BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH

DEPARTMENT OF BIOMEDICAL ENGINEERING

CURRICULUM AND SYLLABUS

(R2018)

CHOICE BASED CREDIT SYSTEM

(Applicable to the batches admitted from July 2018)

M.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 regional 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.

PROGRAMME OUTCOMES (POs)

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

PO1: Engineering Knowledge: Apply the knowledge of science and engineering to solve complex health related problems.

PO2: Problem Analysis: Analyze the data in various domains and learn the features for possible predictions in health condition.

PO3: Design/Development of Solutions: Design and develop healthcare-instruments using modern and innovative engineering technologies.

PO4: 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.

PO5: Modern Tool Usage: Use the techniques, skills, and modern engineering tools necessary for biomedical engineering practice.

PO6: 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.

PO7: Environment and Sustainability: Developing professional competency in healthcare sector and leadership qualities with a harmonious blend of ethics leading to an integrated personality development

PO8: Ethics: Evaluate the impact of their work on society, including ethical, economic, global and environmental aspects.

PO9: Individual and Team Work: Function effectively as an individual, and as a member or work in multidisciplinary team.

PO10: Communication: Communicate effectively orally and in writing scientific concepts and ideas.

PO11: Life-long Learning: Have life-long learning skills and are able to apply their engineering knowledge to critically evaluate relevant literature and new technologies or systems.

PO12: Project Management and Finance: Practice intellectual integrity, ethical research, and become capable of fabricating functional prototypes leading to patenting and technology transfer 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: Work in research field by applying skills and knowledge towards the advancement of health care technology

PSO 2: Work with health care professional and to develop medical equipment's in order to solve the clinical problems.

M.Tech – BIOMEDICAL ENGINEERING

(FULL TIME)

I – IV SEMESTERS

SEMESTER I								
Sl. No.	**Course Code**	**Category**	**Course Title**	**Contact Period**	**L**	**T**	**P**	**C**
THEORY								
1	P18PCBM101	PC	Anatomy and Physiology	3	3	0	0	3
2	P18PCBM102	PC	Advance In Biomedical Instrumentation	3	3	0	0	3
3		PE	Professional Elective I	3	3	0	0	3
4		PE	Professional Elective II	3	3	0	0	3
5	P18PRBM101	PR	Bio-Research Methodology and IPR	2	2	0	0	2
6		AC	Audit Course I	2	2	0	0	0
PRACTICAL								
7	P18PCBM1L1	PC	Bio medical Instrumentation lab	4	0	0	4	2
8	P18PCBM1L2	PC	Anatomy And Physiology Lab	4	0	0	4	2
Total				**24**	**16**	**0**	**8**	**18**

SEMESTER II								
Sl. No.	**Course Code**	**Category**	**Course Title**	**Contact Period**	**L**	**T**	**P**	**C**
THEORY								
1	P18PCBM201	PC	Medical Image Analysis	3	3	0	0	3
2	P18PCBM202	PC	Biomedical Signal Analysis	3	3	0	0	3
3		PE	Professional Elective III	3	3	0	0	3
4		PE	Professional Elective IV	3	3	0	0	3
5		AC	Audit II	2	2	0	0	0
PRACTICAL								
6	P18PCBM2L1	PC	Medical Image analysis lab	4	0	0	4	2
7	P18PCBM2L2	PC	Biomedical signal Analysis	4	0	0	4	2
8	P18PRBM2P1	PR	Mini Project with Seminar	4	0	0	4	2
			Total	**26**	**14**	**0**	**12**	**18**

SEMESTER III								
Sl. No.	**Course Code**	**Category**	**Course Title**	**Contact Period**	**L**	**T**	**P**	**C**
THEORY								
1		PE	Professional Elective - V	3	3	0	0	3
2		OE	Open Elective	3	3	0	0	3
PRACTICAL								
3	P18PRBM3P2	PR	Dissertation- Phase – I	20	0	0	20	10
			Total	**26**	**6**	**0**	**20**	**16**

SEMESTER IV								
Sl. No.	**Course Code**	**Category**	**Course Title**	**Contact Period**	**L**	**T**	**P**	**C**
1	P18PRBM4P3	PR	Dissertation- Phase-II	32	0	0	32	16
			Total	**32**	**0**	**0**	**32**	**16**

TOTAL CREDITS FOR THE PROGRAM = 68

LIST OF ELECTIVES

PROFESSIONAL ELECTIVE

S.No.		SUBJECT NAME	L	T	P	C
PROFESSIONAL ELECTIVE (PE) - I						
1	P18PEBM011	Advanced Biosensor And Transducers	3	0	0	3
2	P18PEBM012	Advance Mathematics For Biomedical Engineering	3	0	0	3
3	P18PEBM013	Computer Based Medical Instrumentation.	3	0	0	3
PROFESSIONAL ELECTIVE (PE) –II						
1	P18PEBM021	Tissue Engineering	3	0	0	3
2	P18PEBM022	Biomaterials And Implantable Devices	3	0	0	3
3	P18PEBM023	Physiological Modeling	3	0	0	3
PROFESSIONAL ELECTIVE (PE) - III						
1	P18PEBM031	Bio MEMS	3	0	0	3
2	P18PEBM032	Health Hospital And Equipment Management	3	0	0	3
3	P18PEBM033	Tele Health Technology	3	0	0	3
PROFESSIONAL ELECTIVE (PE) - IV						
1	P18PEBM041	Advanced Neural Computing.	3	0	0	3
2	P18PEBM042	Nuclear Medicine	3	0	0	3
3	P18PEBM043	Brain Control Interfaces.	3	0	0	3
PROFESSIONAL ELECTIVE (PE) – V						
1	P18PEBM051	Principles Of Genetic Analysis	3	0	0	3
2	P18PEBM052	Human Assist Devices	3	0	0	3
3	P18PEBM053	Advances In Electronics Applied To Hospital Engineering	3	0	0	3

OPEN ELECTIVE

S.No	Code No.	Course Title	L	T	P	C
1	P18OECS001	Business Analytics	3	0	0	3
2	P18OEMA002	Operations Research	3	0	0	3
3	P18OEME003	Industrial Safety	-	-	-	-
4	P18OEBA004	Cost Management Of Engineering Projects	3	0	0	3
5	P18OEME005	Composite Materials	3	0	0	3
6	P18OEEE006	Waste To Energy	3	0	0	3
7	P18OECE007	Environmental Health Engineering	3	0	0	3
8	P18OEBT008	Bio Entrepreneurship Development	3	0	0	3
9	P18OEBM009	Rehabilitation Engineering.	3	0	0	3
10	P18OEBM010	Bio Mechanics	3	0	0	3

AUDIT COURSES I &II

Sl.No.	Code No.	Course Title	Contact Periods	L	T	P	C
1	P18ACEN001	English for Research Paper Writing	2	2	0	0	0
2	P18ACCE002	Disaster Management	2	2	0	0	0
3	P18ACEN003	Sanskrit for Technical Knowledge	2	2	0	0	0
4	P18ACBA004	Value Education	2	2	0	0	0
5	P18ACLW005	Constitution of India	2	2	0	0	0
6	P18ACBA006	Pedagogy Studies	2	2	0	0	0
7	P18ACYO007	Stress Management by Yoga	2	2	0	0	0
8	P18ACBA008	Personality Development through Life Enlightenment Skills	2	2	0	0	0

Grand Total credits and contact hours

SEMESTER	I	II	III	IV	TOTAL
TOTAL CONTACT HOURS	24	26	26	32	**108**
CREDITS	18	18	16	16	**68**

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		
1.	Professional Core (PC)	10	10			20	29.41
2.	Professional Electives(PE)	6	6	3		15	22.06
3.	Open Electives (OE)			3		3	4.41
4.	Project Work, Soft Skill etc. (PR)	2	2	10	16	30	44.11
	Total Credit	18	18	16	16	**68**	
	Total Contact Hour	24	26	26	32	**108**	100

P18PCBM101	ANATOMY AND PHYSIOLOGY	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Biology (+2 level)				
	Course Coordinator Name & Department:-Dr.Emerson Solomon F. & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To understand basics of Human Anatomy and Physiology.
- To study the organs and systems involved in body functions.
- To apply the knowledge gained about the organ functions, reflexes, and special senses into biomedical engineering field.

COURSE OUTCOMES (COs)

CO1	Learn the basic terminologies, structural and functional elements of human body
CO2	Learn the physiological aspects of respiratory and cardiac system
CO3	Learn the structure and function of nervous tissue, visual and auditory pathways
CO4	The process of temperature regulation; understand the process of GI reflex
CO5	Attain a good knowledge on the role of hormones and functions of Endocrine gland
CO6	Learn the anatomical features of organs to construct medical instruments.

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	PSO2
2	CO1	2	3	1	3	2	2	2	2						1
	CO2	2	3	1	3	2	2	2	2						
	CO3	2	3	1	3	2	2	2	2						
	CO4	2	3	1	3	2	2	2	2						
	CO5	2	3	1	3	2	2	2	2						
	CO6	2	3	1	3	2	2	2	2						

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
					✓					

4	Approval	47th Meeting of Academic Council, Aug 2018

UNIT I CELL PHYSIOLOGY

9

Cell structure, Cell membrane Transport, Resting membrane potential and ionic basis of potentials, Recording of Action potentials, patch clamp, Action potential in nerve, Muscle and Heart.

UNIT II GASTROINTESTINALAND RESPIRATORY SYSTEM

9

Structure of gastrointestinal system, layers in Gastro-intestinal System (deglutition, Peristalsis) movement in stomach, small intestine and movements in GI tract and factors regulating the movement. Respiratory pathway, volumes capacities and measurement, respiratory centers and its regulation of respiration, Artificial Respiration

UNIT III ENDOCRINE AND NEURAL REFLEXES

9

Mention of Endocrine glands general hormonal action, Second messengers, anterior and posterior pituitary hormones. Components in a Simple reflex. Structure of kidney and micturition reflex, Cystometerogram.

UNIT IV CARDIOVASCULAR AND SPECIAL SENSES 9

Structure of Heart, conducting pathway and ECG, BP and its measurements. Structure of Eye and Ear, errors of refraction, photochemistry of vision and visual pathway, Middle Ear mechanics, organ of Corti and Auditory pathway, Audiometers**.**

UNIT V NERVOUS SYSTEM

9

Neuron, properties of Synapse, Cross section of spinal cord, ascending and descending tracts, EEG, Automatic nervous system, body temperature regulation. Cortical functions.

