―Medical Imaging Physics‖, Fourth Edition William, Wiley Liss, 2002**.**

REFERENCES:

1. Gopal B. Saha ―Physics and Radiobiology of Nuclear Medicine‖- Third edition Springer, 2006.
2. B.H.Brown, PV Lawford, R H Small wood, D R Hose, D C Barber, ―Medical physics and Biomedical Engineering‖, - CRC Press, 1999.
3. Myer Kutz, ―Standard handbook of Biomedical Engineering and design‖, McGraw Hill, 2003.
4. P.Ragunathan, ―Magnetic Resonance Imaging and Spectroscopy in Medicine Concepts and Techniques‖, Paperback – Import, 2007

COURSE OUTCOMES (COs)	
CO1	To describe the working principle of X ray machine and its application
CO2	To illustrate the principle computed tomography
CO3	To interpret the technique used for visualizing various sections of the body using magn resonance imaging
CO4	To demonstrate the applications of radio nuclide imaging
CO5	To outline the methods of radiation safety.
CO6	To learn radiation hazards and precaution steps

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	2		2	3		2	1						3
	CO2			2			1			1					
	CO3		1		3				2		2				
	CO4						2	3		2		2			
	CO5	3	2						2		3	3	2		
	CO6	3		3	2			3	2						
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM604	TELEMEDICINE	L	T	P	C
	Total Contact Hours – 30	2	0	0	2
	Prerequisite course – Analog and Digital Communication				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To introduce telemedicine advancements in telemedicine .Benefits of telemedicine , Functional Block of a telemedicine system, Tele healthcare and E-medicine.
- To study Communication infrastructure for telemedicine LAN and WAN technology Satellite communication Mobile hand held devices and mobile communication Internet technology and telemedicine using World Wide Web Video and audio conferencing.
- Introduction to Network Configuration , circuit and packet switching.
- To learn Ethical and legal issues of Telemedicine - Confidentiality and the law – Patient rights and consent - Access to medical Records.

UNIT I - FUNDAMENTALS OF TELEMEDICINE 6

History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits &limitations of telemedicine.

UNIT II -TYPE OF INFORMATION & COMMUNICATION INFRASTRUCTURE FOR TELEMEDICINE 6

Audio, video, still images, text and data, fax-type of communications and network: PSTN, POTS, ANT, ISDN, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.

UNIT III ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE 6

Confidentiality, patient rights and consent: confidentiality and the law, the patient-doctor relationship, access to medical records, consent treatment - data protection & security, jurisdictional issues, intellectual property rights.

UNIT IV PICTURE ARCHIVING AND COMMUNICATION SYSTEM 6

Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical issues, PACS architecture.

UNIT V APPLICATIONS OF TELEMEDICINE 6

Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, eHealth and Cyber Medicine.

TEXT BOOK

1. Olga Ferrer-Roca, M.Sosa Ludicissa, **"**Handbook of Telemedicine", IOS press 2002.
2. Norris A.C, "Essentials of Telemedicine and Telecare", John Wiley & Sons, 2002
3. Wootton R, Craig J, Patterson, "Introduction to Telemedicine", Royal Society of Medicine Press Ltd. (2nd ed.), 2006.

REFERENCE BOOK

1. Maheu M.M, Whitten P, Allen A, "E-Health, Telehealth, and Telemedicine", Jossy-Bass, 2001.
2. Keith J, Dreyer, David S, Hirschron, James Thrall H, Amit Mehta, "PACS: A Guide to the Digital Revolution", 2nd Edition, Springer.

3. Huang H K, "PACS and imaging informatics – Basic Principles & application", Wiley-Blackwell
4. Latifi R, "Current Principles and Practices of Telemedicine and e-Health". Washington DC: IOHS , 2008.
5. Bashshur R L, Shannon G W, "History of Telemedicine", New Rochelle. NY, Mary Ann Liebert Publishers,2009.

COURSE OUTCOMES (COs)	
CO1	To learn about the telemedicine
CO2	To study about the communication and networking system in telemedicine
CO3	To have a knowledge about the standards of telemedicine and encryption
CO4	To get knowledge about uses of telemedicine
CO5	To aware about laws of telemedicine
CO6	To learn about broadband technologies

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			2	3	1	2			2	1		2	
	CO2			2					2				2		
	CO3	2	3		3		2			2	2	3			
	CO4					3		3	2						
	CO5	3									3				
	CO6	3			2	3	1	2		2	2	1			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM6L1	**PATHOLOGY AND MICROBIOLOGY LAB**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	0	0	2	1
	Prerequisite course – Anatomy and Physiology Lab				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To learn about the morphology of Cells
- To gain knowledge about the cultivation and identification of microbes

LIST OF EXPERIMENTS:

1. Peripheral smear study
   (i) Morphology.
   (ii) Different count
   (iii) Total count.
2. Study on inclusion bodies.
3. Antigen-Antibody reaction Immuno electrophoresis.
4. Simple staining.
5. Gram staining.
6. Acid-fast staining.
7. IMVIC test.
8. Oxidase-Citrate.

9. Hydrogen sulphide test.
10. Sterilisation of Media.
11. Preparation of Media (solid & Liquid Media)
12. Cultivation of microbes (pour plate, Streak plate, Spread Plate method)
13. Antibiotic sensitivity test

COURSE OUTCOMES (COs)															
CO1	To have a Fundamental Knowledge about the culture techniques.														
CO2	To have knowledge about basic concepts of Media and Culture of Microbes.														
CO3	To acquire the fundamental knowledge of antibiotic Sensitivity.														
CO4	To know the uses of various microbiology based techniques														
CO5	To have a Fundamental Knowledge about the culture techniques.														
CO6	To Learn about morphology of different microorganisms														
Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low															
1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			2	3	3	2			2	1		2	
	CO2			2									2		
	CO3	2			3		3		2		2				
	CO4		1	2		3	2	3				3			
	CO5	3					3		3	2	3	3	2		
	CO6	3			2	3	3	2			2	1			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM6L2	**VIRTUAL MODELING LAB**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	0	0	2	1
	Prerequisite course – Digital Signal Processing Lab for Bio Engineers				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To gain the practical knowledge about the various bio signals and its characteristics with Lab view
- To understand the concepts of virtualization and virtual machines
- To gain expertise in server, network and storage virtualization

LIST OF EXPERIMENTS

1. Basic arithmetic operations
2. Boolean operations
3. Sum of ‘n’ numbers using ‘for’ loop
4. Factorial of a give number using for loop
5. Array maximum and minimum
6. Flat and stacked sequence
7. Median filter
8. Discrete cosine transform
9. Convolution of two signals

10. Windowing technique
11. Instrumentation of an amplifier to acquire an ECG signal
12. Acquire, analyse and present an EEG using virtual instrumentation

COURSE OUTCOMES (COs)	
CO1	To represent the Basic arithmetic operations and analyze it
CO2	To analyze the Discrete cosine transform
CO3	To analyze various types of Windowing technique
CO4	To acquire ECG signal
CO5	To represent EEG using virtual instrumentation
CO6	To execute datas in a availed frame

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			2	3		2			2		3	2	
	CO2			2			3			3		3			
	CO3	2			3		1		3		2	2	2		
	CO4		1			3		3							
	CO5	3							2		3	3	3		
	CO6	3			2	3		2			2		3		
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18MCAB611	**SPIRITUAL, MINDFULNESS AND MEDITATION**	**L**	**T**	**P**	**C**
		0	0	2	0

The human mind especially among the youth needs to transcend its preoccupation with negative experiences such as fear, anxiety, anger and obsession and to become more comfortable with the experience of compassion, acceptance and forgiveness. The student's attitude of acceptance towards negativity, aggression and turbulent emotions should be diffused with the practice of mindfulness. Rather than suppressing emotions or by indulging in them, the student be taught to handle such vibes with acceptance and generosity and with the observation of the self.

A mindful state has to be achieved when negative thoughts and experiences are becoming more personalized and do not serve as dictators of subsequent feelings and activities (e.g. suicide attempts, violence etc.). Both concentrative and insight meditation techniques may be practiced for 10-day sessions during every two months. Behavioral techniques of self monitoring should also be practiced to observe the stream of consciousness from the perspective of a vigilant but detached observer.

The students should be trained to practice different models of mindfulness and meditation so as to elicit a state of deep physical and behavioral relaxation. They may work on selectively influencing or changing the symmetry in hemispheric brain activity. Positive addiction, meta -cognitive practices etc. are exercised to make the students experience the universal human capacity through spiritual experiences.

The students may learn to turn-off or bypass the cognitive processing of usual daily pre-

occupations and concerns, allowing access to mindful, spiritual and meditative state of self realization.

Activities:
Reading (10 books/ narrations)
Exercises (Mindfulness based Stress Reduction (MBSR) and 10 more)
Sessions: multiple 10-day sessions may be organized over a semester.

U18MCAB612	RELIGION AND INTER-FAITH	L	T	P	C
		0	0	2	0

The objective is to gain knowledge about the beliefs and philosophies of different religions on issues like environment, gender equality, unity, financial equality etc.
The scholars of different religious and philosophical sects should be invited to talk about the issues mentioned above. Efforts should be made to ensure that such talks and discourses should stay clear-off making a critical study on these areas.
Following activities must be included.

- Reading of books on religious texts of different faiths by famous authors. (Reading methods may be as suggested under 'book reading'.)
- Organizing lecture on interfaith issues covering philosophies and chronology and contemporary situations world over at a given time.

