ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
B.E. BIOMEDICAL ENGINEERING
REGULATIONS – 2017
CHOICE BASED CREDIT SYSTEM

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO1 - To enable the graduates to demonstrate their skills in solving challenges in their chosen field through the core foundation and knowledge acquired in engineering and biology.

PEO2 - To enable the graduates to exhibit leadership, make decisions with societal and ethical responsibilities, function and communicate effectively in multidisciplinary settings.

PEO3 - To ensure that graduates will recognize the need for sustaining and expanding their technical competence and engage in learning opportunities throughout their careers.

PROGRAM OUTCOMES (POs):

Engineering Graduates will be able to:

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

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

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

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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

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

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OBJECTIVES (PSOs):

1) To design and develop diagnostic and therapeutic devices that reduces physician burnout and enhance the quality of life for the end user by applying fundamentals of Biomedical Engineering.

2) To apply software skills in developing algorithms for solving healthcare related problems in various fields of Medical sector.

3) To adapt to emerging information and communication technologies (ICT) to innovate ideas and solutions for current societal and scientific issues thereby developing indigenous medical instruments that are on par with the existing technology

Provide mapping of 1) POs to PEOs and 2) PSOs to PEOs.
Use the following marking:

Contribution   1: Reasonable   2:Significant   3:Strong

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the programme objective and the outcomes is given in the following table

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	A	B	C	D	E	F	G	H	I	J	K	L
1	3	3	3	3	2	2	2	2	1	1	1	1
2	1	1	1	2	1	3	3	3	3	3	3	1
3	3	3	3	2	2	1	1	1	2	2	2	3

MAPPING OF PROGRAM SPECIFIC OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the Program Specific Objectives and the outcomes is given in the following table

PROGRAM SPECIFIC OBJECTIVES	PROGRAMME OUTCOMES											
	A	B	C	D	E	F	G	H	I	J	K	L
1	3	3	3	3	2	3	3	3	2	2	1	2
2	3	3	3	3	3	1	1	1	1	1	1	2
3	3	3	3	3	3	2	1	2	1	1	1	3

ANNA UNIVERSITY, CHENNAI
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B.E. BIOMEDICAL ENGINEERING
REGULATIONS – 2017
CHOICE BASED CREDIT SYSTEM
I SEMESTER

COURSE OUTCOMES MAPPING WITH PROGRAMM OUTCOMES

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
COMMUNICATIVE ENGLISH	• Develop listening skills for academic and professional purposes.							✓		✓		✓
	• Gain familiarity with learning approaches connected to successful writing								✓	✓		✓
ENGINEERING MATHEMATICS I	• Demonstrates confidence in using mathematics to obtain realistic solutions to problems	✓				✓			✓			
	• Interpret and communicate mathematics in a variety of problem solving.	✓				✓			✓			
ENGINEERING PHYSICS	• Ability to identify, formulate, and solve real world problems.	✓	✓									
	• Apply basic knowledge of science to explain observable phenomena.	✓	✓									

ENGINEERING CHEMISTRY	• Demonstrate the principles of basic chemistry including the chemical reactions and mechanism	✓	✓										
	• Enhance the thinking capabilities in the modern trends in Engineering & Technology	✓	✓										
PROBLEM SOLVING AND PYTHON PROGRAMMING	• Identify and eliminate errors in programs	✓	✓	✓									
	• Specify, trace, and implement programs written in a contemporary programming language that solve a stated problem in a clean and robust fashion	✓	✓	✓									
ENGINEERING GRAPHICS	• Know and understand the conventions and the methods of engineering drawing.	✓	✓	✓	✓								
	• Students will be able to improve their visualization skills so that they can apply these skills in developing new products.	✓	✓	✓	✓								

Course	Course Outcome												
PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	• Apply good programming design methods for program development.	✓	✓	✓	✓								
	• Design and implement Computer programs for simple applications.	✓	✓	✓	✓								
PHYSICS AND CHEMISTRY LABORATORY	• Practice applications of various phenomena of light, which includes laser, fibre optics, spectrometer grating.	✓	✓	✓		✓							
	• Gain hands-on knowledge in the quantitative chemical analysis of water quality related parameters	✓	✓	✓		✓							