REFERENCES

1. Guyton 'Text book of Medical Physiology – WB Jaunder company Philadelphia - 10 edition 2002
2. Cyrul A Keele and Eric Neil – Samsons Wrights Applied physiology – Oxford University press New Delhi – 1991
3. Ranganathan T S,Text Book of human Anatomy S. Chand and company New Delhi – 1994
4. Best and Taylor, The livery Body – BC publication New Delhi 1980

P18PCBM102	**ADVANCE IN BIOMEDICAL INSTRUMENTATION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3

		Prerequisite course – Basic Instrumentations
		Course Coordinator Name & Department:-Mr.Prasath S. & 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

COURSE OUTCOMES (COs)

CO1		Explain about measurements of parameters related to respiratory system
CO2		Describe the measurement techniques of sensory responses
CO3		Analyze different types and uses of diathermy units
CO4		Discuss ultrasound imaging techniques and its usefulness in diagnosis
CO5		Outline the importance of patient safety against electrical hazard
CO6		The application of patient monitoring 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	PSO2
2	CO1	3	3			2			2	2		2			3
	CO2	3	3	3	3	3			3	3	3	3			
	CO3	3	3	2	2	2			2		2				
	CO4	3	3		3	3				3		3			
	CO5	3	3			2			2	2					
	CO6	3	3			2			2	2					

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
					✓					

4	Approval		47th Meeting of Academic Council, Aug 2018

UNIT I - ELECTRO PHYSIOLOGICAL MEASUREMENTS **9**

Electrodes –Limb electrodes –floating electrodes – pre-gelled disposable electrodes – Micro-, needle- electrodes – Amplifiers – Differential amplifiers, Instrumentation amplifier, Chopper amplifiers – Isolation amplifier. ECG, EEG, EMG - Lead systems and recording methods.

UNIT II - BLOOD GAS ANALYZERS AND OXIMETERS

9

Blood pH measurement- Blood pCO2 measurement- Blood pO2 measurement- intra arterial - complete blood gas analyzer – Oximetry - Principle, ear, pulse, skin reflectance, intravascular oximeter.

UNIT III- PATIENT MONITORING SYSTEMS

9

Patient monitoring system-Bedside, Central monitoring, Measurement of heart rate, pulse rate, blood pressure-Direct-, and indirect- methods, temperature, respiration rate, catheterization laboratory instrumentation

UNIT IV - EAR AND OPTHALMOLOGICAL EQUIPMENTS

9

Ear: Hearing loss, Sound conduction system, Basic audiometer - Pure tone audiometer - Audiometer system-Bekesy - Evoked response audiometer system - Hearing aids. Vision: Visual acuity - Errors in vision slit lamp, Tonometer, Ophthalmoscope, Perimeter.

UNIT V – CLINICAL LAB INSTRUMENTS

9

Introduction-medical diagnosis with chemical test – Spectrophotometer – Colorimeter - Auto analyzers - clinical flame photometer - selective ion based electrolytes - Electrical safety in medical environment - shock hazards – leakage current-safety codes-electrical safety analyzer - testing of biomedical equipments.

REFERENCES

1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 2nd Edition, Tata McGraw Hill, 2003.
2. Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer "Biomedical Instrumentation and Measurements'', Prentice Hall of India, 2011. 8
3. Joseph J. Carr and John M Brown, "Introduction to Biomedical Equipment Technology", 4 th edition, Pearson Education, 2008.
4. John G.Webster (editor), "Bioinstrumentation", John Wiley & Sons, 2004.
5. Joseph Bronzino, "Biomedical Engineering & Instrumentation", Taylor & Francis, 3rd edition, 2006.
6. Ronald Pitts Crick, Pang Khaw "Text book of clinical Ophthalmology", 2nd Edition, World Scientific publication. ISBN 981- 238-128-7.

P18PRBM101	**BIO-RESEARCH METHODOLOGY & IPR**	**L**	**T**	**P**	**C**
	Total Contact Hours –45	2	0	0	2
	Prerequisite – NIL				
	Course Designed by – Dept. of Electronics and Communication Engineering.				

OBJECTIVES

- Student will understand research problem formulation and Analyze research related information

Unit 1: RESEARCH CONCEPTS

Concepts, meaning, objectives, motivation, types of research, approaches, research (Descriptive research, Conceptual, Theoretical, Applied & Experimental).

Formulation of Research Task – Literature Review, Importance & Methods, Sources, quantificationof Cause Effect Relations, Discussions, Field Study, Critical Analysis of Generated Facts, Hypothetical proposals for future development and testing, selection of Research task.

Unit 2: DATA ANALYSIS AND INTERPRETATION

Effective literature studies approaches, analysis Plagiarism, Research ethics

Unit 3: REPORT WRITING

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: NATURE OF INTELLECTUAL PROPERTY

Patents, Designs, Trade and Copyright, Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: PATENT RIGHTS AND NEW DEVELOPMENTS IN IPR

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications, Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

REFERENCE BOOKS:

1. J.J. Grainger &W.D.Stevenson, "Power system analysis ", McGraw Hill ,2003
2. A. R. Bergen & Vijay Vittal , "Power System Analysis" ,Pearson , 2000
3. L.P. Singh , "Advanced Power System Analysis and Dynamics", New Age International, 2006
4. G.L. Kusic, "Computer aided power system analysis" ,Prentice Hall India, 1986
5. A.J. Wood, " Power generation, operation and control" , John Wiley, 1994

P18PCBM1L1	**ADVANCE BIO MEDICAL INSRUMENTATION LAB**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	0	0	4	2
	Prerequisite course – NIL				
	Course Coordinator Name & Department:- Mr.Prasath S. & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To provide practice on recording and analysis of different Bio potentials
- Study the function of different Therapeutic equipment's.

COURSE OUTCOMES (COs)

CO1	IC circuits, Op-amps, rectifiers and its applications
CO2	Safety concerns in hospitals
CO3	Use of filters in biomedical applications
CO4	Different types of read-out devices used
CO5	Use of timers and counters
CO6	The applications of amplifiers in instrumentation

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	PSO2
2	CO1	3	2	3	2	2			2	2		2			3
	CO2	2	2	3	2	3			2	3	2				
	CO3	3	2	2	3	2			3		2	3			
	CO4	3	3	2	3	2			2	3	3	2			
	CO5	2	3	3	3	3				2		3			
	CO6	2	3	3	3	3			2	2	2	2			

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
					✓					

4	Approval	47th Meeting of Academic Council, Aug 2018

LIST OF EXPERIMENTS

1. Construction and testing of Instrumentation amplifier
2. Design of Instrumentation amplifier using Single IC and Single supply
3. Patient monitoring system and Bio-telemetry.
4. Plotting of Human auditory response using audiometer.
5. Performance and testing of Surgical Diathermy unit using Diathermy analyzer.
6. Recording of Electromyogram.
7. Construction and testing of nerve stimulator.
8. Study of ECG machine.
9. Study of EEG machine.

P18PCBM1L2	ANATOMY AND PHYSIOLOGY LAB	L	T	P	C
	Total Contact Hours – 45	0	0	4	2
	Prerequisite course – NIL				
	Course Coordinator Name & Department:- Dr.Emerson Solomon F. & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To understand basics of Human Anatomy and Physiology.
- To study the organs and systems involved in body functions.
- To apply the knowledge gained about the organ functions, reflexes, and special senses into biomedical engineering field.

COURSE OUTCOMES (COs)

CO1	Learn the basic terminologies, structural and functional elements of human body
CO2	The physiological aspects of respiratory and cardiac system
CO3	Learn the structure and function of nervous tissue, visual and auditory pathways
CO4	Analyze the process of temperature regulation; understand the process of GI reflex
CO5	Attain a good knowledge on the role of hormones and functions of Endocrine gland
CO6	The features of blood in clotting and bleeding time

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	PSO2
2	CO1	3	2	3	2	2			2	2		2		1	
	CO2	2	2	3	2	3			2	3	2				
	CO3	3	2	2	3	2			3		2	3			
	CO4	3	3	2	3	2			2	3	3	2			
	CO5	2	3	3	3	3				2		3			
	CO6	2	3	3	3	3			2	2	2	2			

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
					✓					

4	Approval	47th Meeting of Academic Council, Aug 2018

LIST OF EXPERIMENTS

1. Determination of Blood group
2. Differential Count Of WBC
3. Estimation Of Haemoglobin
4. Enumeration of WBC
5. Enumeration Of RBC
6. Determination Of Erythrocytes Sedimentation Rate
7. Determination of Bleeding time &Clotting Time
8. Osmotic Fragility of RBC
9. Determination of Blood Pressure
10. Study of the effects of Exercise on Cardiovascular and Respiratory system
11. Effect of Postural change on Blood pressure and pulse rate
12. ECG -Demonstration
13. Recording of Respiratory movements using Stethography
14. Examination of the Sensory system
15. Examination of the Reflexes

P18PCBM201	**MEDICAL IMAGE ANALYSIS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Knowledge in image processing (B.Tech/B.E)				
	Course Coordinator Name & Department:-Ms.Kripa N & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To study the production of x-rays and its application to different medical Imaging techniques.
- To study the different types of Radio diagnostic techniques.
- To study the special imaging techniques used for visualizing the cross sections of the body.
- To study the imaging of soft tissues using ultrasound technique

COURSE OUTCOMES (COs)

CO1	Students will get the clear domain knowledge about the various medical Imaging techniques.
CO2	Students have various diagnostic applications of the medical imaging techniques.
CO3	Students will get the clear domain knowledge the image fundamentals and Image transforms
CO4	Study the image enhancement techniques
CO5	Study the image restoration procedures and image compression procedures.

CO6		Study the image visualizations													
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	PSO2
2	CO1	3		2	3				3			2		2	
	CO2						2								
	CO3	2			2						2				
	CO4			1											
	CO5				3				3						
	CO6	3		2	3				3			2			
3	Category	Humanities & Social Studies (HS)		Basic Sciences (BS)	Engg Sciences (ES)		Professional Core (PC)	Core Elective (CE)		Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)		
							✓								
4	Approval		47th Meeting of Academic Council, Aug 2018												

UNIT I IMAGE FUNDAMENTALS 9

Image perception, MTF of the visual system, Image fidelity criteria, Image model, Image sampling and quantization – two dimensional sampling theory, Image quantization, Optimum mean square quantizer, Image transforms – 2D-DFT and other transforms.

UNIT II IMAGE PREPROCESSING 9

Image enhancement – point operation, Histogram modeling, spatial operations, Transform operations, Image restoration – Image degradation model, Inverse and Weiner filtering. Image Compression – Spatial and Transform methods

UNIT III MEDICAL IMAGE RECONSTRUCTION 9

Mathematical preliminaries and basic reconstruction methods, Image reconstruction in CT scanners, MRI, fMRI, Ultra sound imaging., 3D Ultra sound imaging Nuclear Medicine Imaging Modalities-SPECT,PET, Molecular Imaging

UNIT IV IMAGE ANALYSIS AND CLASSIFICATION 9

Image segmentation- pixel based, edge based, region based segmentation. Image representation and analysis, Feature extraction and representation, Statistical, Shape, Texture, feature and image classification – Statistical, Rule based, Neural Network approaches

UNIT V IMAGE REGISTRATIONS AND VISUALIZATION 9

Rigid body visualization, Principal axis registration, Interactive principal axis registration, Feature based registration, Elastic deformation based registration, Image visualization – 2D display methods, 3D display methods, virtual reality based interactive visualization.