U18PCBM701	DIGITAL AND MEDICAL IMAGE PROCESSING	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Digital signal processing for bioengineers				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- The aim of the courses to show how to extract, model, and analyze information from medical data
- To understand application in order to help diagnosis, treatment and monitoring of diseases through computer sciences.

UNIT-I DIGITAL IMAGE FUNDAMENTAL 9

Fundamental steps in DIP, Components of digital image processing system, Structure of human eye, Image formation in the eye, Brightness adaptation and discrimination, light, Image sensing and acquisition, Image formation model, Pixels, Basic relationship between pixels, coordinate conventions, Imaging Geometry, sampling and quantization, Basic geometric transformations.

UNIT-II IMAGE TRANSFORM 9

Definition of image transforms, Need for transforms, applications, Two dimensional Fourier transform, properties, Walsh, Hadamard, Discrete Cosine Transform, Haar, Karhunen – Loeve transforms

UNIT-III IMAGE RESTORATION 9

Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order

Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering

UNIT-IV IMAGE SEGMENTATION 9

Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing-erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.

UNIT-V RECONSTRUCTION OF MEDICAL IMAGES 9

Image reconstruction from projections - Radon transforms, inverse radon transform - Filter back projection algorithm, Fourier reconstruction of MRI Images- Reconstruction of PET, SPECT and fMRI images

TEXT BOOK:

1. Kavyan Najarian and Robert Splerstor ”Biomedical Signals and Image Processing”, CRC – Taylor and Francisn, New York, 1991
2. John L. Semmlow, “Biosignal and Biomedical Image Processing Matlab Based applications” Marcel Dekker Inc., New York, 2004

REFERENCES:

1. **http://www.cs.uu.nl/docs/vakken/ibv/reader/readerINFOIBV.pdf**

COURSE OUTCOMES (COs)															
CO1	To have a Fundamental Knowledge of digital image processing with Fourier transforms														
CO2	To acquire knowledge about the image sampling, Modelling and quantization														
CO3	To have a fundamental knowledge of image enhancement, its process and types of filters used in image processing														
CO4	To have knowledge about image analysis, classification and reconstruction of act and MRI images														
CO5	To acquire the skills in the transmission of biological images.														
CO6	To reconstruct radiological images														
Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low															
1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			3	2			2			1		3	
	CO2		3	2						3			1		
	CO3	2			3		3				3				
	CO4			3		3		2		2		2			
	CO5		3	2							3	3	2		
	CO6	3			3	2			2						
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM702	ROBOTICS AND NANOTECHNOLOGY IN MEDICINE	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Medical Instrumentation I & II				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To introduce about basic principle of robotics and nanotechnology
- To understand the basics of Robotics, Kinematics.
- To explore various applications of Robots in Medicine.

UNIT I: INTRODUCTION **9**

Geometric configuration of robots - manipulators - drive systems - internal and external sensors – end effectors - control systems - robot programming languages and applications - Introduction to robotic vision

UNIT II: ROBOTIC SURGERY **9**

Surgical robots-types, advances and advantages. Technologies involved in robotic surgery-sensors, actuators, micromechanics, communication control, virtual reality and artificial intelligence.

UNIT III: MOBILE ROBOTICS **9**

Architecture for advanced mobile robotics, actuator design, navigation, obstacle avoidance, sensors and vision systems. Legged robotic devices, control of mobile robots in semi structured environment

UNIT IV: ADVANCES IN MICROMECHATRONICS **9**

Robot force control strategies, autonomous mobile multi jointed systems. Development of specialized sensors for online monitoring of biological parameters, computer assisted surgery, rehabilitation robotics in virtual environment, applications in unstructured environment.

UNIT V: BIOMEDICAL APPLICATIONS **9**

Nerve cell repair using micro mechatronics, micro and Nano devices for targeted delivery of medicines to tumour sites . Surgeries performed using robotic systems TECAB, mitral valve surgery, bariatric surgery, minimally invasive surgeries. Surgical procedures in general surgery, neurology, urology, gasteroenterology, cardiology, Orthopedics, paediatrics and radio surgery

TEXT BOOK

1. Niku Saeed B, Introduction to Robotics: Analysis, System, Applications, PHI Publishers.
2. Tony Hyland, Scientific and Medical Robotics, Smart Apple Media Publishers, 2007.
3. Hari Singh Nalwa, "*Nanostructured Materials and Nanotechnology*", Academic Press, 2002.

COURSE OUTCOMES (COs)	
CO1	To study about Definition and origin of robotics
CO2	To learn about Hydraulic, pneumatic and electric drives determination
CO3	To introduce about Construction of manipulators – manipulator dynamics
CO4	To learn about basic concepts of Nano science and technology
CO5	To study about material processing by Sol – Gel method
CO6	To design robotic arms

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low														
1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			2	3		2			2	1		2	
	CO2			2						3		3	1		
	CO3	2			3		1		3		2		1		
	CO4		1			3		3							
	CO5	3									3	3			
	CO6	3			2	3		2			2	1			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18PCBM703	**HEALTH, HOSPITAL AND EQUIPMENT MANAGEMENT**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course –Medical Instrumentation				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To learn about the Health, Hospital and Equipment management.
- To understand the overview of Hospital Organization and Planning.
- To study about various types of communication and safety aspects in Hospital.

UNIT-I HEALTH SYSTEM 9

Health organization of the country, the state, the cities and the region, Health Financing System, Organisation of Technical Section.

UNIT-II HOSPITAL ORGANISATION AND MANAGEMENT 9

Management of Hospital Organization. Nursing section Medical Sector, Central Services, Technical Department, Definition and Practice of Management by Objective, Transactional Analysis Human relation in Hospital. Importance to Team Work, Legal aspect in Hospital Management

UNIT-III REGULATORY REQUIREMENT AND HEALTH CARE CODES 9

FDA Regulation, joint commission of Accreditation for Hospitals, National Fire Protection Association Standard, IRPC.

UNIT-IV EQUIPMENT MAINTENANCE MANAGEMENT 9

Organizing Maintenance Operations, Paperwork Control, Maintenance Job, Planning Maintenance Work Measurement and Standards, Preventive Maintenance, Maintenance Budgeting and Forecasting, Maintenance Training, Contract Mainframe.

UNIT-V TRAINED TECHNICAL PERSONNEL 9

Function of Clinical Engineer, Role to be performed in Hospital, Man power Market, Professional Registration, Structure in Hospital.

TEXTBOOKS:

1. Kunders G D, “Biomechanics: Hospitals, facilities planning and management”, Tata McGraw Hill, 2008.

2. Sakharkar B M, "Principles of hospital administration and planning", Jaypee Brothers Medical Publishers Pvt Limited, 2nd edition, 2009.

REFERENCES:

1. Cesar A. Caceres and Albert Zara, The Practice of Clinical Engineering. Academic Press, 1977.
2. Webster, J. G. and Albert M. Cook, Clinical Engineering Principles and Practices, Prentice Hall Inc. Eng/ewood Cliffs, 1979.
3. Antony Kelly, Maintenance planning and control, Butterworths London, 1984.
4. Hans Pfeiff Vera Dammann (Ed.) Hospital Engineering In Developing Countries, Z report Eschborn, 1986.
5. Jacob Kline, Handbook of Bio Medical Engineering, Academic Press. San Diego 1988.
6. R.C.Goyal. Handbook of Hospital Personal Management. Prentice Hall of India. 1993.
7. http://www.scribd.com/doc/18278414/Hospital-management#scribd

COURSE OUTCOMES (COs)															
CO1	To gain Knowledge about the Health Organization of the Country.														
CO2	To acquire well defined knowledge in Hospital Organization and Management														
CO3	Develop the fundamental knowledge of regulatory requirements and Health Care Codes														
CO4	To know the skills of Equipments Maintenance Management														
CO5	To understand the functions and role of Clinical Engineers.														
CO6	To study about the role of Biomedical Engineers in Hospitals														
Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low															
1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			3	2			2			1		2	
	CO2		3	2			3			1			1		
	CO3	2			3						3				
	CO4			3		3	2	2				2			
	CO5		3	2			L			3	3		2		
	CO6	3			3	2			2			1			
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18MCTH603	ESSENCE OF INDIAN KNOWLEDGE TRADITION	L	T	P	C
		2	0	0	0

ESSENCE OF INDIAN KNOWLEDGE TRADITION-Pt-1

भारतीयविद्यासार - 1

Course Objective

- The course aims at imparting basic principles of thought process, reasoning and inferencing. Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature. Holistic life style of yogic science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions. Part-1 focuses on introduction to Indian Knowledge Systems, Indian perspective of modern scientific world-view, and basic principles of Yoga and holistic health care system.

Course contents

- Basic Structure of Indian Knowledge System: अष्टादश विद्या – ४ वेद, ४ उपवेद (आयुर्वेद, धनुर्वेद, गान्धर्व वेद, स्थापत्य आदि), ६ वेदांग (शिक्षा, कल्प, निरुक्त, व्याकरण, ज्योतिष, छंद), ४उपाङ्ग (धर्म शास्त्र, मीमांसा, पुराण, तर्कशास्त्र)
- Modern Science and Indian Knowledge System
- Yoga and Holistic Health Care
- Case studies

References

- V. Sivaramakrishnan (Ed.), *Cultural Heritage of India – course material*, BharatiyaVidyaBhavan, Mumbai.5th Edition, 2014
- Swami Jitatmanand, *Modern Physics and Vedant*, BharatiyaVidyaBhavan.
- Swami Jitatmanand, *Holistic Science and Vedant*, BharatiyaVidyaBhavan.
- Fritzof Capra, *Tao of Physics*.
- Fritzof Capra, *The Wave of Life*.
- VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmay Foundation, Velliarnad, Arnakulam
- *Yoga Sutra of Patanjali*, Ramakrishna Mission, Kolkatta.
- GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanam with Vyasa Bhashya*, VidyanidhiPrakashan, Delhi 2016
- RN Jha, *Science of Consciousness Psychotherapy and Yoga Practices*, VidyanidhiPrakashan, Delhi 2016
- P B sharma (English translation), *ShodashangHridayam*

Pedagogy: Problem based learning, group discussions, collaborative mini projects

Outcome: Ability to understand, connect up and explain basics of Indian traditional knowledgein modern scientific perspective.