SEMESTER II													
TECHNICAL ENGLISH	• Read different genres of texts, infer implied meanings and critically analyse and evaluate them for ideas as well as for method of presentation.						✓	✓			✓	
	• Listen/view and comprehend different spoken excerpts critically and infer unspoken and infer unspoken and implied meanings.						✓	✓			✓	
ENGINEERING MATHEMATICS II	• The subject helps the students to develop the fundamentals and basic concepts in vector calculus, ODE, Laplace transform and complex functions.	✓				✓		✓				
	• Students will be able to solve problems related to engineering applications by using mathematical	✓				✓		✓				

	techniques.													
PHYSICS FOR ELECTRONICS ENGINEERING	• Organize, analyze and interpret information and use the scientific method to make inferences about material physics	✓	✓			✓			✓				
	• Relate concepts learned in Physical Science and Engineering Department classes to real world situations	✓	✓			✓			✓				
ENGINEERING MECHANICS FOR BIOMEDICAL ENGINEERS	• Use scalar and vector analytical techniques for analysing forces in statically determinate structures	✓	✓			✓							
	• Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems	✓	✓			✓							
FUNDAMENTALS OF BIO CHEMISTRY	• Wide view about the classification, structures and properties of	✓	✓										

		1	2	3	4	5	6	7	8	9	10	11	12
	carbohydrates, lipids, aminoacids, proteins and nucleic acid and their metabolism.												
	• Knowledge about the mechanism of actions of enzymes and co-enzymes, clinical importance of enzymes and interpretation of their activities.	✓	✓										
CIRCUIT ANALYSIS	• Learn how to develop and employ circuit models for elementary electronic components	✓	✓			✓							
	• Become adopt at using various methods of circuit analysis	✓	✓			✓							
ENGINEERING PRACTICES LABORATORY	• Ability to fabricate electrical and electronics circuits.	✓		✓									
	• Demonstrate wide knowledge on mechanical and civil operations	✓		✓									
BIO CHEMISTRY LABORATORY	• Demonstrate a qualitative and quantitative	✓	✓	✓				✓					

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	understanding of major biomolecules such as carbohydrates, lipids and proteins												
	• Demonstrate the basic analytical techniques for biochemical applications	✓	✓	✓					✓				

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
LINEAR ALGEBRA AND PARTIAL DIFFERENTIAL EQUATIONS	Compute basic objects associated with vector spaces and linear transformation.	✔											
	Concepts on eigenvalues and eigenvectors of a matrix and inner product spaces.	✔	✔										
	The fundamental concepts of partial differential equations and the various solution procedures for solving the first order non-linear partial differential equations.	✔	✔	✔						✔			
	Analytical methods for solving higher order partial differential equations and the application of Fourier series for solving the initial boundary value problems in one dimensional wave and heat equations and boundary value problems in elliptic equations.	✔		✔						✔			✔

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
ANATOMY AND HUMAN PHYSIOLOGY	Students would be able to explain basic structure and functions of cell								✔			✔	
	Students would be able to explain interconnect of various systems	✔							✔				
	Students would be learnt about anatomy and physiology of various systems of human body	✔					✔		✔	✔			✔
ELECTRON DEVICES AND CIRCUITS	Explain the structure and working operation of basic electronic devices.	✔	✔			✔				✔			
	Able to identify and differentiate both active and passive elements	✔		✔									
	Analyze the characteristics of different electronic devices such as diodes and transistors	✔	✔		✔				✔				✔
	Choose and adapt the required components to construct an amplifier circuit.	✔		✔	✔				✔		✔	✔	✔
	Employ the acquired knowledge in design and analysis of oscillators	✔	✔			✔						✔	
PATHOLOGY AND MICROBIOLOGY	Analyze structural and functional aspects of living organisms.		✔			✔			✔				
	Explain the function of microscope	✔				✔				✔			✔
	Discuss the importance of public health.					✔	✔		✔	✔			
	Describe methods involved in treating the pathological diseases.		✔				✔		✔		✔	✔	✔