REFERENCES

1. Atam P.Dhawan, 'Medical Image Analysis', Wiley Interscience Publication, NJ, USA 2003.
2. R.C.Gonzalez and R.E.Woods, 'Digital Image Processing', Second Edition, Pearson Education, 2002.
3. Anil. K. Jain, 'Fundamentals of Digital Image Processing', Pearson education, Indian Reprint 2003.
4. Alfred Horowitz, 'MRI Physics for Radiologists – A Visual Approach', Second edition Springer Verlag Network, 1991.
5. Kavyan Najarian and Robert Splerstor," Biomedical signals and Image processing",CRC – Taylor and Francis,New York,2006
6. John L.Semmlow,"Biosignal and Biomedical Image Processing Matlab Based applications" Marcel Dekker Inc.,New York,2004
7. Jerry L.Prince and Jnathan M.Links," Medical Imaging Signals and Systems"- Pearson Education Inc. 2006

P18PCBM202	**BIOMEDICAL SIGNAL ANALYSIS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic Digital Signal Processing				
	Course Coordinator Name & Department:- Mr.Kishore K & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To learn discrete Fourier transform and its properties
- To know the characteristics of IIR and FIR filters learn the design of infinite and finite impulse
- response filters for filtering undesired signals
- To understand Finite word length effects
- To study the concept of Multi-rate and adaptive

COURSE OUTCOMES (COs)

CO1	Apply DFT for the analysis of Digital Signals & Systems
CO2	Design IIR and FIR Filters
CO3	Characterize finite word length effect on filters
CO4	Design the Multi-Rate Filters
CO5	Apply Adaptive Filters to equalization
CO6	To learn the feature extraction of the time frequency

	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	PSO2
2	CO1	3			2	3		2			2			2	
	CO2			2											
	CO3	2			3						2				
	CO4					3		3							
	CO5	3									3				
	CO6			2	3						2				
3	Category	Humanities & Social Studies (HS)		Basic Sciences (BS)	Engg Sciences (ES)		Professional Core (PC)	Core Elective (CE)		Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)		
								✓							
4	Approval		47th Meeting of Academic Council, Aug 2018												

UNIT I SIGNAL, SYSTEM AND SPECTRUM 9

Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum – power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

UNIT II TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION 9

Time series analysis – linear prediction models, process order estimation, lattice representation, non stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG signals, Time varying analysis of Heart-rate variability, model based ECG simulator. Spectral estimation – Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals,

UNIT III ADAPTIVE FILTERING AND WAVELET DETECTION 9

Filtering – LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in FECG, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

UNIT IV BIOSIGNAL CLASSIFICATION AND RECOGNITION 9

Signal classification and recognition – Statistical signal classification, linear discriminate function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats.

UNIT V TIME FREQUENCY AND MULTIVARIATE ANALYSIS 9

Time frequency representation, spectrogram, Wigner distribution, Time-scale representation,

scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA, ICA

REFERNCES

1. Arnon Cohen, Bio-Medical Signal Processing Vol I and Vol II, CRC Press Inc., Boca Rato, Florida 1999.
2. Rangaraj M. Rangayyan, 'Biomedical Signal Analysis-A case study approach', Wiley-Interscience/IEEE Press, 2002
3. Willis J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2003.
4. Emmanuel C. Ifeachor, Barrie W.Jervis, 'Digital Signal processing- A Practical Approach' Pearson education Ltd., 2002
5. Raghuveer M. Rao and Ajith S.Bopardikar, Wavelets transform – Introduction to theory and its applications, Pearson Education, India 2000.
6. K.P.Soman,K.I Ramachandran,"Insight into wavelet from theory to practice", PHI, New Delhi,2004
7. John L.Semmlow," Biosignal and Biomedical Image Processing Matlab Based applications" Marcel Dekker Inc.,New York,2004
8. Kavyan Najarian and Robert Splerstor," Biomedical signals and Image processing", CRC – Taylor and Francis,New York,2006
9. D.C.Reddy,"Biomedical Signal Processing – Principles and Techniques",TMH,New Delhi,2005
10. Gari D.Clifford, Francisco Azuaje and Patrick E.McSharry," Advanced Methods and Tech for ECG Data Analysis", ARTECH House,Boston,2006

P18PCBM2L1	**MEDICAL IMAGE ANALYSIS LAB**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	0	0	4	2
	Prerequisite course – Knowledge in image processing (B.Tech/B.E)				
	Course Coordinator Name & Department:- Ms.Kripa N & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To study the production of x-rays and its application to different medical Imaging techniques.
- To study the different types of Radio diagnostic techniques.
- To study the special imaging techniques used for visualizing the cross sections of the body.
- To study the imaging of soft tissues using ultrasound technique

COURSE OUTCOMES (COs)

CO1	Students will get the clear domain knowledge about the various medical imaging techniques.
CO2	Students have various diagnostic applications of the medical imaging techniques.
CO3	Students will get the clear domain knowledge the image fundamentals and image transforms

CO4		Study the image enhancement techniques
CO5		Study the image restoration procedures and image compression procedures.
CO6		Study the x-ray features and procedures

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	PSO2
2	CO1	3	2	3			3			2					
	CO2					2									
	CO3	2		2					2					**2**	
	CO4		1								1				
	CO5				3				3						
	CO6	2					2			3					

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)	
					✓						
4	Approval		47th Meeting of Academic Council, Aug 2018								

LIST OF EXPERIMENTS

1. Fundamentals of medical image analysis
2. Gray level transformation and histogram processing of X-ray images.
3. Noise removal and filtering in various medical images.
4. Pixel based segmentation of MRI images
5. Edge based segmentation of CT images.
6. Morphological operations on x-ray images.
7. Statistical feature extraction on X-ray and CT images.
8. Medical Image registration.
9. Vessel extraction in angiographic images using MIMICS software.
10. Geometrical measurements in Medical images using MIMICS software

P18PCBM2L2	**BIOMEDICAL SIGNAL ANALYSIS LAB**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic Digital Signal Processing				

		Course Coordinator Name & Department:- Ms.Kishore K & Department. of Biomedical Engineering

COURSE OBJECTIVES:-

- To learn discrete Fourier transform and its properties
- To know the characteristics of IIR and FIR filters learn the design of infinite and finite impulse
- response filters for filtering undesired signals
- To understand Finite word length effects
- To study the concept of Multi-rate and adaptive

COURSE OUTCOMES (COs)

CO1		Apply DFT for the analysis of Digital Signals & Systems
CO2		Design IIR and FIR Filters
CO3		Characterize finite word length effect on filters
CO4		Design the Multi-Rate Filters
CO5		Apply Adaptive Filters to equalization
CO6		Learn the designing of Filters

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	PSO2
2	CO1	3			2	3		2			2			2	
	CO2			2											
	CO3	2			3						2				
	CO4					3		3							
	CO5	3									3				
	CO6														

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
						✓				

4	Approval		47^{th} Meeting of Academic Council, Aug 2018

LIST OF EXPERIMENTS

1. Representation of basic signals
2. Linear convolution
3. Autocorrelation and cross correlation
4. FFT and IFFT Difference equation

5. Representation Digital IIR
6. Butterworth filter-LPF & HPF
7. Digital IIR chebychev filter-LPF & HPF
8. Design of FIR filter using windowing technique
9. Upsampling and downsampling
10. Analysis of ECG
11. Analysis of EEG
12. Analysis of PCG

PROFESSIONAL ELECTIVE

P18PEBM011	**ADVANCED BIOSENSOR AND TRANSDUCERS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic knowledge of electronic devices and sensors				
	Course Coordinator Name & Department:- Mr.Prasath S. & 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.

COURSE OUTCOMES (COs)

CO1	Describe the purpose and methods of measurements
CO2	Explain different display and recording devices for various applications.
CO3	Know the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications
CO4	Remember and understand the concepts, types, working and practical applications of important biosensors.
CO5	Know some of the commonly used biomedical transducers
CO6	Learn to apply the application based n biosensors in medical 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	PSO2
2	CO1														
	CO2			3	3		2								3
	CO3		2	3	3		3								

	CO4	3	2	3	3										
	CO5			3		3									
	CO6														
3	Category	Humanities & Social Studies (HS)		Basic Sciences (BS)	Engg Sciences (ES)		Professional Core (PC)	Core Elective (CE)		Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)		
								✓							
4	Approval		47th Meeting of Academic Council, Aug 2018												

UNIT - I CHEMICAL SENSORS 9

Blood –Gas and Acid –base physiology Electrochemical sensors, Chemical Fibro sensors, Iron-Selective Field-Effect Transistor (ISFET), Immunologically Sensitive Field Effect Transistor (IMFET) , Integrated flow sensor and Blood Glucose sensors.

UNIT - II CHARACTERISTICS OF TRANSDUCERS 9

Static characteristics - accuracy, precision, sensitivity, linearity etc - mathematical model of transducers - zero first - order and second - order transducers - response to impulse step, ramp and sinsoidal inputs.Non polarizable electrodes and body surface recording electrodes. Ultrasonic Transducers for Measurement and therapy – radiation detectors – NIR spectroscopy .

UNIT - III BIOMEDICAL SENSORS 9

Sensors Terminology in human body, Introduction, Cell, Body Fluids Musculoskeletal system, Bioelectric Amplifiers, Bioelectric Amplifiers for Multiple input Circuits, Differentional Amplifiers, Physiological Pressure and other cardiovascular measurements and devices.

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UNIT – IV BIOSENSORS - PHYSIOLOGICAL RECEPTORS - J RECEPTORS 9

Chemo receptors, Baroreceptors, Touch receptors, Biosensors - Working Principle and Types, Applications.

UNIT – V ADVANCED SENSOR DESIGN 9

Fluoroscopic machines design, Nuclear medical systems, EMI to biomedical sensors, types and sources of EMI, Fields, EMI effects. Computer systems used in Xray and Nuclear Medical equipments. Calibration, Typical faults, Trouble shooting, Maintenance procedure for medical equipments and Design of 2& 4 wire transmitters with 4 – 20 mA output.