U18PCBM7L1	IMAGE PROCESSING LAB	L	T	P	C
	Total Contact Hours – 45	0	0	2	1
	Prerequisite course – Digital Signal Processing Lab for Bioengineers				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To practice the basic image processing techniques.
- To analyze various types of bio image and study its characteristics.
- To enhance the medical images by applying various filters.

LIST OF EXPERIMENTS:

1. Display of Grayscale Images.
2. Histogram Equalization.
3. Spatial filtering
4. Non-linear Filtering.
5. Edge detection using Operators.

6. 2-D DFT and DCT.
7. Filtering in frequency domain.
8. Display of color images.
9. Conversion between color spaces.
10. DWT of images.
11. Segmentation using watershed transform.
12. Study of DICOM standards.
13. Medical Image Compression techniques.
14. Medical image fusion

COURSE OUTCOMES (COs)	
CO1	To understand the fundamentals of digital image and its properties
CO2	To enhance the medical images by applying various filters
CO3	To segment the region of interest using various image processing algorithms
CO4	To study on DICOM standards
CO5	To analyze different fusion techniques.
CO6	To learn filtering methods

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			3	2	2		2					3	
	CO2		3	2						3					
	CO3	2			3		3				3				
	CO4			3		3		2		3		2			
	CO5		3	2			3				3	3	2		
	CO6	3			3	2	2		2						
3	Category	Professional Course (PC)													
4	Approval	48th Meeting of the Academic Council													

U18MCAB713	**BEHAVIORAL AND INTERPERSONAL SKILLS (NON-VERBAL SKILLS / BEHAVIOURS, NON-AGGRESSION)**	**L**	**T**	**P**	**C**
		0	0	2	0

Each individual has behavior patterns that are shaped by the context of his or her past. Most often, adapting the behaviour to the changing context of the reality a person lives in becomes difficult which may lead to the reduction in personal effectiveness and natural self-expression. The main focus of this course is to equip the students with useful approaches to help in the deeper understanding of self and help individuals empower themselves to be the source of their own growth and development. The course will help students to learn effective communication skills, Group and team building skills and will help them learn the goal setting process and thus become more effective in achieving their goals.

The broader objective of this course is to make the students aware about the different facets of self and to help them learn skills to strengthen their inner capacities. So that they are able to understand themselves, think and act effectively, to be able to communicate in an effective manner and to learn to lead and to form an effective team. The specific objectives, however, are as following.

- To help the students to understand their real self by recognizing different aspects of their self-concept that will lead to an increased self-confidence.
- To train the students for communicating effectively in both formal as well as in informal settings.
- To help the students to understand the importance of non-verbal aspects of effective communication.
- To help the students to understand Emotion and emotional intelligence, Managing ones' own emotional reservoirs, effective dealing with emotions at work
- To facilitate the students in understanding the formation and function of group and team and to help them to learn the skills of a successful leader.
- To help the students in understanding and practicing the goal setting process by recognizing the importance of each step involved in goal setting. The activities involved are designed to facilitate their career goal decision making.

The activities to achieve the above objectives can be suggested as follows.

- Motivational lectures
- Group Discussions/activities
- Case Study
- Games/Stimulation Exercises
- Role-Playing
- Mindfulness training.

U18MCAB714	NATURE CLUB	L	T	P	C
		0	0	2	0

Nature club (bird watching, recognizing plants at institute/at home, recognizing local animals, appreciating biodiversity

Impart knowledge and inculcate the habit of taking interest and understanding biodiversity in and around the college campus. The students should be encouraged to take interest in bird watching, recognizing local plants, herbs and local animals. The students should be encouraged to appreciate the difference in the local biodiversity in their hometown, in the place of their study and other places they visit for vacation/breaks etc.
Following activities must be included.

Identify a tree fruit flower peculiar to a place or having origin from the place.

- Making high resolution big photographs of small creatures (bees, spiders, ants. mosquitos etc.) especially part of body so that people can recognize (games on recognizing animals/plants).
- Videography/ photography/ information collections on specialties/unique features of different types of common creatures.
- Search and explore patents and rights related to animals, trees etc.
  Studying miracles of mechanisms of different body systems.

U18EEBM8C1	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 seventh semester				
	Course Designed by – Dept of Biomedical Engineering				

OBJECTIVES

- To provide a complete review of Bio Medical Engineering topics covered up to fifth semesters, so that a comprehensive understanding is achieved.
- It will also help students to face job interviews, competitive examinations and also to enhance the employment potential.
- To provide overview of all topics covered and to assess the overall knowledge level up to fifth semester.

U18MCAB815	INNOVATION PROJECT BASED – SC., TECH, SOCIAL, DESIGN & INNOVATION	L	T	P	C
		0	0	2	0

Many students, when they enter engineering, are full of enthusiasm to understand new areas, to build systems and to experiment and play with them. This enthusiasm is to be tapped and to direct it to exploration and sustained pursuit by the student which may result in development of a working system, a prototype, or a device or material, etc. They are not required or even expected to produce research or an innovation.

Students may be encouraged to take up projects which are aimed at providing solutions to societal problems, reduce drudgery and improving efficiency in rural work, green technologies, utilization of rural and urban waste, sanitation and public health, utilizing non -conventional energy sources, technologies for the benefit of the differently abled people and technologies ready to be implemented in the Institute.

Two types of activities may be undertaken under this

Exposure to social problems (which are amenable to technological solutions)

Design & Innovation (to address above problems)

After this students be encouraged to undertake technology projects of social relevance.

PROFESSIONAL ELECTIVE

U18PEBM011	BIOFLUID AND BIOMECHANICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Anatomy and Physiology				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- An understanding on the physiology and anatomy of studied systems,
- A capability to analyze cardiac, respiratory mechanics
- Explain about soft tissue and orthopedic mechanics

UNIT-I BIOMECHANICS **9**

Newton's law, Stress, Strain, Hookes-law, Elasticity, Shear, Tension, Compression, Bone – Cancellous and cortical bone, structure, Mechanical Properties and mechanical testing of bone, UTM, creep and Fatigue.

UNIT II BIOFLUID MECHANICS **9**

Viscosity, Newtonian fluid, Non-Newtonian fluid, Viscoelastic, Vascular tree, Flow properties of Blood, Physical, Chemical and Rheological properties of blood, Apparent and Relative and Viscosity, Problems associated with extra corporeal blood flow

UNIT-III BIOSOLID MECHANICS 9

Constitutive equation of viscoelasticity –Maxwell &Voight models, anisotropy, Hard Tissues –Structure, blood circulation, elasticity and strength, viscoelastic properties, functional adaptation, Skeletal Muscle –Muscle action, Hill's models, mathematical modeling, Bone fracture mechanics, Implants for bone fractures.

UNIT IV SOFT TISSUE MECHANICS 9

Tissue Mechanics-Mechanical Properties of Tissues, Biological materials, Pseudo elasticity, nonlinear stress-strain relationship, viscoelasticity, structure, function and mechanical properties of skin, ligaments and tendons.

UNIT V ORTHOPAEDIC MECHANICS 9

Mechanical properties of cartilage, diffusion properties of articular cartilage, kinetics and kinematics of joints, lubrication of joints analysis of force in orthopaedic implants. Biomechanics of Elbow Shoulder hip and Knee.

TEXT BOOK

1. Biofluid Mechanics,The Human Circulation, Second Edition,ByKrishnan B. Chandran, Stanley E. Rittgers, Ajit P. Yoganathan.

REFERENCES

1. Cyrul A Keele and Eric Neil – Samsons Wrights Applied physiology – Oxford University press New Delhi – 1991
2. Ranganathan
3. T S,Text Book of human Anatomy S. Chand and company New Delhi – 1994
4. Arthur.C.Guyton, John E Hall, "*Textbook of medical physiology*", W.B. Saunders Company, 11th edition, 2000.
5. Sarada Subramanyam, K.Madhavan Kutty and H.D.Singh, "*Text book of human physiology*", S.Chand& Company, 5th edition, 2014.
6. Guyton 'Text book of Medical Physiology – WB Jaunder company Philadelphia - 10 edition 2002
7.

COURSE OUTCOMES (COs)	
CO1	Outline the fundamental concepts and definitions related to Biomechanics
CO2	Demonstrate the Cardiovascular and pulmonary system in human body
CO3	Identify the different blood properties, especially the anatomy and physiology of blood vessels.
CO4	Able to explain the laws concerning bio-fluid mechanics
CO5	Develop the model for orthopedic device
CO6	Explain the mechanism of human physiology

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	1		2	3		2	3	3	2		1		2
	CO2			2			3					3			
	CO3	2			3					3	2	1	1		
	CO4					3		3							
	CO5	3	3				1		2		3	2	1		

	CO6	3	1		2	3		2	3	3	2		1		
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM012	HUMAN ASSIST DEVICES	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course –Medical Instrumentation-I				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To know the various Bio- potential recordings for enabling students to record various signals.
- To know the various functional blocks present in cardiac care units so that the students can handle these equipments with care and safety.
- To develop an understanding of the physiotherapy and diathermy equipment so that the student can learn to operate.
- To study the concept of various Human Assist Devices so as to enable the students to develop new devices with innovative technology.
- To introduce the recent trends in the field of Diagnostic and Therapeutic Equipments.