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
PATHOLOGY AND MICROBIOLOGY LABORATORY	Student can perform practical experiments on tissue processing, cryoprocessing, staining Processes etc.		✔	✔		✔			✔	✔			
HUMAN PHYSIOLOGY LABORATORY	Identification and enumeration of blood cells	✔				✔					✔		✔
	Enumeration of haematological parameters			✔		✔			✔	✔			
	Analysis of special sensory organs test	✔	✔				✔						✔
MEDICAL PHYSICS	Explain about non-ionizing radiation, interaction with tissue and its effects.	✔					✔				✔		
	Define and compare intensities of sensory stimuli	✔	✔										
	Summarizes how ionizing radiation interacts with the human body, how to quantify it and its levels seen in the environment and healthcare	✔			✔		✔		✔			✔	
	Explain the fundamentals of radioactivity and radioactive isotopes			✔						✔		✔	✔
	Illustrates the methods of detecting and recording the ionizing radiation and its interaction with matter			✔	✔					✔			✔

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
BASICS OF ELECTRICAL ENGINEERING	Make right choice on motors for different applications			✔					✔	✔			
	Understand power distribution and hence apply safety principles to biomedical equipments	✔	✔	✔				✔				✔	✔
	Analyze electromagnetic fields and its effects on different media		✔		✔			✔			✔		✔
LINEAR INTEGRATED CIRCUITS	Design linear and non linear applications of op – amps		✔				✔						
	Design applications using analog multiplier and PLL	✔		✔	✔						✔		✔
	Design ADC and DAC using op – amps	✔		✔		✔							✔
	Generate waveforms using op – amp circuits					✔							
	Analyze special function ICs		✔		✔		✔			✔			
INTEGRATED CIRCUITS LABORATORY	Design oscillators and amplifiers using operational amplifiers	✔				✔				✔			✔
	Design filters using Op-amp and perform experiment on frequency response.		✔	✔			✔						✔
	Analyze the working of PLL and use PLL as frequency multiplier.				✔	✔							
	Design DC power supply using ICs.		✔							✔			
	Acquire knowledge in using SPICE	✔	✔		✔			✔		✔	✔		✔

SUBJECT NAME	COURSE OUTCOMES		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
SENSORS AND MEASUREMENT	Analyse various electrical parameters with accuracy, precision, resolution			✔	✔	✔									
	Select appropriate passive or active transducers for measurement of physical phenomenon.			✔	✔	✔	✔	✔	✔						
	Understand and select appropriate light sensors for measurement of physical phenomenon.			✔	✔	✔	✔		✔						
	Employ AC and DC bridges for relevant parameter measurement			✔	✔	✔			✔						
	Employ Multimeter, CRO and different types of recorders for appropriate measurement.			✔	✔	✔	✔		✔						
DEVICES AND CIRCUITS LABORATORY	Analyze the characteristics of basic electronic devices		✔	✔	✔										
	Design RL and RC circuits		✔	✔	✔	✔									
	Understand and Verify Thevinin& Norton theorem KVL & KCL, and Super Position Theorems		✔	✔	✔	✔									
BIOCONTROL SYSTEMS	Understand the need for mathematical modeling of various systems, representation of systems in		✔	✔			✔								

Course	Course Outcome															
	block diagrams and signal flow graphs and are introduced to biological control systems															
	Analyze the time response of various systems and discuss the concept of system stability	✓	✓	✓												
	Analyze the frequency response characteristics of various systems using different charts	✓	✓	✓												
	Understand the concept of modeling basic physiological systems	✓	✓	✓	✓					✓		✓				
	Comprehend the application aspects of time and frequency response analysis in physiological control systems.	✓	✓	✓	✓											
BIOMEDICAL INSTRUMENTATION LABORATORY	Inculcating the knowledge acquired from basic integrated circuits lab to design preamplifiers for various bio signal acquisition.	✔	✔	✔		✔				✔						
	Design and analyze the characteristics of Isolation amplifier	✔	✔	✔		✔				✔						
	To analyze the non-electrical and biochemical measurement techniques	✔		✔		✔				✔						
DIAGNOSTIC AND THERAPEUTIC EQUIPMENT- I	Students would be able to describe the functioning and recording setup of all cardiac and neurological equipments			✔		✔	✔									
	To explain the recording of			✔		✔	✔									