Text Book

1. Sensors Hand Book Sabaree Soloman - Sensors Hand Book, McGraw Hill,1998
2. Smith H.M. - Principles of Holography, John Wiley & Sons, New York, 1975
3. J.G. Webster Medical instrumentation Application and Design, Houghton Mifilin Co. 2004

References

1. Carr and Brown - Introduction to Medical Equipment Technology, Addison Wesley. 1999
2. Culshaw B and Dakin J (Eds) Optical Fibre Sensors, Vol. 1 & 2 Artech House, Norwood. (1989)-
3. P. Garnell– Guided Weapon Control Systems – Pergamon Press. 1980

P18PEBM012	ADVANCE MATHEMATICS FOR BIOMEDICAL ENGINEERING	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Engineering Maths Knowledge				
	Course Coordinator Name & Department:- Mr.Kishore K & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

To encourage students to develop a working knowledge of the central ideas of linear algebra; notion of a Markov chain, and how simple ideas of conditional probability and matrices can be used to give a thorough and effective account of discrete-time Markov chains and To provide the student with the concept and an understanding of basic concepts in Linear Programming techniques, Duality Principles, Transportation and Assignment problems, PERT/CPM.

COURSE OUTCOMES (COs)

CO1	To understand the matrices and some applications.
CO2	To understand the Geometric, Uniform, Exponential, Gamma
CO3	To understand the linear program
CO4	Apply the concepts of Transportation Problem and Assignment Problem, participate in the class room discussion on Transportation algorithm.
CO5	Explain and demonstrate the basic concepts of PERT- CPM and their application, reproduce the network model.
CO6	To learn about the Random processed 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	PSO2

2	CO1	3	3	2	2	3					1	3		2	
	CO2	3			3	3					2	3			
	CO3	3	3	3							3	3			
	CO4	3	2	2					1	2	1	2			
	CO5	3			3	2			2	2	2	1			
	CO6	3	2	2					2		2	2			

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)	
					✓						
4	Approval		47th Meeting of Academic Council, Aug 2018								

UNIT I LINEAR ALGEBRA **9**

Vector spaces – norms – Inner Products – Eigen values using QR transformations – QR factorization - generalized eigenvectors – Canonical forms – singular value decomposition and applications - pseudo inverse – least square approximations --Toeplitz matrices and some applications.

UNIT II RANDOM PROCESSES **9**

Classification – Auto correlation - Cross correlation - Stationary random process – Markov process –- Markov chain - Poisson process – Gaussian process.

UNIT III LINEAR PROGRAMMING **9**

Formulation – Graphical solution – Simplex method – Two phase method

UNIT IVTRANSPORTATION &ASSIGNMENT PROBLEMS **9**

Transportation models – Vogel's approximation method MODI method – Unbalanced transportation problem – Degeneracy in transportation models - Assignment problems – Hungarian method

UNIT V NETWORKS & REPLACEMENT MODELS **9**

Networks – PERT and CPM – Network diagrams – Shortest route – Minimum spanning tree, Replacement models– Individual and Group replacement policy

REFERENCES:

1. Andrews,L.C. and Philips.R.L. "Mathematical Techniques for engineering and scientists", Printice Hall of India,2006.
2. O'Neil P.V. "Advanced Engineering Mathematics", (Thomson Asia Pvt Ltd, Singapore) 2007, cengage learning India private limited.
3. Kanti Swarup, Gupta P.K., and Manmohan, "Operations Research", Sultan Chand &

Sons 1997. Paneerselvam R., Operations research, Prentice-Hall of India, New Delhi, 2001.
4. T. Veerarajan, "Operations Research", Published by Orient Black Swan, 2010.
5. Oliver C. Ibe, "Fundamentals of Applied Probability and Random Processes, Academic Press, (An imprint of Elsevier), 2010.

P18PEBM013	COMPUTER BASED MEDICAL INSTRUMENTATION	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic Medical Instrumentations				
	Course Coordinator Name & Department:- Ms.Vinodini R. & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- Computer assisted instruction in education, including biomedical engineering education, has been explored and changed dramatically for more than two decades.
- The Internet, with its capacity to transmit synchronous and asynchronous audio, text, and graphics, presents educators with tremendous opportunities for distance education and independent learning.
- In this work, we have developed a new educational hypermedia for medical instrumentation courses

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COURSE OUTCOMES (COs)

CO1	About computer hardware components and its interface
CO2	Different microprocessors and its architecture
CO3	Pentium processors and its architecture
CO4	Telemedicine and applications
CO5	Biometric systems in use today.
CO6	Understand the network security

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	PSO2
2	CO1	3		3				3			2				
	CO2					2									
	CO3	2		2											
	CO4		1									1			3
	CO5							3							
	CO6	3		3				3			2				

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
						✓				
4	Approval	47th Meeting of Academic Council, Aug 2018								

UNIT I PC HARDWARE AND OVERVIEW 9

Hardware – BIOS – DOS interaction, POST, Functional and Architecture Block diagram of a PC, Mother Board – I / O slots – Mother Board logics- Memory and I/O map, Peripheral interfacing and controllers- Serial and Parallel interface – CRT Display Adapter – FDC – HDC – PC buses

UNIT II 80186, 80286, 80386 AND 80486 MICROPROCESSORS 9

80186 Architecture, Enhancements of 80186 – 80286 Architecture – Real and Virtual Addressing Modes – 80386 Architecture – Special Registers – Memory Management – Memory Paging Mechanism – 80486 Architecture – Enhancements – Cache Memory Techniques – Exception Handling – Comparison of Microprocessors (8086 – 80186 – 80286 – 80386 – 80486).

UNIT III PENTIUM MICROPROCESSORS 9

Pentium Microprocessor Architecture – Special Pentium Registers – Pentium Memory Management – New Pentium Instructions – Pentium Pro Microprocessor Architecture – Special features – Pentium II Microprocessor Architecture – Pentium III Microprocessor Architecture – Pentium III Architecture – Pentium IV Architecture – Comparison of Pentium Processors.

UNIT IV COMPUTERISED DATA ACQUISITION AND PROGRAMMING 9

Plug-in-data acquisition and Control Boards, Data acquisition using GPIB and Serial Interfaces and Programming in C, Virtual reality – Multimedia - Telemedicine – Computers in Critically Care Units and radiological centres

UNIT V BIOMETRICS FOR NETWORK SECURITY 9

Introduction to Biometrics and its characteristics, Finger print technology, feature extraction and classification, Face recognition and hand geometry - feature extraction and classification, Biometric authentication system

REFERENCES

1. RamachandraLele, Computers in Medicine Progress in Medical Informatics, Tata

McGraw Hill Publishing Company, New Delhi, 2005
2. N.Mathivanan, PC Based Instrumentation: Concepts and Practice, Prentice Hall of India, New Delhi 2007.
3. B.Govindarajalu, IBM PC and Clones: Hardware, Trouble shooting and Maintenance, Tata McGraw Hill Publishing Company, New Delhi, 2005
4. Herbert Schildt, The Complete Reference – JAVA, Tata McGraw Hill Publishing Company, New Delhi, 2005
5. John P Woodward, Biometrics – The Ultimate Reference, Dreamtech Publishers, New Delhi, 2003
6. Ranjan Parekh, Principles of Multimedia, Tata McGraw Hill Publishing Company, New Delhi, 2006
7. Stephen J Bigelow, Trouble shooting, Maintaining and Repairing of PCs, Tata McGraw Hill Publishing Company, New Delhi, 2005

P18PEBM021	TISSUE ENGINEERING	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course –				
	Course Coordinator Name & Department:- Dr.Vasukidevi R & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To study the Tissue Exchange and Tissue Development.
- To know the Cell growth and differentiation, Cell and tissue mechanism.
- To study the cell adhesion, cell migration, cell aggregation and tissue equivalent.

COURSE OUTCOMES (COs)

CO1	To learn objectives of Tissue engineering, Element of Tissue development.
CO2	Learn the Cell and tissue mechanism, cell adhesion, cell migration, cell aggregationand tissue equivalent.
CO3	To learn Delivery molecular agents in tissue engineering, control releaser agents intime and space.
CO4	To learn cell interaction with polymer cell, cell interaction with polymer insuspension, cell interaction with gels.
CO5	Study the Replacement in Tissue structure or Functional Tissue engineering cartilage.
CO6	To understand the tissue generation

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	PSO2
2	CO1	3		3				3			2				
	CO2					2									
	CO3	2		2											
	CO4		1									1			2
	CO5							3							
	CO6	1		2				3							
3	Category	Humanities & Social Studies (HS)		Basic Sciences (BS)	Engg Sciences (ES)		Professional Core (PC)	Core Elective (CE)		Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)		
								✓							
4	Approval		47th Meeting of Academic Council, Aug 2018												

UNIT I FUNDAMENTAL OF TISSUE ENGINEERING 9

Tissue Exchange and Tissue Development, objectives of Tissue engineering, Element of Tissue development.

UNIT II CELLULAR STUDIES 9

Cell growth and differentiation, Cell and tissue mechanism, cell adhesion, cell migration, cell aggregation and tissue equivalent.

UNIT III TISSUE BARRIERS TO MOLECULAR AND CELLULAR TRANSPORT
9

Cell delivery and recirculation, Delivery molecular agents in tissue engineering,control releaser agents in time and space.

UNIT IV INTRODUCTION TO POLYMERS 9

Non degrade polymer, Bio degradable polymer, cell interaction with polymer cell, cell interaction with polymer in suspension, cell interaction with gels.

UNIT V APPLICATION OF TISSUE ENGINEERING 9

Artificial organs, synthetic components, Replacement in Tissue structure or Functional Tissue engineering cartilage, Skin, and nerve regeneration.

REFERENCES

1. W Mark Saltzman Tissue Engineering – Engineering principles for design of replacement organs and tissue –- Oxford University Press inc New York 2004
2. Gray E Wnek, Gray L Browlin – Encyclopaedia of Biomaterials and Biomedical Engineering – Marcel Dekker Inc New York 2004.

P18PEBM022	**BIOMATERIALS ANDIMPLANTABLE DEVICES**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic Biomaterials (B.Tech)				
	Course Coordinator Name & Department:- Ms.Geetha & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To study about the artificial organs and various medical materials like implant materials, polymeric implants, tissue replacement implants and its applications.

COURSE OUTCOMES (COs)

CO1	To understand the basic definition and classification of various biomaterials
CO2	To learn the properties of various biomaterials, metallic implants and alloys
CO3	To apply the mechanical properties of various materials in therapeutic applications
CO4	To get introduced about different artificial organs

CO5		To understand the properties of bio glass, bio ceramics and biopolymers.													
CO6		To understand the neuro muscular implants													
	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	PSO2
2	CO1	3	2		3				3			2			
	CO2						2								
	CO3	2			2						2				
	CO4		1												3
	CO5														
	CO6	2			1										
3	Category	Humanities & Social Studies (HS)		Basic Sciences (BS)	Engg Sciences (ES)		Professional Core (PC)	Core Elective (CE)		Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)		
							✓								
4	Approval		47th Meeting of Academic Council, Aug 2018												

UNIT-I **9**

Definition and classification of Biomaterials, Metallic implant materials- Ceramic implant materials- Polymeric implant materials, composites

UNIT-II **9**

Biocompatibility- interfacial phenomena, Material response function and degradation of materials, in vivo- host response - Methods of test for biological performance.