UNIT I HEART LUNG MACHINE AND ARTIFICIAL HEART 9

Condition for H/L System, Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Mock test setup for assessing its Functions

UNIT II CARDIAC ASSIST DEVICES 9

Synchronous Counter pulsation, Assisted through Respiration Right Ventricular Bypass Pump, Left Ventricular Bypass Pump, Open Chest and closed Chest type, Intra Aortic Balloon Pumping Veno Arterial Pumping, Prosthetic Cardio Valves, Principle and problem, Biomaterials for implantable purposes, its characteristics and testing.

UNIT III ARTIFICIAL KIDNEY 9

Indication and Principle of Haemodialysis, Membrane, Dialysate, Different types of heamodialysers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.

UNIT IV PROSTHETIC AND ORTHODIC DEVICES 9

Hand and Arm Replacement - Different Types of Models Externally Powered Limb Prosthesis Feedback in Orthodic System, Functional Electrical Stimulation, Sensory Assist Devices, Materials for Prosthetic and orthodic devices, Haptic Devices

UNIT V RESPIRATORY AND HEARING AIDS 9

Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters, Types of Deafness, Hearing Aids, Construction and Functional Characteristics.

TEXT BOOK

1. Kolff W.J., Artificial Organs, John Wiley and Sons, New York, 1979.
2. Andreas.F.Vonracum, Hand book of bio material evalution, Mc-Millan publishers, 1980.

REFERENCES

1. Albert M.Cook and Webster J.G., Therapeutic Medical Devices, Prentice Hall Inc., New Jersey, 1982
2. Gray E Wnek, Gray L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering – Marcel Dekker Inc New York 2004.
3. John. G . Webster – Bioinstrumentation - John Wiley & Sons (Asia) Pvt Ltd - 2004.

COURSE OUTCOMES (COs)	
CO1	To Discuss about the working principle of Heart Lung Machine and Artificial Heart
CO2	To Able to categorize the different classes of Cardiac assist devices and its Applicatio
CO3	To Identify the suitable requirements for Haemodialysis and performance analysis of Dialysers
CO4	To Able to choose the suitable materials and model for Rehabilitation
CO5	To analyse the mechanism for Audiometer and the common Hearing aids
CO6	To Explain the mechanism of Human Assist Devices

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	2		2	3		2	1			1			3
	CO2			2			1			1			1		
	CO3		1		3				2		2				
	CO4						2	3		2		2			
	CO5	3	2						2		3	3	2		
	CO6	3		3	2			3	2						
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM013	**MEDICAL INFORMATICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Medical Instrumentation				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To learn about the historical information of hospitality and recent trends in the Hospital information system.
- To know about the basic concepts of artificial intelligence and expert systems.
- To study the hospital management information systems and computer assisted patient education.

UNIT-I INTRODUCTION **9**

Structure of Medical Informatics, Internet and Medicine, Security issues, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, e-health services, Health Informatics, Medical Informatics, Bioinformatics

UNIT-II COMPUTERIZED PATIENT RECORD 9

History taking by computer, Dialogue with the computer, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology, Application server provider, Clinical information system, Computerized prescriptions for patients

UNIT-III COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGINING 9

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System, Computerized ECG, EEG and EMG, Computer assisted medical imaging- nuclear medicine, ultrasound imaging ultrasonography-computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance

UNIT-IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9

Neuro-computers and Artificial Neural Networks application, Expert system, General model of CMD, Computer-assisted decision support system, production rule, system cognitive model, semester networks, decisions analysis in clinical medicine, computers in the care of critically patients, computer assisted surgery, designing.

UNIT-V RECENT TRENDS IN MEDICAL INFORMATICS 9

Virtual reality applications in medicine, Computer assisted surgery, Surgical simulation, Telemedicine, Tele surgery computer aids for the handicapped, computer assisted instrumentation in Medical Informatics, Computer assisted patient education and health, Medical education and health care information.

TEXT BOOK:

1. R.D.Lele '"Computer in Medicine" Tata McGraw Hill, Newyork, 1999.

REFERENCES:

1. S.K.Chauhan "PC Organisation", S.K.Kataria and Sons, Delhi 2000.
2. Harold Sackamn "Bio Medical Information Technology", Academic Press, Newyork.
http://www.springer.com/series/684

COURSE OUTCOMES (COs)															
CO1	To Infer the function of Hospital Information Systems														
CO2	To Develop the concepts of artificial intelligence and expert systems														
CO3	To Interpret the various concept of Hospital management and information system														
CO4	To Construct the 3 dimensional imaging and its applications.														
CO5	To Relate the various trends of medical informatics														
CO6	To organize the information technology in hospital														
Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low															
1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	3		2	3		2		3	2	1		2	
	CO2			2			2		2				1		
	CO3	2	3		3				2	2	2				
	CO4					3		3	1			2	3		
	CO5	3	2	3	3		2			1	3				
	CO6	3	3		2	3		2		3	2	1			
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM021	TROUBLESHOOTING OF MEDICAL INSTRUMENTS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Electronic Devices and Circuits				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To provide the knowledge of planning, designing and safety management in hospital services.
- To know the Fundamental Troubleshooting Testing Procedures.
- To understand the Fault Diagnosis in Analog & Digital Integrated Circuits.

UNIT I - FUNDAMENTAL TROUBLESHOOTING TESTING PROCEDURES 9

Equipment failure and its causes, Functional block diagram of a troubleshooting system, Troubleshooting process & fault finding aids, Troubleshooting techniques and their correction action, Testing of active and passive components: resistor,capacitor, inductor, BJT, JFET & MOSFET.

UNIT II - FAULT DIAGNOSIS IN ANALOG & DIGITAL INTEGRATED CIRCUITS 9

Characteristics of ideal op-amps, typical op-amp based medical circuits, Fault diagnosis in op-amp circuits, Digital troubleshooting methods, Digital IC Troubleshooters, logic clip, logic probe, logic pulser, logic current tracer, logic comparator, Circuit board Troubleshooting.

UNIT III - BIOMEDICAL EQUIPMENT TROUBLESHOOTING 9

Troubleshooting- ECG Machine, EEG Machine, defibrillator, electrosurgical unit, anesthesia machine, autoclaves & sterilizers, endoscope, incubators, nebulizer, oxygen concentrators, sphygmomanometers, suction machine, X-ray machine.

UNIT IV - MEDICAL DEVICE DESIGN QUALITY 9

Definition of quality, essence of quality, Quality operating system and the device life cycle, Evolution of quality, Business excellence: a value proposition, Health care quality.

UNIT V - DESIGN FOR SIX SIGMA AND MEDICAL DEVICE REGULATION 9

Global Perspective on medical device regulations, medical device classification (USA, Europe & GHTF), Medical device safety, medical device quality management systems requirements, Medical device regulation throughout the product development life cycle, Purpose of ISO 9001:2001&ISO 13485.

TEXT BOOKS:

1. Khandpur R S, "Troubleshooting Electronic Equipment- Includes Repair & Maintenance", Tata McGraw Hill, 2nd Edition, 2009.
2. Basem S EL-Haik& Khalid S Mekki, "Medical Device Design for Six Sigma: A Road Map for Safety and Effectiveness", John Wiley & Sons, 1st Edition, 2008.

REFERENCES:

1. Nicholas Cram & Selby Holder, "Basic Electronic Troubleshooting for Biomedical Technicians", TSTC Publishing, 2nd Edition, 2010.
2. Dan Tomal& Neal Widmer, "Electronic Troubleshooting", McGraw Hill, 3rd Edition, 2004.

3. World Health Organisation, "Maintenance & Repair of Laboratory, Diagnostic imaging & Hospital Equipment", Geneva, 1994.

COURSE OUTCOMES (COs)	
CO1	To Outline the trouble shooting basic procedure
CO2	To Infer the various analog and digital circuits trouble shooting procedures
CO3	To Apply the trouble shooting procedures to various biomedical equipments
CO4	To Develop the quality procedure for healthcare equipment
CO5	To Relate the various regulations for biomedical devices
CO6	To explain briefly about analog and digital integrated circuits

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	2			3		2	1		2	1		3	
	CO2			2			1			1		3	3		
	CO3	2	1		3				2		2				
	CO4							3		2		2			
	CO5	3	2						2		3		1		
	CO6	3	2			3		2	1		2	1			
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM022	**REAL TIME PROCESSOR AND BIOMEMS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Microprocessor and Microcontroller in Biomedical Applications				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To learn about the Digital Signal Processing and BIOMEMS in the real time.
- To provide knowledge in PSOC
- To Know about working principle of MEMS and Microsystems

UNIT-I INTRODUCTION TO DIGITAL SIGNAL PROCESSING DEVICES 9

Architecture of TMS 320C54XX Digital Signal Processor-18. Addressing Modes and Instruction sets of TMS 320C54XX DSP-19. TMS 320VC5416 Assembly Language Programming-. Interfacing and Real Time C Programming with TMS 320C54XX- TMS 320C6713 Floating Point Processor Architecture and Real Time C Programming

UNIT-II PROGRAMMABLE EMBEDDED SYSTEM-ON-CHIP (PSOC) PROCESSOR 9

Architecture- Designer- Developing tools- biomedical applications

UNIT-III INTRODUCTION TO REAL-TIME IMAGING 9

Basic Hardware Architecture.-Linear Image Processing Algorithms-Compression by Matrix Transforms-Nonlinear Image Processing Algorithms-Parallel Architectures-Programming Languages-Optimization Techniques

UNIT IV MEMS AND MICROSYSTEMS 9

Working principle of Microsystems, materials for MEMS and Microsystems, micromachining, System modeling and properties of materials

UNIT V BIOMEMS 9

Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR), DNA hybridization, Electronic nose, Bio chip.