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	Course Outcome															
	EMG and respiratory parameters															
	Describe the measurement techniques of sensory responses			✔		✔	✔									
BIOMECHANICS	Understand the principles of mechanics	✔	✔	✔	✔	✔	✔									
	Outline the principles of biofluid dynamics	✔	✔	✔	✔											
	Explain the fundamentals of bio-solid mechanics	✔	✔	✔												
	Apply the knowledge of joint mechanics.	✔	✔	✔	✔	✔	✔									
	Give Examples of computational mathematical modelling applied in biomechanics.	✔	✔	✔	✔	✔	✔									
DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY	Learn methods to measure different bioelectrical signals and non-electrical parameters	✔		✔		✔						✔				
	Acquire knowledge about the various diagnostic and therapeutic techniques	✔		✔		✔						✔				
	Familiarise with electrical safety measurements	✔		✔		✔	✔					✔				
	Analyse the characteristics of different bio signals using MATLAB and Lab VIEW.	✔		✔		✔						✔				
DIAGNOSTIC AND THERAPEUTIC EQUIPMENT- II	Discuss the various equipments used in ICU and applications of telemetry.			✔		✔	✔									
	Explain the types of diathermy and its applications.			✔		✔	✔									
	Understand the basics of			✔		✔	✔									

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	ultrasound and its application in medicine														
	Discuss the various extracorporeal and special diagnostic devices used in hospitals			✔		✔	✔								
	Outline the importance of patient safety against electrical hazard			✔		✔	✔								
RADIOLOGICAL EQUIPMENTS	Describe the working principle of X ray machine and its application	✔	✔												
	Illustrate the principle computed tomography	✔	✔		✔										
	Interpret the technique used for visualizing various sections of the body using magnetic resonance imaging	✔	✔	✔											
	Demonstrate the applications of radio nuclide imaging	✔	✔		✔										
	Outline the methods of radiation safety.	✔	✔					✔	✔						
REHABILITATION ENGINEERING	Gain adequate knowledge about the needs of rehabilitations and its future development	✔	✔	✔	✔	✔	✔				✔				
	Have an in depth idea about Engineering Concepts in Sensory & Motor rehabilitation.	✔	✔												
	Apply the different types of Therapeutic Exercise Technique to benefit the society	✔	✔	✔	✔	✔	✔				✔				

		1	2	3	4	5	6	7	8	9	10	11	12
	Design and apply different types Hearing aids, visual aids and their application in biomedical field and hence the benefit of the society.	✔	✔	✔	✔	✔	✔			✔			
	Gain in-depth knowledge about different types of models of Hand and arm replacement.	✔	✔										
BIOMEMS	Describe various MEMS fabrication techniques	✔	✔	✔			✔						
	Explain different types of sensors and actuators and their principles of operation at the micro Scale level.	✔	✔	✔	✔		✔						
	Apply MEMS in different field of medicine				✔	✔	✔						
BIO SIGNAL PROCESSING	Plot different types of biomedical signals and analyse their spectral components.	✔	✔			✔							
	Implement different filters on biomedical signals and analyse its performance	✔	✔	✔		✔							
	Identify physiological interferences and artifacts affecting ECG signal	✔	✔			✔							
	Compute power and correlation spectra of EEG signal.	✔	✔	✔		✔							

PHYSIOLOGICAL MODELLING / ROBOTICS IN MEDICINE	Outcome										
	Propose an algorithm to classify biomedical signals.	✔	✔	✔	✔	✔	✔				
PHYSIOLOGICAL MODELLING	Explain the application of Physiological models	✔				✔	✔				
	Describe the methods and techniques for analysis and synthesis of Linear and dynamic system	✔	✔	✔	✔						
	Develop differential equations to describe the compartmental physiological model	✔	✔	✔	✔		✔				
	Describe Nonlinear models of physiological systems	✔	✔	✔	✔	✔					
	Illustrate the Simulation of physiological systems	✔	✔	✔	✔	✔	✔				
ROBOTICS IN MEDICINE	Understand the basics of robotic systems.	✓									
	Design basic Robotics system and formulate Kinematics.	✓	✓	✓	✓				✓		
	Construct Inverse Kinematic motion planning solutions for various Robotic configurations.	✓	✓								