UNIT-III **9**

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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. Orthopaedic implants- Hard tissue replacements- total hip and knee joint replacements

UNIT-IV **9**

PhysioChemical Characteristics of Biopolymers- biodegradable polymers for medical purposes- synthetic polymers,biopolymers in Controlled release systems. Artificial skin, surface Modification of biopolymer materials.

UNIT-V **9**

Cardiac Implants, Neuro Muscular Implants, Transcutaneous Implants, Intraocular lenses**,**Dental implants.

REFERENCES

1. Park. J.B. "Biological science and engineering", Plenum Press, 1994.
2. Jonathan Black "Biological Performance of Materials', Marcel Dekker", 1981.
3. Piskin.E. & Hoffmann.A.S. "Polymeric biomaterials" Martinus Nijihoff pub, 1986
4. "Biomaterials", Sujata V Bhat., Narosa Publishing House, New Delhi, 2002
5. *Park. J.B. "Biomaterials: An Introduction", CBS Publishers, 2007.*
6. F.H. Silver, "Biomaterials, Medical Devices and Tissue Engineering: An Intergrated Approach" 1st Edn., Chapman & Hall, London, 1994.
7. Buddy Ratner *etal.,* " Biomaterials Science – An Introduction to Materials in Medicine", Academic Press, San Diego, 2004.

P18PEBM023	**PHYSIOLOGICAL MODELING**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – basic knowledge anatomy& physiology (B.Tech/B.E)				
	Course Coordinator Name & Department:- Mr.Kishore K & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To study the concept and different mathematical techniques applied in analyzing any given system
- To learn the analysis of given system in time domain and frequency domain
- To study the stability analysis of the given system

COURSE OUTCOMES (COs)

CO1	Analyze the time and frequency domains of the given system using different mathematical techniques
CO2	Learn the basics of control systems
CO3	Time and frequency response analysis
CO4	Bio-control system definition and modeling
CO5	Study the model of eye, respiratory system, etc
CO6	To Understand the working of physiological model

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	PSO2
2	CO1	2		2				3				2			
	CO2				3				2						
	CO3		2			2		3		3		2			
	CO4			2											2
	CO5	3		2		2	2					2			
	CO6	1		2			2								

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
						✓				
4	Approval	47th Meeting of Academic Council, Aug 2018								

UNIT I INTRODUCTION 9

System Concept, System Properties, Piece-Wise Linear Approximation, Electrical Analog for Compliance, Thermal Storage, Mechanical Systems, Step response of a Resistance/Compliant Systems, Pulse Response of First Order System.

UNIT II TRANSFER FUNCTION 9

System as an Operator use of Transfer Function, Bio Engineering of a Coupled System, Example of Transformed Signals and Circuits for the Transfer Function with Impedance Concept, Prediction of Performance.

UNIT III PERIODIC SIGNALS 9

Sinusoidal Functions, Sinusoidal Analysis of Instrumentation System, Evaluation of Transfer Function s from Frequency Response, Relationship between Phase Lag and Time Delay Transient Response of an Undamped Second Order system, General Description of Natural Frequency Damping, Physical Significance of Under Damped Responses.

UNIT IV FEEDBACK 9

Characterization of physiological feedback systems, uses and testing of system stability.

UNIT V SIMULATION OF BIOLOGICAL SYSTEMS 9

Simulation of Skeletal muscle servomechanism, thermo Regulation, cardiovascular control System, Respiration controls, Occulo Motor System, Endocrine control system and Modeling of receptors.

REFERENCES

1. William B. Blesser, A System Approach to Biomedicine, McGraw Hill Book Co, New York, 1969.
2. ManfreoClynes and John H. Milsum, Biomedical Engineering System, McGraw Hill and Co, New York, 1970.
3. Douglas S. Rigg, Control Theory and Physiological Feedback Mechanism, The William

and Wilkins Co, Baltimore, 1970 .
4. Richard Skalak and ShuChien, Hand Book of Biomedical Engineering, McGraw Hill and Co, New York, 1987.
5. Michael C.K. Khoo, "Physiological Control System" - Analysis, Simulation and Estimation"- Prentice Hall of India, New Delhi, 2001

P18PEBM031	BIO MEMS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Knowledge in Microprocessor (B.Tech/B.E)				
	Course Coordinator Name & Department:- Mr.Prasath S. & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To study the Working principle of Microsystems.
- To know System modeling and properties of materials.
- To study the Fundamental principle of MOEMS technology.

COURSE OUTCOMES (COs)

CO1	To learn objectives of materials for MEMS and Microsystems and micromachining.
CO2	Learn the Peltier effect heat pumps and thermal flow sensor.
CO3	To learn digital micromirror devices, light detectors, optical switch.
CO4	To learn expression for liquid flow in a channel.
CO5	Study the micro system approaches to polymerase chain reaction (PCR).
CO6	To understand the applications of mems in medical 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	PSO2
2	CO1	3	3	2				3			2				
	CO2				3				3			2	3		
	CO3		2				2	3			2				
	CO4			2					3						3
	CO5	3					2	2				2	3		
	CO6		2		2			1							

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)

						✓				
4	Approval		47th Meeting of Academic Council, Aug 2018							

UNITI MEMS AND MICROSYSTEMS 9

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

UNIT II MICROSENSORS AND ACUATORS 9

Mechanical sensors and actuators – beam and cantilever, piezoelectric materials, thermal sensors and actuators- micromachined thermocouple probe, Peltier effect heat pumps, thermal flow sensors, Magnetic sensors and actuators- Magnetic Materials for MEMS, Devices

UNIT III MICRO OPTO ELECTRO MECHANICAL SYSTEMS 9

Fundamental principle of MOEMS technology, light modulators, beam splitter, microlens, digital micromirror devices, light detectors, optical switch

UNIT IV MICROFLUIDIC SYSTEMS 9

Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, dielectrophoresis, microfluid dispenser, microneedle, micropumps-continuous flow system

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

REFERENCES

1. Tai Ran Hsu , " MEMS and Microsystems design and manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002
2. NitaigourPremchandMahalik, " MEMS", Tata McGraw Hill Publishing Company, New Delhi, 2007
3. Wanjun Wang, Steven A.Soper " BioMEMS- Technologies and applications", CRC Press,Boca Raton,2007
4. Abraham P. Lee and James L. Lee, BioMEMS and Biomedical Nano Technology, Volume I, Springer 2006.

P18PEBM032	HEALTH HOSPITAL AND EQUIPMENT MANAGEMENT	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Knowledge in Microprocessor (B.Tech/B.E)				
	Course Coordinator Name & Department:- Dr.Vasuki R. & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To expose the students for planning and operation of hospitals in a detailed mannerwhich will include all facts of hospital planning activities covering every department that is involved both in clinical care as well as supportive services.
- To introduce the equipment maintenance management skills and how to protect equipment from electromagnetic interferences.

COURSE OUTCOMES (COs)

CO1	Expert in understanding the various health policies
CO2	Planning activities at health care centres.
CO3	Equipment installation ,service & calibration needs
CO4	Organizing maintenance operations
CO5	Function of a clinical engineer in a hospital
CO6	Learning the hospital safety and applicaions

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	PSO2
2	CO1	3	3	2			3			2				2	
	CO2				3			3			2	3			
	CO3		2			2	3			2					
	CO4			2				3							
	CO5	3				2	2				2	3			
	CO6	2	2			2						2			

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
						✓				

4	Approval		47th Meeting of Academic Council, Aug 2018

UNIT IHEALTH SYSTEM **9**

Health organisation 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 Organisation, Nursing Sector, Medical Sector, Central Services, Technical Department, Definition and Practice of Management by Objective, Transactional Analysis Human Relation in Hospital, Importance of 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, IRPQ.

UNIT IV EQUIPMENT MAINTENANCE MANAGEMENT **9**

Organising Maintenance Operations, Paper Work Control, Maintenance Job Planning, Maintenance Work Measurement and Standards, Preventive Maintenance, Maintenance Budgeting and Forecasting, Maintenance Training, Contract Maintenance.

UNIT V TRAINED TECHNICAL PERSONNEL **9**

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

REFERENCES

1. Cesar A.Caceres and Albert Zara,The Practice of Clinical Engineering, Academic Press, New York,1977.
2. Webster.J.G. and Albert M.Cook,Clinical Engineering Principles and Practices Prentice Hall Inc. ,Englewood Cliffs, New Jersey, 1979.
3. Hans Pfeiff,VeraDammann (Ed.),Hospital Engineering in Developing Countries, Z Report, Eschbom,1986
4. Jacob Kline, Handbook of Bio Medical Engineering, Academic Press Inc. SanDeigo1988
5. R.C.Goyal, Human Resource Management in Hospital, Prentice Hall of India, 3rd edition,2000.
6. Syed Amin Tabish “Hospital and Health services Administration Principles and Practices Oxford Press New Delhi 2001

	TELEHEALTH TECHNOLOGY	L	T	P	C
	Total Contact Hours – 45	3	0	0	3

P18PEBM033		Prerequisite course – Knowledge in Microprocessor (B.Tech/B.E)
		Course Coordinator Name & Department:- Dr.Vasuki R. & Department. of Biomedical Engineering

COURSE OBJECTIVES:-

- To study the Series History and Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine.
- To know Social and legal issues, Safety and regulatory issues and Advances in Telemedicine.

COURSE OUTCOMES (COs)

CO1		To learn objectives of Tele health, Tele care and Organs of telemedicine**.**
CO2		Learn the Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications.
CO3		To learn Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320series (Video phone based ISBN).
CO4		To learn Basic parts of teleradiology system.
CO5		Introduction to robotics surgery, tele surgery, Tele cardiology and Teleoncology
CO6		To understand the applications of telemedicine

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	PSO2
2	CO1	2		2				3				2		2	
	CO2				3				2						
	CO3		2			2		3		3		2			
	CO4			2											
	CO5	2		2		2	2					2			
	CO6		2		3				2						

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
						✓				

4	Approval	47th Meeting of Academic Council, Aug 2018

UNIT I TELEMEDICINE AND HEALTH 9

History and Evolution of telemedicine, Functional diagram of telemedicine system,

Telemedicine, Tele health, Tele care, Organs of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

UNIT II TELEMEDICAL TECHNOLOGY 9

Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Modulation techniques, Types of Antenna, Integration and operational issues, 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 (www). Video and audio conferencing.clinical data–local and centralized

UNIT III TELEMEDICAL STANDARDS 9

Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Real-time Telemedicine integrating doctors / Hospitals, Clinical laboratory data, Radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentially of medical records and access control, Cyber laws related to telemedicine.