TEXT BOOKS

1. Udayashankara, V. ,Real time digital signal processing : fundamentals, algorithms and implementation using tmsprocessor,phi 2007.
2. Edward R. Dougherty, Phillip A. Laplante ,Introduction to Real-Time Imaging ISBN: 978-0-8194-1789-3,February 1995, Wiley-IEEE Press.
3. Tai Ran Hsu , " MEMS and Microsystems design and manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002.

REFERENCES

1. Technical Reference Manuals,Cyprus Semiconductors,USA 2008.
2. https://nanohub.org/resources/992/download/2005.02.07-Bashir1.pdf

COURSE OUTCOMES (COs)	
CO1	To Infer the architectures of various processors and programming
CO2	To Develop the biomedical devices using PSOC
CO3	To Classify the various Nonlinear Image Processing Algorithms
CO4	To Interpret the working principle of Microsystems.
CO5	To Outline the applications of MEMS in biomedical field
CO6	To Able to Develop programming languages for image processing

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	2		2	3		2	1		2				2
	CO2			2			1			1			1		
	CO3	2	1		3				2		2	1	2		
	CO4			3	1	3	2	3		2		2			
	CO5	3	2						2		3	3			
	CO6	3	2		2	3		2	1		2				
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM023	**CLINICAL ENGINEERING**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Health Hospital and Equipment Management				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To educate on the basic concepts of laboratory animal care and ethical requirements and to introduce the principles of biological standardization.
- To provide the basic knowledge in clinical trials
- To understand about phase of conducting clinical trials

UNIT I REGULATION FOR LABORATORY ANIMAL CARE AND ETHICAL REQUIREMENTS 9

Introduction to commonly used experimental animals and their limitations in biological screening. Guidelines for care and handling of laboratory animals CPCSEA (including IAEC), OECD, ICH, GLP and ICMR Guidelines. Proforma (s) for performing experiments on animals as per various guidelines. Maintenance and Breeding techniques for laboratory animals. Organization of screening: Pharmacological activity of new substances and safety assessment tests. Toxicity studies: acute, subacute (Repeated dose), subchronic and chronic toxicity.

UNIT II PRINCIPLES OF BIOLOGICAL STANDARDIZATION 9

Methods of biological assay, principles of biological assays, official bioassays of some important drugs (Digitalis, insulin, nor adrenaline and histamine).Modern Techniques and New Approaches in drug evaluations: Animal cell lines and their uses, Radiological and binding assay

UNIT III INTRODUCTION TO CLINICAL TRIALS 9

Glossary of terms in clinical trials, history, requirements, new drug development process, need for new drug, selection of a chemical compound as a potential drug, screening of chemical compounds, translation medicine, assessment of preclinical data, Goals of clinical trials- Target population and patient selection.

UNIT IV PHASES OF CLINICAL TRIALS AND LEGAL ISSUES IN CLINICAL TRIALS 9

Phase 1, Phase 2, Phase 3 studies, Phase 4,Drug regulations- National- good clinical practice and schedule Y, Critical evaluation of literature- Systematic review and meta analysis, evidence based medicine

UNIT V PROCESS OF CONDUCTING A CLINICAL TRIAL 9

Drug development ,The process of ethical approval ,pre-study organization, protocol design, case Report Form (CRF) design ,Informed consent ,ethics approval, monitoring & Source Data Verification (SDV) ,safety Assessment - Good Clinical Practice Guidelines (GCP) & adverse events ,essential documentation, audit & inspections.

TEXTBOOK

1 Friedman LM, Furberg CD, DeMets DL**.** *Fundamentals of Clinical Trials*. 4th ed. New York, NY: Springer; 2010.Additional Reading Parmigiani, G. (2002).

2 Modeling in Medical Decision Making: A Bayesian Approach, John Wiley and Sons.

REFERENCES

1. Shein-Chung Chow, Jen-Pei Liu, Design and Analysis of Clinical Trials: Concepts and Methodologies.
2. Eleanor McFadden (2007), Management of Data in Clinical Trials, Frontier Science , Ltd.
3. Susanne Prokscha (2011) Practical Guide to Clinical Data Management.
4. Richard K.Bondel, Sheila A.Varley, Colin F.Webb,(2000),Clinical Data Management, Second Edition, Wiley Publications.
5. John I. Gallin, Frederick P. Ognibene (2012), Principles and Practice of Clinical Research, Elsevier Publications.

COURSE OUTCOMES (COs)															
CO1	To Outline the various regulations and ethical requirements for animal care														
CO2	To Infer the basics of principles of biological standardization														
CO3	To List the drug development process														
CO4	To Relate the phases of clinical trials and legal issues in clinical trials														
CO5	To Build the process of conducting a clinical trial														
CO6	To Design protocols for ethical acceptance														
Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low															
1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			2	3		2			2	3		2	
	CO2			2									1		
	CO3	2			3						2				
	CO4					3		3				2	1		
	CO5	3									3				
	CO6	3			2	3		2			2	3			
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM031	NUCLEAR MEDICINE	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Radiological Equipments				
	Course Designed by:-Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To understand the fundamentals of Nuclear Medicine and learn about the instruments involved in production techniques and therapeutic uses of Nuclear Medicine.
- To learn about various nuclear medicine instrumentation
- To educate radiation safety

UNIT I - BASICS OF NUCLEAR MEDICINE **9**

Radioactivity and interaction of radiation; Alpha, Beta and gamma emission, Laws of radioactive decay, Mechanisms of radioactive delay, Radiation intensity and exposure, Decay schemes and energy levels, Compton scattering, Pair productions, Particle interactions

UNIT II - RADIOPHARMACEUTICALS **9**

Radionuclide production, 99Mo/99mTc generator, Mechanism of localization, Types of radiopharmaceuticals, characteristics of radio pharmaceuticals, Radiopharmaceuticals for diagnosis and treatments in human, Dispensing of radio pharmaceuticals, RIA radiopharmaceuticals and kits production.

UNIT III - NUCLEAR MEDICINE INSTRUMENTATION **9**

Construction and principle operation of Gamma camera, Rectilinear scanner, Basic principles of pulse height analyser, Radiation detectors-Ionization chamber, Geiger Muller counter, Semiconductor detectors, Scintillation detectors, Electronic Instrumentation for radiation detection system,

UNIT IV - DIAGNOSTIC AND THERAPEUTIC APPLICATIONS OF RADIONUCLID **9**

PET-CT, Single photon emission computed tomography (SPECT), Radio iodine therapy for Thyrotoxicosis , Differentiated thyroid cancers, Palliative treatment for bone metastasis - 32P and 89 Strontium Dosage, Intravascular particulate radio nuclide Therapy, Receptor targeted therapy, 131I- MIBG Therapy, Targeted internal radiation in HCC: 90 Y, Radio-synovectomy using Yttrium

UNIT V - RADIATION SAFETY **9**

Radiation protection indifferent nuclear isotope therapy procedures, Management of radiation accidents, Radiation effect on pregnancy and fertility, Diagnosis, evaluation and treatment of radiation overexposure, Instruments used in radiation survey & monitoring, Handling of radioactive patients, Role of national and international bodies in radiation safety, ICRP recommendations, BARC regulations regarding limits of radiation exposure.

TEXTBOOKS

1. Simon Cherry, James Sorenson, Michael Phelps. "Physics in Nuclear Medicine", Elsevier Saunders , 4th Edition ,2012.
2. Jennifer Prekeges, "Nuclear Medicine Instrumentation", Jones and Barlett publishers, 1st edition, 2011.

REFERENCES

1. Max.H.Lombardi, "Radiation safety in Nuclear Medicine", CRC Press, Florida, USA, 2nd edition 1999.

COURSE OUTCOMES (COs)															
CO1	To Label the basics of nuclear medicine														
CO2	To Interpret the construction and principle of operation of various nuclear medicine Instruments.														
CO3	To Infer the characteristics and mechanisms of Radiopharmaceuticals														
CO4	To Identify the diagnostics and therapeutic applications of nuclear medicine.														
CO5	To List the radiation safety procedures and regulations.														
CO6	To recall about radiation safety precautions														
Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low															
1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	3		2	3		2	1		2	1			2
	CO2			2			1			1			1		
	CO3	3	1		3				2		2		2		
	CO4			3	1	3	2	3		2					
	CO5	3	3						2		3	3			
	CO6	3	3		2	3		2	1		2	L			
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM032	MODELLING OF PHYSIOLOGICAL SYSTEM	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Bio-control System				
	Course Designed by:-Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To design the physiological systems
- To analyze about control system
- To learn about various human systems, frequency analysis and modelling of physiological control systems

UNIT I INTRODUCTION TO PHYSIOLOGICAL CONTROL SYSTEMS 9

Introduction to modeling methodology- need for models-approaches to modeling, simulation, model identification- model validation- Engineering control system versus physiological control system-generalized system properties.