UNIT IV MOBILE TELEMEDICINE 9

Tele radiology: Definition, Basic parts of teleradiology system: Image Acquisition system Display system, Tele pathology, multimedia databases, color images of sufficient resolution, Dynamic range, spatial resolution, compression methods, Interactive control of color, Medical information storage and management for telemedicine- patient information medical history, test reports, medical images diagnosis and treatment. Hospital information system - Doctors, paramedics, facilities available.Pharmaceutical information system.

UNIT V TELEMEDICAL APPLICATIONS 9

Telemedicine access to health care services – health education and self care. · Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability., Telemedicine access to health care services – health education and self-care, Business aspects - Project planning and costing, Usage of telemedicine.

REFERENCES

1. Norris, A.C. Essentials of Telemedicine and Telecare. Wiley (ISBN 0-471-53151-0), 2002
2. Wootton, R., Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006
3. O'Carroll, P.W., Yasnoff, W.A., Ward, E., Ripp, L.H., Martin, E.L. (Eds), Public Health Informatics and Information Systems. Springer (ISBN 0-387-95474-0), 2003
4. Ferrer-Roca, O., Sosa-Iudicissa, M. (editors), Handbook of Telemedicine. IOS

Press (Studies in Health Technology and Informatics, Volume 54). (ISBN 90-5199-413-3), 2002.
5. Simpson, W. 2006. Video over IP. A practical guide to technology and applications. Focal Press (Elsevier). ISBN-10: 0-240-80557-7
6. Bemmel, J.H. van, Musen, M.A. (Eds.) (1997). Handbook of Medical Informatics. Heidelberg, Germany: Springer. (ISBN 3-540-63351-0)
7. Wootton, R., Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006
8. O'Carroll, P.W., Yasnoff, W.A., Ward, E., Ripp, L.H., Martin, E.L. (Eds), Public Health Informatics and Information Systems. Springer (ISBN 0-387-95474-0), 2003
9. Ferrer-Roca, O., Sosa-Iudicissa, M. (editors), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54). (ISBN 90-5199-413-3), 2002.
10. Simpson, W. 2006. Video over IP. A practical guide to technology and applications. Focal Press (Elsevier). ISBN-10: 0-240-80557-7
11. Bemmel, J.H. van, Musen, M.A. (Eds.) (1997). Handbook of Medical Informatics. Heidelberg, Germany: Springer. (ISBN 3-540-63351-0)

P18PEBM041	**ADVANCED NEURAL COMPUTING**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – knowledge on neural networks (B.Tech/B.E)				
	Course Coordinator Name & Department:- Mr.Kishore K & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- The course will teach a variety of contemporary approaches to neural networks and introduce the theory underlying these approaches.
- The approaches to be covered will include such things as biological and statistical foundations of neural networks, Perception, MLPs, RBFN, SVM and competitive learning.
- Additionally, a brief introduction to optimization techniques using Genetic algorithm and its applications will be given.

COURSE OUTCOMES (COs)

CO1	Upon completion of this course student gains knowledge about various neural networks that can be used for biomedical signal analysis and Medical image analysis.
CO2	About the genetic algorithms as well as techniques used in its implementation
CO3	Examinations of human central nervous systems inspired the concept of artificial neural network.
CO4	Applications in ANN
CO5	Capability of approximating non linear functions of their
CO6	To Understand the applications of Neural networks in medical 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	PSO2
2	CO1	3	3	2			3			2				3	
	CO2				3			3			2	3			
	CO3		2			2	3			2					
	CO4			2				3							
	CO5	3				2	2				2	3			
	CO6		2			2		2				3			
3	Category	Humanities & Social Studies (HS)		Basic Sciences (BS)	Engg Sciences (ES)		Professional Core (PC)	Core Elective (CE)		Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)		
								✓							
4	Approval		47th Meeting of Academic Council, Aug 2018												

UNIT I FUNDAMENTAL CONCEPTS AND MODELS OF ARTIFICIAL NEURAL SYSTEMS 9

Biological Neurons and their artificial models, Models of Artificial Neural Networks, Learning and Adaptation, Neural Network Learning Rules, Single Layer Perceptron Classifiers.

UNIT II BPN AND BAM 9

Back Propagation Network, Generalized Delta Rule, BPN Application, Associative Memory Definition, BAM, Hopfield Memory, Simulated Annealing-Boltzmann Machine.

UNIT III OTHER NETWORKS 9

Counter Propagation Network, Feature Mapping, Self-Organizing Feature Maps, Adaptive Resonance Theory (ART) Network Descriptions,

UNIT IV GENETIC ALGORITHMS & IMPLEMENTATION TECHNIQUES 10

The Appeal of Evolution, Search Spaces and Fitness Landscapes, Elements of Genetic Algorithms, Data Structures, Adaptive Encoding. Selective Methods, Genetic Operators, Fitness Scaling

UNIT V ADVANCES AND APPLICATIONS 8

Support Vector Machines, R B F Network, Neocognitron Evolving neural networks using GA, Applications of ANN in biomedical signal analysis and Medical image analysis

REFERENCES

1. Philip D.Wasermann, Advanced Methods in neural Computing, Van NostrandReinhold,NewYork 1993.
2. David Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison - Wesley USA,1997.
3. Melanie Mitchell, An Introduction to Genetic Algorithms: Prentice Hall of India, New Delhi 1998. .
4. Simon Haykins, Neural Networks ,Prentice Hall international lnc, 1999.
5. James A Freeman and David M. Skapura, Neural Networks, Addison - Wesley, India 1999.

P18PEBM042	**NUCLEAR MEDICINE**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Knowledge in Biomedical Equipments (B.Tech/B.E Level)				
	Course Coordinator Name & Department:- Dr.Emerson Solomon F. & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- This course is designed to prepare graduates to function as technologists in nuclear medicine departments. This subject will enable the students to learn the basic principles of different imaging modalities used in nuclear medicine

COURSE OUTCOMES (COs)

CO1	To understand the basic physics of various imaging modalities in nuclear medicine.
CO2	To gain knowledge about various detectors used in nuclear medicine
CO3	To gain knowledge in maintenance, handling and operation of the various Equipments in this field.
CO4	To understand the basic working principle of Emission Tomography.
CO5	To understand the basic physics of various imaging
CO6	To learn the applications of nuclear medicine

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	PSO2
2	CO1	3		2	3				3			2		1	
	CO2						2								
	CO3	2			2						2				
	CO4			1											
	CO5				3				3						
	CO6	3		2	3				3			2			

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
					✓					
4	Approval	47th Meeting of Academic Council, Aug 2018								

UNIT I – BASIC PHYSICS BEHIND RADIOACTIVITY 9

Physics of Radioactivity: Radionuclide Decay Terms and Relationships – Activity – Physical half Life – Fundamental Decay Equation, Nuclear Transformation – Alpha Decay, Beta-Minus Decay-Beta Plus – Electron Capture – Isomeric Transition – Decay Schemes

UNIT II – PRODUCTION OF RADIOACTIVE ELEMENTS 9

Radionuclide Production: By cyclotron, nuclear reactor, neutron activation method, and generators, Radiopharmaceuticals – Characteristics, applications, quality control and regulatory issues in medical imaging, Radiopharmaceutical mechanisms of localization

UNIT II I RADIOACTIVITY DETECTORS 9

Radionuclide detection and measurement - Type of detectors – pulsed and current mode - spectroscopy, Gas Filled detectors, Scintillation detectors, Semiconductor detectors, Pulse height spectroscopy, Non– imaging detector applications, Counting statistics

UNIT IV – NUCLEAR IMAGING 9

Planar Nuclear Imaging: Anger Scintillation Camera – Design and principles of operation-performance – design factors, Computers in Nuclear Imaging – Digital image formats – image acquisition – Image processing in nuclear medicine

UNIT V – EMISSION TOMOGRAPHY AND APPLICATIONS 9

Nuclear Imaging Emission Tomography: Focal plane tomography - Single photon emission computed tomography (SPECT) – image acquisition – Image reconstruction – attenuation correction in SPECT, Positron emission tomography – Design and principles of operation – 2-D and 3-D acquisition – Comparison of SPECT and PET – Combines X-ray CT and SPECT – Applications: Whole body, Heart and Brain. 40

REFERENCES

1. Jerrold T Bushberg, J.Anthony Seibert, Edwin M Leidholdt,John M Boone, Lippincott, "The Essential Physics of Medical Imaging" Williams & Wilkins,3rd edition,2011.
2. S Webb, "The Physics of Medical Imaging", Adam Highler, Bristol Published by CRC Press, first edition 1988.
3. Webb's, "Physics of Medical Imaging", Taylor and Francis Group", CRC Press,2nd edition, 2012.
4. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill, 2nd edition,

2003.

P18PEBM043	BRAIN CONTROL INTERFACES	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – knowledge on neural networks (B.Tech/B.E)				
	Course Coordinator Name & Department:- Ms.Kripa N. & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To study the concept and different mathematical techniques applied in analyzing any given system
- To learn the analysis of given system in time domain and frequency domain
- To study the stability analysis of the given system

COURSE OUTCOMES (COs)

CO1	To learn EEG Data Acquisition ,Pre-processing ,Hardware and Software and Artifacts
CO2	Study the Case Study of Brain Actuated Control of Khepera Mobile Robot.
CO3	Learn the Movement Related EEG Potentials and Mental States and Visual EvokedPotential Based – P300 component.
CO4	To learn Laplacian Filters their Linear and Non-linear Features.
CO5	To learn Vector Quantization and Gaussian Mixture Modeling.
CO6	To Understand the Interface between the brain in instruments in external environemnt

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	PSO2
2	CO1	3	3	2			3			2				2	
	CO2				3			3			2	3			
	CO3		2			2	3			2					
	CO4			2				3							
	CO5	3				2	2				2	3			
	CO6			2				3			2				

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
						✓				

4	Approval	47th Meeting of Academic Council, Aug 2018

UNIT I INTRODUCTION TO BCI 8

Concept of BCI – Invasive and Non-invasive Types – EEG Standards – Signal Features – Spectral Components – EEG Data Acquisition – Pre-processing – Hardware and Software – Artifacts – Methods to Remove – Near Infrared BCI.

UNIT II BCI APPROACHES 9

Mu Rhythm – Movement Related EEG Potentials – Mental States – Visual Evoked Potential Based – P300 component.

UNIT III EEG FEATURE EXTRACTION METHODS 9

Time/Space Methods – Fourier Transform – Wavelets – AR models – Band pass filtering – PCA – Laplacian Filters – Linear and Non-linear Features.

UNIT IV EEG FEATURE TRANSLATION METHODS

9

LDA – Regression – Memory Based – Vector Quantization – Gaussian Mixture Modeling – Hidden Markov Modeling.