UNIT II ANALYSIS OF CONTROL SYSTEM 9

Open loop versus closed loop - Determination of steady state operating point for simple model of muscle stretch reflex - Regulation of glucose-insulin - Chemical regulation of ventilation.

UNIT III HUMAN SYSTEMS 9

Respiratory system: Modeling oxygen uptake by RBC and pulmonary capillaries, mass balancing by lungs, gas transport mechanism of lungs, oxygen and carbon dioxide transport in blood and tissues.

UNIT IV FREQUENCY ANALYSIS 9

Frequency response analysis – response to sinusoidal inputs – Closed loop and open loop response – Relationship between transient and frequency response – Graphical representation of Frequency response – Pupillary Retinal system .

UNIT V MODELING PHYSIOLOGICAL CONTROL SYSTEM 9

Identification of physiological control systems – Parametric and non-parametric identification methods – Identification of closed loop systems – minimal model of blood glucose regulation – Model based approaches – Neural network for control systems

TEXT BOOKS:

1. Advanced Methods of Physiological System Modelingby V.Z. Marmarelis
2. Applied mathematical model in Human Physiology, by Johnny T. Ottesen, Mette S. Olufsen, Jesper K.Larsen.

REFERENCE BOOKS:

1. Physiological basis of Ventilatory Support, By John. J. Marini, Arthur S. Slutsky
2. Pharmacokinetic and Pharmaco dynamic Data Analysis: Concepts and Applications**,** By Daniel (Weiner, Johan Gabrielsson).
3. http://physiology.arizona.edu/people/secomb/472-572lecturenotes09

COURSE OUTCOMES (COs)	
CO1	To Extend Knowledge about the physiological process in the biological system

CO2	To Compare the open and closed loop system with physiological system
CO3	To Interpret the working of various physiological
CO4	To Develop the frequency response analysis of Pupillary Retinal system
CO5	To Modelling of various physiological control system
CO6	To explain about gas transportation mechanism

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			1	2			2			3		2	
	CO2		1	2			3	3		3	2		1		
	CO3	2			3				3				3		
	CO4		2			3		2		2	3	2			
	CO5	2		2			2								
	CO6	3			1	2			2			3			
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM033	**TISSUE ENGINEERING**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Biomaterials and artificial organs				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To understand about the different types of tissues.
- To illustrate the aspects of cell culture.
- To illustrate the molecular aspects and biomaterials for tissue engineering.
- To analyze the case study and regulatory issues in tissue engineering.

UNIT I INTRODUCTION 9

Basic definition, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing.

UNIT II CELL CULTURE 9

Different cell types, progenitor cells and cell differentiations, different kind of matrix, cell-cell interaction. Aspects of cell Culture: cell expansion, cell transfer, cell storage and cell characterization, Bioreactors.

UNIT III MOLECULAR BIOLOGY ASPECTS 9

Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, and Cell surface markers.

UNIT IV SCAFFOLD AND TRANSPLANT 9

Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology stems cells: introduction, hepatopoiesis.

UNIT-V CASE STUDY AND REGULATORY ISSUES 9

Case study of multiple approaches: cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering.

TEXT BOOK:

1. Robat Lanza and Robert Langer, **"Principles of Tissue Engineering"**, Elsevier, 2007.

REFERENCES:

1. Bernhard O. Palsson, Sangeeta N. Bhatia, **"Tissue Engineering"**, Pearson Publishers2009.
2. Ed. Joseph D. Bronzino, **"The Biomedical Engineering Hand Book"**, Second Edition, CRC Press LLC,200

COURSE OUTCOMES (COs)	
CO1	To Infer the structure and organization of tissues.
CO2	To List the different cell types and aspects of cell culture.
CO3	To Analyze the molecular aspects in tissue engineering
CO4	To List the types of biomaterials used for development of tissue
CO5	To Interpret the different case studies of physiological modeling
CO6	To Design biocompatible materials for organ transplant

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	2		2	3		2	1		2	1		2	
	CO2			2			1			1					
	CO3	2	1		3				2		2				
	CO4			3	1	3	2	3		2					
	CO5	3	2						2		3	3	2		
	CO6	3	2		2	3		2	1		2	1			
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM041	**NEURAL NETWORKS AND PATTERN RECOGNITION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course –Digital and Medical Image Processing				
	Course Coordinator Name & Department:- Ms.Vinodhini R. & Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- This course makes the students to understand the neurological systems and some simple neural networks.
- To understand the types of neural networks and its applications.
- To provide the knowledge about pattern recognition and classification

UNIT I INTRODUCTION AND SIMPLE NEURAL NET 9

Elementary neurophysiology and biological neural network-Artificial neural network – Architecture, biases and thresholds, Hebb net, Perceptron, Adaline and Madaline.

UNIT II BACK PROPOGATION AND ASSOCIATIVE MEMORY 9

Back propogation network, generalized delta rule, Bidirectional Associative memory, Hopefield network

UNIT III NEURAL NETWORKS BASED ON COMPETITION 9

Kohonen Self organising map, Learning Vector Quantisation, counter propogation network.

UNIT IV UNSUPERVISED LEARNING AND CLUSTERING ANALYSIS 9

Patterns and features, training and learning in pattern recognition, discriminant functions, different types of pattern recognition. Unsupervised learning- hierarchical clustering, partitional clustering. Neural pattern recognition approach – perceptron model 58

UNIT V SUPERVISED LEARNING USING PARAMETRIC AND NON PARAMETRIC APPROACH 9

Bayesian classifier, non parametric density estimation, histograms, kernels, window estimators, k-nearest neighbour classifier, estimation of error rates.

TEXT BOOKS

1. Hagan, Demuth and Beale, "Neural network design", Vikas Publishing House Pvt. Ltd., New Delhi , 2002
2. Freeman J.A., and Skapura B.M, " Neural networks, algorithms, applications and programming techniques", Addison – Wesley,2003
3. Duda R.O, Hart P.G, "Pattern classification and scene analysis", Wiley Edition,2000
4. Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall of India Pvt. Ltd., New Delhi, 1999.

REFERENCES:

1. Robert Schalkoff, " Pattern recognition, Statistical, Structural and neural approaches" John Wiley and Sons(Asia) Pte. Ltd., Singapore, 2005
2. LaureneFausett ," Fundamentals of neural networks – Architectures, algorithms and applications", Prentice Hall, 1994.

COURSE OUTCOMES (COs)	
CO1	To Outline the fundamentals of neurophysiology
CO2	To List the various artificial neural network
CO3	To Infer about the Self organizing maps and competitive networks
CO4	To Recall the fundamentals of pattern recognition
CO5	To Classify the different supervised learning algorithm
CO6	To Differentiate unrecognized and recognized data

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3					1					2		3	
	CO2	3	2		2					3			2		
	CO3	3		2		2	2		2				2		

	CO4	3	1	2		1		1			2		2		
	CO5	1				2	1	2					2		
	CO6	3					1					2			
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM042	REHABILITATION ENGINEERING	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course –Biomaterials and artificial organs				
	Course Coordinator Name & Department:- Ms.Geetha S. & Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To understand the rehabilitation concepts.
- To understand the Engineering Concepts of Sensory & Motor rehabilitation.
- To study different types of Therapeutic Exercise Techniques.
- To Understand the different types Hearing aids, visual aids and their application in biomedical field.
- To study the various orthotic devices and prosthetic devices to overcome orthopedic problems.

UNIT-I INTRODUCTION TO REHABILITATION 9

What is Rehabilitation, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Rehabilitation team Classification of members, The Role of Psychiatrist, Occupational therapist, Physical therapist, Recreation therapist, Prosthetist - Orthotist, Speech pathologist, Rehabilitation nurse, Social worker, Corrective therapist, Psychologist, Music therapist, Dance therapist & Biomedical engineer.

UNIT-II PRINCIPLES OF REHABILITATION 9

Introduction, The Human Component, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering-Key Engineering Principles, Key Ergonomic Principles -Practice of Rehabilitation and Assistive Technology.

UNIT III THERAPEUTIC EXERCISE TECHNIQUE 9

Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercise-Strength training, Types of Contraction, Mobilization exercises, Endurance exercises.

UNIT IV MANAGEMENT OF COMMUNICATION 9

Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids.

UNIT V ORTHOTIC, PROSTHETIC DEVICES & RESTORATION TECHNIQUES 9

General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Calipers-FO, AFO, KAFO, HKAFO. Prosthetic devices: Hand and arm replacement, Body powered prosthetics; Myoelectric controlled prosthetics and Externally

powered limb prosthetics. Functional Electrical Stimulation systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems(HAS).

TEXT BOOKS:

1. Sunder, "Textbook of Rehabilitation", Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007
2. Joseph D.Bronzino, "The Biomedical Engineering Handbook", Third Edition-3 volume set, Taylor & Francis,2006.

REFERENCES:

1. Horia-NocholaiTeodorecu, L.C.Jain, "Intelligent systems and technologies in rehabilitation Engineering", CRC; December2000.
2. Keswick. J., "What is Rehabilitation Engineering, Annual Reviews of Rehabilitation", Springer-Verlag, New York, 1982.
3. Warren E. Finn,Peter G. LoPresti, "Handbook of Neuroprosthetic Methods", CRC; Edition2002.
4. Rory A Cooper (Editor), HisaichiOhnabe (Editor), Douglas A. Hobson (Editor), "An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering", CRC Press,2006.

COURSE OUTCOMES (COs)	
CO1	To Outline the rehabilitation concepts.
CO2	To Label the principles of rehabilitation.
CO3	To Compare the types of therapeutic exercise techniques.
CO4	To Extend the knowledge in different communication management
CO5	To Outline the various orthotic devices and prosthetic devices to overcome orthopedic problems.
CO6	To design orthopedic devices

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	3		2	3	3	2			2	1		2	
	CO2			2					2	2			1		
	CO3	2			3		3			3	2				
	CO4		2			3		3	2			2			
	CO5	3					3			3	3	3	2		
	CO6	3	3		2	3	3	2			2	1			
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM043	**BRAIN CONTROL INTERFACE**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course –Biosensors and Measurements				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To know the techniques used for visualizing various sections of the body.
- To learn the principles of different radio diagnostic equipment in Imaging
- To discuss the radiation therapy techniques and radiation safety

UNIT-I INTRODUCTION TO BRAIN CONTROL INTERFACE FUNDAMENTALS OF BCI 9

Structure of BCI system – Classification of BCI: Invasive, Non-invasive and Partially invasive BCI Brain signal acquisition, Signal Preprocessing, Artifacts removal .

UNIT-II ELECTROPHYSIOLOGICAL SOURCES SENSORIMOTOR ACTIVITY 9

Neuronal activity in motor cortex and related areas- Electric and magnetic fields produced by the brain- signals reflecting brain metabolic activity- Mu rhythm, Movement Related Potentials – Slow Cortical Potentials - P300 Event related potential - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms

UNIT-III FEATURE EXTRACTION METHODS TIME/SPACE METHODS 9

Fourier Transform, Wavelets, AR, MA, ARMA models, Bandpass filtering, Template matching, Kalman filter, PCA, Laplacian filter – Linear and Non-Linear Features

UNIT-IV FEATURE TRANSLATION METHODS LINEAR DISCRIMINANT ANALYSIS 9

Nearest neighbours, Support Vector Machines - Regression – Learning Vector Quantization – Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks

UNIT-V APPLICATIONS OF BCI 9

Dataset I, II, III, IV and V, Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device controllers.

TEXT BOOKS

1. Jonathan Wolpaw,Elizabeth Winter Wolpaw,'Brain Computer Interfaces: Principles and practice", Edition 1, Oxford University Press, USA, January 2012.

REFERENCE BOOKS

1. Special Issue on Brain Control Interfaces, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 14, June 2006.
2. R. Spehlmann, "EEG Primer", Elsevier Biomedical Press, 1981.
3. Bernhard Graimann, Brendan Allison, GertPfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010
4. Ali Bashashati, MehrdadFatourechi, Rabab K Ward, Gary E Birch," A survey of signal Processing algorithms in brain–computer interfaces based on electrical brain signals" JOURNAL OF NEURAL ENGINEERING, VOL.4, 2007, PP.32-57

COURSE OUTCOMES (COs)	
CO1	To Outline the fundamentals of brain control interface
CO2	To Interpret the different measuring parameters of EEG
CO3	To Recall the various feature extraction methods
CO4	To Infer about the feature translational methods
CO5	To Extend about the BCI applications
CO6	To Explains about functional datasets

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			2	3		2	3		2			3	

	CO2			2			2			3					
	CO3	2	3		3				2		2				
	CO4					3	1	3		2		2	2		
	CO5	3	1		2				1		3	3	2		
	CO6	3			2	3		2	3		2				
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM051	BIOPROCESS TECHNOLOGY	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course –Biochemistry				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To introduce Bioprocess Technology and Enzyme based actions in Medical Applications
- To understand the bioreactors design
- To learn about bioprocess estimation

UNIT I INTRODUCTION OF BIOPROCESS TECHNOLOGY 9

Introduction to bioprocess technology, Screening, preservation and improvement of industrially important microorganisms, Raw material and media formulation for fermentation process, Influence of environmental factors on growth and product formation.

UNIT II BIOREACTORS 9

Bioreactor design.Batch, fed batch and continuous cultivation.Solid state cultivation.Sterilization of media reactor and air.Agitation and aeration and mass transfer of oxygen.Inoculum development, addition and sampling.

UNIT III GROWTH RATE ANALYSIS 9

Growth rate parameters : Specific growth rate, doubling time, validity of exponential growth law, growth yield, metabolic quotient, Effect of substrate concentration, Monod Kinetics, Determination of Ks, Definition of lag period.

UNIT IV ENZYME TECHNOLOGY 9

Kinetics and thermodynamics of enzyme-catalyzed reactions, techniques of enzyme immobilisation, basic design and configuration of immobilised enzyme reactors, applications of immobilised enzyme technology.

UNIT V BIOPROCESS ESTIMATIONS 9

Methods of on-line and off-line biomass estimation; Flow injection analysis for measurement of substrates.Product and other metabolites; State and parameter estimation techniques for biochemical processes; Computer-based data acquisition, monitoring and control-LABVIEW Software.

TEXT BOOK

1. Principles of Fermentation Technology : Whitekar&Stanbury
2. Industrial Microbiology – Casida.

REFERENCE BOOKS

1. Shule and Kargi, " Bioprocess Engineering ", Prentice Hall, 1992.
http://www.slideshare.net/yongkangbirdnest/lecture-5-bioprocess-technology-operation-mode-and-scale

COURSE OUTCOMES (COs)	
CO1	To Recall the basic principle of bioprocess
CO2	To Demonstrate the Bioreactor design, Batch, fed batch and continuous cultivation
CO3	To Extend the knowledge in growth rate parameters
CO4	To Outline the fundamentals of enzyme technology
CO5	To Recall about Methods of biomass estimation
CO6	Recalls configuration of immobilization enzyme reactors

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			2	3		2	1		2			2	
	CO2			2			1			1		2	1		
	CO3		1		3				2		2				
	CO4			3		3		3				3			
	CO5	3	2						2		3	3			
	CO6	3			2	3		2	1		2				
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM052	**VLSI DESIGN**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course –Analog and Digital IC's				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To introduce NMOS, PMOS, CMOS devices and their characteristics
- To design principles, design layout rules, construction of multiplexers
- To gain the knowledge in Verilog HDL

UNIT I : MOS TRANSISTOR THEORY AND PROCESS TECHNOLOGY 9

NMOS and PMOS transistors - Threshold voltage - Body effect - Design equations - Second order effects -MOS models and small signal AC characteristics - Basic CMOS technology.

UNIT II: INVERTERS AND LOGIC GATES 9

NMOS and CMOS Inverters - Stick diagram - Inverter ratio - DC and transient characteristics –switching times - Super buffers - Driving large capacitance loads - CMOS logic structures - Transmission gates -Static CMOS design - Dynamic CMOS design.

UNIT III: CIRCUIT CHARACTERISATION AND PERFORMANCE ESTIMATION 9

Resistance estimation - Capacitance estimation - Inductance - Switching characteristics – Transistor sizing- Power dissipation and design margining - Charge sharing - Scaling.

UNIT IV: VLSI SYSTEM COMPONENTS CIRCUITS **9**

Multiplexers - Decoders - comparators - Priority encoders - Shift registers - Arithmetic circuits -Ripple carry adders - Carry look ahead adders - High-speed adders - Multipliers- Physical design -Delay modelling -Cross talk - Floor planning - Power distribution - Clock distribution - Basics of CMOS testing.

UNIT V: VERILOG HARDWARE DESCRIPTION LANGUAGE **9**

Overview of digital design with Verilog HDL - Hierarchical modeling concepts - Modules and port definitions- Gate level modeling - Data flow modeling – Behavioralmodeling - Task & functions -Test Bench.

TEXT BOOK

1. Subbaram N.R. " Handbook of Indian Patent Law and Practice ", S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1998.

REFERENCES

1. Eli Whitney, United States Patent Number : 72X, Cotton Gin, March 14, 1794.
2. Intellectual Property Today : Volume 8, No. 5, May 2001, [www.iptoday.com].
3. https://www.wto.org/english/tratop_e/trips_e/intel1_e.html

COURSE OUTCOMES (COs)	
CO1	To Understand the characteristics of different metal oxide semiconductor
CO2	To Interpret the knowledge in working principle of inverters and logic gates
CO3	To Understand the performance characteristics of transistor
CO4	To Relate the different circuits used in VLSI system
CO5	To Understand the VHDL model for combinational networks
CO6	To recall Hierarchical modeling concepts

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3			2	3	2	2	3		2				3
	CO2		3	2						3		3			
	CO3	2			3		3		2		2		2		
	CO4		2			3		3		3		3			
	CO5	3		1							3	3			
	CO6	3			2	3	2	2	3		2				
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM053	**VIRTUAL INSTRUMENTATION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course –Digital and Medical Image Processing				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To introduce Historical perspectives, advantages, block diagram and architecture of a virtual instrument, data flow techniques.
- To study CAN bus characteristics. Bus interface for R8422 and RS485.

- To study Principles of PAL's PLD's GAL's CPLD and their design considerations.
- To study Principles and design considerations of specific PROM, EPROM, SRAM, SDRAM. Dual ported memories, FIFO's flash memories
- To study Multiphase clock generators, LCD display controller.

UNIT-1: REVIEW OF VIRTUAL INSTRUMENTATION 9

Historical perspectives, advantages, block diagram and architecture of a virtual instrument, data flow techniques. Graphical programming in data flow, comparison with conventional programming.

UNIT-2 : VIRTUAL INSTRUMENTATION PROGRAMMING TECHNIQUES 9

VIS and subVIS loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O.