UNIT V CASE STUDY 9

Case Study of Problems in BCI Competition III(2005) – Dataset I, II, III, IV and V – Solutions.
Case Study of Brain Actuated Control of Khepera Mobile Robot.

REFERENCES:

1. Special Issue on Brain Control Interfaces, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 14, June 2006.
2. Andrew Webb, "Statistical Pattern Recognition", Wiley International, Second Edition, 2002
3. R.Spehlmann, "EEG Primer", Elsevier Biomedical Press, 1981. ArnonKohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, ocaRato, Florida.
4. Bishop C.M, "Neural Networks for Pattern Recognition", Oxford, Clarendon Press, 1995
5. TorstenFelzer, "On the possibility of Developing a Brain Computer Interface", Technical Report, Technical University of Darmstadt, Germany, 2001.

	PRINCIPLES OF GENETIC ANALYSIS	L	T	P	C
P18PEBM051	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Basic Knowledge on genetic (B.Tech/B.E)				
	Course Coordinator Name & Department:- Dr.R. Vasukidevi & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To study the Pattern of inheritance and Chromosomal basis of inheritance.
- To know DNA sequencing, DNA Amplification.

- To study the Protein synthesis and regulation of gene expression.

COURSE OUTCOMES (COs)

CO1	To learn objectives of Chromosome mapping by recombination , Genetics of Bacteria and viruses.
CO2	Learn the DNA structure and replication, DNA sequencing, DNA Amplification and DNA Hybridization.
CO3	To learn Gene isolation and manipulation.
CO4	To learn Genetic basis of development.
CO5	Study the Quantitative Genetics and Evolution Genetics.
CO6	To understand the various Genomic expressions

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	PSO2
2	CO1	3			2	3		2			2			3	
	CO2			2											
	CO3	2			3						2				
	CO4					3		3							
	CO5	3									3				
	CO6	2		2		3									

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
						✓				

4	Approval	47th Meeting of Academic Council, Aug 2018

UNIT I INHERITANCE - GENETIC ANALYSIS 9

Pattern of inheritance, Chromosomal basis of inheritance, Chromosome mapping by recombination, Genetics of Bacteriaand viruses.

UNIT II DNA AND PHENOTYPE 9

From Gene to Phenotype, DNA structure and replication- DNA sequencing, DNA Amplification, DNA Hybridisation and DNA Polymorphism, RNA transcription and processing, Protein synthesis and regulation of gene expression.

UNIT III GENOME STRUCTURE AND GENETIC ENGINEERING 9

Gene isolation and manipulation, Genomics, mutations, repair and recombination, site directed

mutagenesis, large-scale chromosomal changes and genetic polymorphism.

UNIT IV GENETIC PROCESSES 9

Gene function, Genetic organization, Genetic regulation, normal and cancer cells, Genetic basis of development

UNIT V IMPACT OF GENETIC VARIATION 9

Population Genetics, Quantitative Genetics, Evolution Genetics.

REFERENCES

1. Watson. J. etal, " Molecular Biology of the Gene ", 5th Edition, Pearson Publication, 2004.
2. Griffiths, Wesslers, Lewontin, Bart Gel, Suzuki, Miller "Introduction to Genetics Analysis", – W.H Freeman & company, New York 8th Edition - 2005.
3. Glick, B.R and J.J Pasternak "Molecular Biotechnology", Principles and application of Recombinant DNA" 3rd Edition ASM Press, 2003
4. Karp, Gerald." Cell and Molecular Biology". Concepts and Experiments, 4th Edition, John Wiley Sons, 2005.
5. Weaver. R.F. " Molecular Biology " 3rd Edition, McGraw – Hill, 2005.
6. Tom Strachan, Andrew P Read "Human molecular Genetics" 3rd Edition, Garland Publishing – 2004.

P18PEBM052	HUMAN ASSIST DEVICES	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – basic knowledge signal processing (B.Tech/B.E)				
	Course Designed by – Dept. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To know the various biopotential recordings so as to enable students to record various biosignals.
- To know the various functional blocks present is 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 assist devices so as to enable the students to develop new assist devices.
- To introduce the recent trends in field of diagnostic and therapeutic equipments.

COURSE OUTCOMES (COs)

CO1	Explain about measurements of parameters related to respiratory system
CO2	Describe the measurement techniques of sensory responses

CO3		Analyze different types and uses of diathermy units
CO4		Discuss ultrasound imaging techniques and its usefulness in diagnosis
CO5		Outline the importance of patient safety against electrical hazard
CO6		Explain 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	PSO2
2	CO1	3		3				3			2			2	
	CO2					2									
	CO3	2		2											
	CO4		1									1			
	CO5							3							
	CO6	2				1					2				

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)	
						✓					
4	Approval	47th Meeting of Academic Council, Aug 2018									

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

TOTAL = 45 PERIODS

REFERENCES

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

P18PEBM053	**ADVANCES IN ELECTRONICS APPLIED TO HOSPITAL ENGINEERING**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – basic knowledge signal processing (B.Tech/B.E)				
	Course Coordinator Name & Department:- Mr.Manoj Prasath T. & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To understand the significance of infections, biomedical waste and its proper disposal
- To teach the students about the controls applied to waste management.

COURSE OUTCOMES (COs)

CO1	What clinical engineering is all about and about hospital management
CO2	Types and importance of networking, different topologies and uses
CO3	Principles of fiber optic communication in hospital environment
CO4	Principles of EMI
CO5	Use of virtual environment in medicine
CO6	Understanding the usage of networking in medical 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	PSO2
2	CO1	3		3				3			2				
	CO2					2									

	CO3	2		2										2	
	CO4		1									1			
	CO5							3							
	CO6	2				1					2				
3	Category	Humanities & Social Studies (HS)		Basic Sciences (BS)	Engg Sciences (ES)		Professional Core (PC)	Core Elective (CE)		Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)		
								✓							
4	Approval		47th Meeting of Academic Council, Aug 2018												

UNIT I CLINICAL ENGINEERING 9

Need for Standardization, Medical standards and recalibration, Hospital design, Hospital safety Regulations, hospital Management and Legal aspects.

UNIT II NETWORKING 9

Importance of networking, types of networking, LAN features, network topologies, LAN components, network operating system, basic data communication concept, application, LAN and multi-user system, planning and installing LAN in hospital set up.

UNITIII FIBRE OPTIC SENSORS FOR MEASURING PHYSIOLOGICAL PARAMETERS 9

Different optical sources, optical detectors, principle of fiber optic cables, single mode, multi mode, step index and graded index type, sensors based on polarisation, interferometer principle, magnetic sensors, application of the sensors in measuring pressure, temperature, flow, rotation and chemical activities, principles of smart sensors.

UNIT IV EMI AND EMC APPLIED TO HOSPITAL EQUIPMENTS 9

Principles of EMI, computation Of EMI, measuring techniques to quantify the level of interference, method of suppressing and isolating this unit from interference

UNIT V VIRTUAL REALITY APPLICATION 9

Basic concepts of Virtual Environment , Human Factors and Human Perception, Computer graphics principles used in VR, Modeling of a Virtual Environment ,Existing tools, Avadars, Sensors for Perception, Tracking, Camera, Head mount display used in VR, Applications of Virtual Reality in Medicine

REFERENCES

1. Syed Amin Tabish "Hospital and Health services Administration Principles and Practices Oxford Press New Delhi 2001
2. Jacob Kline – Handbook of Biomedical Engineering Academe press INC Sandiego 1981.
3. Bernhard Keiser, Principles of Electromagnetic Compatibility, Artech House 3rd Edition, 1986.
4. Eric Udd, Fibre Optic Sensors and introduction for engineers and scientists,WileyInterscience Publication, New Delhi, 1991.
5. SK Basandia, Local Area Network,Golgotia Publishing Pvt. Ltd., New Delhi, 1995

OPEN ELECTIVE

P18OECS001 BUSINESS ANALYTICS

P18OECS001	**BUSINESS ANALYTICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Nil				
	Course Designed by – Department of Electrical & Electronics Engineeri				

OBJECTIVES

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

SYLLABUS

Module I Business analytics 9 Hours

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

Module II Trendiness and Regression Analysis 9

Hours

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression, Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Module III Organization Structures of Business analytics 9 Hours

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Module IV Forecasting Techniques 9 Hours

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor, Model, Overbooking Model, Cash Budget Model.

Module V Decision Analysis 5 Hours

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The values of Information, Utility and Decision Making.

Module VI Recent Trends in 4 Hours

Recent Trends in: Embedded and collaborative business intelligence, Visual 4 data recovery, Data Storytelling and Data journalism.

Total No. of Periods: 45

References Books:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

P18OEMA002 OPERATIONS RESEARCH

		L	T	P	C
P18OEMA002	**OPERATIONS RESEARCH**				
	Total Contact Hours – 45	3	0	0	3

	Prerequisite – Nil
	Course Designed by – Department of Electrical & Electronics Engineering

OBJECTIVES

- To apply the dynamic programming to solve problems of discreet and continuous variables.
- To apply the concept of non-linear programming.
- An ability to carry out the sensitivity analysis.
- An ability to model the real world problem and simulate it.

SYLLABUS

Module I Optimization Techniques 9 Hours

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.

Module II Simplex Method 9 Hours

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Module III Nonlinear programming and PERT-CPM 9 Hours

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Module IV Server Models and Geometric Programming 9 Hours

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Module V Graphical AnalysisandSimulation of Game Theory 9 Hours

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Total No. of Periods: 45

References Books:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008

4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010

P18OEME003 INDUSTRIAL SAFETY

		L	T	P	C
P18OEME003	**INDUSTRIAL SAFETY**				
	Total Contact Hours – 45	0	0	0	0
	Prerequisite – Nil				
	Course Designed by – Department of Electrical & Electronics Engineering				

OBJECTIVES

1. To study about the industrial safety and types.
2. To know about the tools and fundamentals of maintenance.
3. To study about the methods of wear and corrosion and their prevention
4. To know about the importance of fault tracing and its concepts.
5. To learn about the periodic and preventive maintenance of safety.

SYLLABUS

Module I Industrial safety 9 Hours

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety color codes. Fire prevention and firefighting, equipment and methods.