UNIT-3: DATA ACQUISITION BASICS 9

ADC, DAC, DIO, counters and timers. PC hardware structure, timing, interrupts, DMA, software and hardware installation.

UNIT-4: COMMON INSTRUMENT INTERFACES 9

Current loop, RS232C/RS485, GPIB, system buses, interface buses: USB, PCMCIA, VXI, SCXI, PXI etc., networking basics for office and industrial applications, visa and IVI, image acquisition and processing, motion control.

UNIT-5: USE OF ANALYSIS TOOLS 9

Fourier transforms, power spectrum correlation methods, windowing uttering, VI application in various fields.

TEXTBOOKS

1. Anand M M S, Electronic Instruments and Instrumentation Technology, PHI Publishers, 2007.
2. Stephen Bennett, Emagic Logic Virtual Instruments, PC Publishing, 2003.

REFERENCES:

1. http://ocw.njit.edu/csla/opse/opse-310/index.php

COURSE OUTCOMES (COs)	
CO1	To Understand the review of virtual instrumentation
CO2	To Outline the programming techniques for virtual instrumentation
CO3	To Infer the basics of data acquisition
CO4	To List the various interfaces and its applications
CO5	To Relate the analysis tools and its use
CO6	To Recall programming techniques

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3	2		2	3		2			2	1			2
	CO2			2			2		3	3			1		
	CO3	2	3		3	1					2				
	CO4			2	3	3	1	3	2	2		2			
	CO5	3	1	2				3	1		3	3	2		

	CO6	3	2		2	3		2			2	1			
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM061	BIOLOGICAL EFFECTS OF RADIATION	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course –Radiological Equipments				
	Course Coordinator Name & Department:- Dr.Vasuki R & Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To learn about the effects of Radiation in living cells
- To know about the Genetic effects of Radiation
- To study about Microwave, RF and UV radiation
- To acquire knowledge about Ionising and Non- ionising Radiation

UNIT – I ACTION OF RADIATION IN LIVING CELLS 9

Various theories related to radiation at cellular level. DNA and chromosomal damages.

UNIT – II SOMATIC APPLICATION OF RADIATION 9

Radio sensitivity protocols of different tissues of human. LD50/30 effective radiation on skin, Bone marrow, eye, endocrine glands, and basis of radio therapy.

UNIT – III GENETIC EFFECTS OF RADIATION 9

Threshold and linear dose, gene control hereditary diseases effect of dose.

UNIT – IV EFFECT OF MICROWAVE AND RF WITH MATTERS 9

Effects of various human organs and systems, Wavelength in tissue, non thermal interaction Standards of protection, national, and international standards and precautions.

UNIT – V UV RADIATION 9

Classification of sources, measurement, photo medicine, UV radiation, safety visible and infrared Radiation.

TEXTBOOK

1. Paul Fryer, Duncan Ward, Radiation, White Cube Publishers (2008).

REFERENCE

1. SteveForshier, Essential of Radiation Biology and Protection, Delmar Publishers (2008).
2.

COURSE OUTCOMES (COs)	
CO1	To Understand the Theories related to Radiation in the living cell.
CO2	To Recall the Somatic application of Radiation.
CO3	To Understand the Genetic effects of Radiation
CO4	To Infer the effect of Microwave and RF with human organs
CO5	To Outline the sources of UV radiation and methods to protect from this Radiation
CO6	To learn International Standards and Precautions

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low															
1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3		2			3		1		2	2		2	
	CO2		3		2	3		3		3		2			
	CO3	2				3	3		2		3		1		
	CO4			2	3	2	3					2			
	CO5					1	2	2		3	2	3			
	CO6	3		2			3		1		2	2			
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM062	**BIOMEDICAL LASER INSTRUMENTATION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course –Semiconductor Physics				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To understand the fundamentals optical properties of of laser,
- To know the operations of laser and types of laser.
- To gain the knowledge of applications in medical field.

UNIT I - OPTICAL PROPERTIES OF TISSUES **9**

Scattering- Absorption- Refractive Index - Light transport inside the tissue - Interaction of light with matter - quantum behavior of light - Light interaction with tissues - Optothermal interaction – Fluorescence Speckles

UNIT II - BASIC THEORY OF LASER **9**

LASER action : stimulated & spontaneous emission- Molecular energy level - characteristics of laser- population inversion - Pumping methods and levels of pumping- Optical cavity configurations –Amplification - Optical resonator and gain - Q-switching - Mode locking- LASER modes - Line broadening

UNIT III - TYPES OF LASER **9**

Solid state, Ruby, Nd:YAG, Tunable solid state, Alexandrite, Titanium-sapphire Gas lasers: Helium-Neon, Argon, Co2 - Tunable dye – Semiconductor

UNIT IV - HOLOGRAPHY AND ITS MEDICAL APPLICATIONS **9**

Holography – Basic principle- methods of Holographic interferometry – applications - Holography for non-destructive testing –applications of LASER holography in medicine: Dentistry, Ophthalmology, Otology, Orthopedics.

UNIT V - MEDICAL APPLICATIONS OF LASER **9**

Photo-chemical interaction- Thermal interaction- Photoablation - Plasma induced ablation – photo-disruption- Applications: Ophthalmology, Dentistry, Urology, Neurosurgery, Dermatology, Orthopedics, Angioplasty, Cardiology, and Surgery- Diffused optical tomography.

TEXTBOOKS

1. Thyagarajan K, Ajoy K, Ghatak A, "Lasers Fundamentals and Applications", Second edition, Springer 2010.
2. Markolf H. Niemz, "Laser-Tissue Interactions: Fundamentals and Applications", Third edition, Springer 2007.

TEXT BOOKS

1. Keiser, "Optical Fiber Communication Systems", McGraw Hill Ltd., Thirdedition, 1983.

REFERENCES

1. John E, Harry, "Industrial lasers and their applications", Second edition,McGraw Hill, 1974.
2. John F Ready, "Industrial applications of lasers", Second edition, AcademicPress, 1978

COURSE OUTCOMES (COs)	
CO1	To Understand the concept of optical properties of tissue
CO2	To Illustrate the laser action and the characteristics of laser
CO3	To List applications of lasers in medical field
CO4	To Outline the holography and its applications
CO5	To Relate the applications of laser in medical field
CO6	To study holography applications in medicine field

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3				3	3	1				1			3
	CO2		2		2					3			3		
	CO3	2				3	2		2		3	2			
	CO4			2	3					1		1			
	CO5					3		2					2		
	CO6	3				3	3	1				1			
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													

U18PEBM063	**BIOPHOTONICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course –Medical Physics				
	Course Designed by:- Department of Biomedical Engineering				

COURSE OBJECTIVES:-

- To impart adequate knowledge on various optical systems used in sensing and Imaging of biological elements.
- To know the principle of bio imaging
- To understand the various optical biosensors

UNIT I - LIGHT - MATTER INTERACTION & PRINCIPLE OF OPTICS 9

Light matter interaction: Interaction of light with bulk matter- Types of spectroscopy: Electronic absorption-, Electronic luminescence-, Vibration-, and Fluorescence-spectroscopy.

UNIT II - BIO-IMAGING: PRINCIPLES AND TECHNIQUES **9**

Introduction of optical imaging, Types of microscopy: Transmission-, Fluorescence-, Scanning- and Multi-photon- microscopy- Advantages and disadvantages of optical imaging- Applications of optical imaging

UNIT III - OPTICAL BIOSENSORS **9**

Principles of Optical biosensing, Immobilization of bio-recognition elements, Types of optical biosensor: Fiber optic-, Planar waveguide-, Evanescent-, Interferometric-, and Surface plasmon resonance- biosensor- Advantages and disadvantages- Applications

UNIT IV - FLOW CYTOMETRY **9**

Flow cytometry: Basis, Components, and Flourochromes- Data manipulation and presentation

UNIT V - PHOTODYNAMIC THERAPY **9**

Photodynamic therapy: Mechanism, and light irradiation- Photo-hemotheraphy- PUVA Technique- Applications.

TEXTBOOKS

1. Jurgen Popp, Valery V, Techin, Arthur Chiou, Stefen Heinemann, "Handbook of BiophotonicsVol 2: Photonics for Health Care", John Wiley & Sons, FirstEdition, 2012.
2. Paras N, Prasad, "Introduction to Biophotonics", John Wiley & Sons, First Edition, 2003.

REFERENCES

1. Harold Sackman, Brian Wilson, ValeriViktorovichTuchin, S. Tanev,HaroldSackman "Advances in Biophotonics", IOS Press, 2005.
2. Paras N Prasad, "Nanophotonics", John Wiley & Sons, First Edition, 2004

COURSE OUTCOMES (COs)	
CO1	To Understand the various interaction mechanisms of light with matter.
CO2	To Infer the working principles of optical imaging systems.
CO3	To List the various sensors used in biosensors
CO4	To Understand the basic concepts of cytometer
CO5	To Outline the importance of phototherapy in treatment of diseases
CO6	To study about applications of optical biosensors

Mapping of Course Outcomes with Program outcomes (POs) (1/2/3 indicates strength of correlation) 3-High, 2-Medium, 1-Low

1	COs/POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PS02**
2	CO1	3					3					2			2
	CO2		3		2			3		3			2		
	CO3	2				2			2		3		2		
	CO4			2	3	3				2		3			
	CO5							2	3			3			
	CO6	3					3					2			
3	Category	Professional Course (PC)													
4	Approval	49th Meeting of the Academic Council													