Module II Fundamentals of maintenance engineering 9 Hours

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Module III Wear and Corrosion and their prevention 9 Hours

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods

Module IV Fault tracing 9 Hours

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Module V Periodic and preventive maintenance 9 Hours

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Total No. of Periods: 45

References Books:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

P18OEBA004 COST MANAGEMENT OF ENGINEERING PROJECTS

		L	T	P	C
P18OEBA004	**COST MANAGEMENT OF ENGINEERING PROJECTS**				
	Total Contact Hours – 35	3	0	0	3
	Prerequisite – Nil				
	Course Designed by – Department of Electrical & Electronics Engineering				

Module I Introduction and Overview of Cost Management of Engineering 9 Hours

Introduction and Overview of the Strategic Cost Management Process Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Module II ProjectCost Management 10 Hours

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities. Detailed Engineering activities. Pre project execution main

clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Module III Cost Behavior and Profit Planning Marginal Costing 10 Hours

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Module IV Quantitative techniques for cost management 6 Hours

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Total No. of Periods: 35 Hours

References Books:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

P18OEME005 COMPOSITE MATERIALS

P18OEME005	**COMPOSITE MATERIALS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Nil				
	Course Designed by – Department of Electrical & Electronics Engineerin				

Module I Introduction 9 Hours

Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

Module II Reinforcements 9 Hours

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

Module III Manufacturing of Metal Matrix Composites 9 Hours

Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

Module IV Manufacturing of Polymer Matrix Composites 9 Hours

Preparation of Moulding compounds andprepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

Module V Strength 9 Hours

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximumstrain criteria, interacting failure criteria, hydro thermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Total No. of Periods: 45 Hours

Text Books:

Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.

Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

References:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W.Tasi.

P18OEEE006 WASTE TO ENERGY

	WASTE TO ENERGY	**L**	**T**	**P**	**C**

P18OEEE006	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Nil				
	Course Designed by – Department of Electrical & Electronics Engineering				

Module I Introduction to Energy from Waste 9 Hours

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forestresidue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Module II Biomass Pyrolysis 9 Hours

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods -Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Module III Biomass Gasification 9 Hours

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Module IV Biomass Combustion 9 Hours

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs,Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Module V Biogas 9 Hours

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technologyand status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Total No. of Periods: 45

References Books:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

P18OECE007 ENVIRONMENTAL HEALTH ENGINEERING

	ENVIRONMENTAL HEALTH ENGINEERING	L	T	P	C
P18OECE007	Total Contact Hours - 45	3	0	0	3
	Prerequisite – Waste Management				
	Course Designed by – Dept of Civil Engineering				

Module I INTRODUCTION 9 Hours

Impact of Development and Water Pollution – Ecology and ecosystems Impact of development, land use and natural resource management, Cause and effects of environmental pollution

Module II SOURCES OF POLLTION 9Hours

Natural Processes: Pollution due to industrial, agriculture and municipal wastes – Limitation of disposal of dilution. BOD considerations in streams- Water Pollution control legislation.

Module III AIR POLLUTION 9 Hours

Air and Noise Pollution and Control- Pollutants and their sources- Effect of pollution of human wealth, vegetation- Air pollution control legislation -noise pollution- sources and effects – Control measures.

Module IV SOLID WASTE MANAGEMENT 9 Hours

Solid Wastes Management and Water Control Sources - Characteristics Quantities – Collection methods and disposal techniques - Sanitary -landfill -Incineration and pyrolysis – composting - water borne diseases – of mosquitoes, flies, rodents.Rational control and naturalistic methods of control, uses and limitations of pesticides, engineering measures of water control.

Module V FOOD SANITATION 9 Hours

Food & Milk Sanitation : Relation of food to disease – principles of food sanitation – Sanitation of Kitchen in restaurants and other catering establishments – Quality changes in milk – Milk as carrier of infection – Pasteurization of milk – HTST and LTLT processes. Cattle shed sanitation.

TEXT BOOKS

1. Ehlws V.M. and E.W. Steel. Municipal and Rural Sanitation – McGraw Hill Co. Inc, New York, 1954

REFERENCES

1. Park J.E. and Park K.,"Text Book of Preventing and Social Medicine",M/s. Banarsidos, Bhanot, Jabalpur, 1980.
2. Stern A.C. *ed,* "Air Pollution Vol. I, II & III", Academic Press, New York, 1968
3. Cuniff P.E,"Environmental Noise Pollution", John Wiley & Sons, New York. 1977.

P18OEBT008 BIO ENTREPRENEURSHIP DEVELOPMENT

P18OEBT008	BIO ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
	Total Contact Hours - 45	3	0	0	3
	Prerequisite –Bioprocess, genetic engineering, TQM				
	Course Designed by – Dept of Industrial Biotechnology				

Module I ENTREPRENEURSHIP FUNDAMENALS 9 Hours

Entrepreneur – Entrepreneurship – Enterprise – Writing good business plan – operations and management.

Module II DECISION MAKING AND TIME MANAGEMENT 9 Hours

Entrepreneur psychology – personal decision making style – Decision making process – setting personal and Business goals – Setting time priorities – Business person working at home.

Module III ENTREPRENEURSHIP – FINANCE AND ECONOMIC FEASIBILITY 9 Hours

Financing the business– Raising venture capital – Financing sources – Pricing the product (or) Service – operating expenses Economic Analysis – Basic financial Analysis worksheets

Module IV COMPANY LAWS AND REGULATIONS 9 Hours

Forming companies– Types of companies – Types of market – Proprietary information: Intellectual property, copy right, ownerships, Trademark, Patent – International Trade

Module V ENTREPRENEURSHIP IN BIOTECHNOLOGY 9 Hours

Various business opportunities in Biotechnology – Development of Biotech companies in India – Case studies on Biotech companies and its growth

TEXT BOOK

1. Exploring Entrepreneurship: D. Allan Barefield and George F. Smith, Ettmae Westbrook, Tennesse State University, 2006

REFERENCES

1. Entrepreneurship fundamentals by Zobias Kollmann International journal of Zechnology management,2007

P18OEBM009	REHABILITATION ENGINEERING	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Knowledge in artificial organs (B.Tech/B.E)				
	Course Coordinator Name & Department:- Ms.Geetha S & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- To develop an understanding of the various rehabilitation aid principle and its working.
- To give various information about rehabilitation medicine and Advocacy.

COURSE OUTCOMES (COs)

CO1		Design rehabilitation aid and apply them with confidence, to help the challenged people.
CO2		The rehabilitation process for people with disabilities often entails the design of assistive devices such as walking aids intended to promote inclusion of their users into the mainstream of society, commerce, and recreation.
CO3		Within the National Health Service of the United Kingdom Rehabilitation Engineers(REs) are commonly involved
CO4		This includes electrically powered wheelchairs, active user (lightweight) manual wheelchairs, and in more advanced clinics this may include assessments for specialist wheelchair control systems and/or bespoke seating solutions.
CO5		Learn about the technologies relating Rehabilitation Engineering
CO6		To Understand the concepts of Rehabilitation in medicine

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	PSO2
2	CO1	3	3	2			3			2				3	
	CO2				3			3			2	3			
	CO3		2			2	3			2					
	CO4			2				3							
	CO5				3				3						
	CO6	3			2			3							

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
								✓		

4	Approval	47th Meeting of Academic Council, Aug 2018

UNIT I REHABILITATION TECHNOLOGY 9

Selection, design or manufacturing of augmentive or assistive devices appropriate for individual with disability

UNIT II REHABILITATION SCIENCE 9

Knowledge about the basic and clinical research about the variation in the physiological functioning and anatomical structure

UNIT III REHABILITATION ADVOCACY 9

Legal aspect helps the handicapped people in choosing the device, the provisions available to them in this regard.

UNIT IV REHABILITATION MEDICINE 9

Physiological aspects of functional recovery, neurological and psychological aspects, rehabilitation therapies, training to restore vision auditory and speech

UNIT V RÉHABILITATION ENGINEERING TECHNOLOGIES: PRINCIPLESOF APPLICATION 9

Conceptual frameworks, Education and Quality Assurance, Specific Impairments and Related technologies, Future Developments – Rehabilitation Robotics, and Brain computer interface systems.

REFERENCES

1. Reswick.J. What is Rehabilitation Engineering? ,Annual Review of rehabilitation Volume 2 Springer - Vorlage, New York, 1982.
2. Robinson.C.J, Rehabilitation Engineering, Handbook of electrical engineering, CRC Press, Bocaraton, 1993

P18OEBM010	**BIO MECHANICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – Knowledge in tissue engineering (B.Tech/B.E)				
	Course Coordinator Name & Department:- Ms.Vinodhini R & Department. of Biomedical Engineering				

COURSE OBJECTIVES:-

- Introduction to bio-mechanics.
- To know mechanical properties of soft biological tissues.

COURSE OUTCOMES (COs)

CO1	To learn Newton's laws, biofluid mechanics, soft tissue mechanics, stress, strain, shearrate, viscosity, visco elasticity and non Newtonian viscosity**.**
CO2	Learn the Flow properties of blood, effect of shear rate.
CO3	To learn Orthopedic biomechanics.
CO4	To learn Skeletal muscles servo mechanism.
CO5	Study the Experimental and Analytical method of analysis, Clinical evaluation, Head Injury tolerance, rotational injury, spine injury.
CO6	To understand the mechanical activity of biological systems

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	PSO2
2	CO1	2	1	3	1	2	2	2	2						
	CO2	2	1	3	1	2	2	2	2						
	CO3	2	1	3	1	2	2	2	2						
	CO4	2	1	3	1	2	2	2	2						3
	CO5	2	1	3	1	2	2	2	2						
	CO6	2	1	3	1	2	2	2	2						

3	Category	Humanities & Social Studies (HS)	Basic Sciences (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Any other	Project/Term Paper/ Seminar/ Internship(PR)
								✓		

4	Approval		47^{th} Meeting of Academic Council, Aug 2018

UNIT I INTRODUCTION 9

Introduction to bio-mechanics, relation between mechanics and Medicine, Newton's laws, biofluid mechanics, soft tissue mechanics, stress, strain, shear rate, viscosity, visco elasticity, non Newtonian viscosity, mechanical properties of soft biological tissues.

UNIT II MECHANICS OF CIRCULATION 9

Flow properties of blood, effect of shear rate, hematocrit, temperature and protein Content of blood, rheology of blood and micro vessels, dynamics of circulatory system, turbulence flow around prosthetic heart valves.

UNIT III MECHANICS APPLIED TO ORTHOPAEDICS 9

Orthopedic biomechanics, mechanical properties of bones, stress induced bone growth, kinematics and kinetics of joints, lubrication of joints, analysis of force in orthopedic implants.

UNIT IV MECHANISM OF BIOLOGICAL SYSTEMS 9

Skeletal muscles servo mechanism, Cardio vascular control mechanism, respiratory control mechanism

UNIT V BIO MECHANICAL ASPECT OF ACCIDENT INVESTIGATION **9**

Experimental and Analytical method of analysis, Clinical evaluation, Head Injury tolerance, rotational injury, spine injury – Accident reconstruction, Analysis of impact, skid analysis – Damage analysis.

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1. Y.C.Fung, Biomechanics : Mechanical properties in living tissues, Springer Verlag, Newyork1981.
2. D.Dawson and Right, Introduction to Bio-mechanics of joints and joint replacement, Mechanical Engineering publications Ltd. 1989.
3. Jacob clime, Head book of Bio Medical Engineering, Academic Press in, Sandiego, 1988.

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