Module	Outcome	1	2	3	4	5	6	7	8	9	10	11	12
	Design Robotic systems for Medical application	✓	✓	✓	✓		✓			✓			✓
VIRTUAL REALITY AND AUGMENTED REALITY	Analyse& Design a system or process to meet given specifications with realistic engineering constraints	✓	✓	✓	✓					✓	✓		✓
	Identify problem statements and function as a member of an engineering design team	✓			✓		✓			✓	✓		✓
	Utilize technical resources					✓	✓			✓			✓
	Propose technical documents and give technical oral presentations related to design mini project results.	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
BRAIN COMPUTER INTERFACE AND ITS APPLICATIONS	Comprehend and appreciate the significance and role of this course in the present contemporary world.		✓					✓					
	Evaluate concept of BCI.	✓	✓		✓					✓			
	Assign functions appropriately to the human and to the machine	✓	✓	✓	✓	✓	✓						
	Select appropriate feature extraction methods	✓	✓			✓							
	Use machine learning algorithms for translation	✓	✓			✓							
	Develop high-fidelity BCI prototypes	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
ANALOG AND DIGITAL COMMUNICATION	Analyze and explain various analog modulation schemes.	✔			✔					✔			✔
	Describe various digital modulation and pulse modulation techniques.	✔		✔				✔				✔	
	Compare and contrast the strengths and weaknesses of various communication systems	✔	✔		✔		✔			✔			✔
	Describe the source and Error control coding of information		✔			✔		✔			✔		
DISCRETE-TIME SIGNAL PROCESSING	Apply DFT for the analysis of digital signals and systems				✔							✔	
	Design IIR and FIR filters	✔		✔									✔
	Characterize the effects of finite precision representation on digital filters	✔	✔		✔						✔		✔
	Design multirate filters		✔	✔		✔						✔	
	Apply adaptive filters appropriately in communication systems		✔			✔		✔			✔	✔	✔

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
ENVIRONMENTAL SCIENCE AND ENGINEERING	Create awareness among the public in maintaining the environment.	✔	✔				✔		✔		✔		
	Inculcate the knowledge of environmental cleanliness among the public and to eradicate misconception.				✔		✔	✔	✔			✔	✔
	To develop and improve the standard of living by reducing the environmental disaster		✔	✔		✔		✔		✔			
HOSPITAL MANAGEMENT	Explain the principles of Hospital administration.	✔		✔								✔	✔
	Identify the importance of Human resource management		✔		✔		✔		✔		✔		
	List various marketing research techniques.			✔			✔				✔		
	Identify Information management systems and its uses.		✔		✔			✔	✔			✔	
	Understand safety procedures followed in hospitals				✔		✔		✔		✔		✔

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
MINI PROJECT	Formulate a real world problem, identify the requirement and develop the design solutions.	✔	✔	✔				✔	✔		✔		✔
	Express the technical ideas, strategies and methodologies.			✔	✔		✔			✔			
	Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.		✔	✔		✔						✔	
	Test and validate through conformance of the developed prototype and analysis the cost Effectiveness.		✔	✔	✔			✔		✔		✔	
	Prepare report and present the oral demonstrations		✔				✔		✔		✔		✔
DIGITAL IMAGE PROCESSING	Characterize images in the transform domain and configure image compression and restoration techniques in the transform domain.	✔	✔				✔			✔			
	Design image enhancement techniques Design image compression techniques		✔		✔	✔						✔	✔
	Apply image segmentation methods as required by the target application	✔			✔	✔		✔		✔	✔		✔

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
RADIOLOGICAL EQUIPMENTS	Describe the working principle of X- ray machine and its application.	✔	✔								✔	✔	
	Illustrate the principle computed tomography.		✔	✔								✔	
	Interpret the technique used for visualizing various sections of the body using magnetic resonance imaging	✔								✔	✔	✔	
	Demonstrate the applications of radio nuclide imaging.									✔		✔	
	Outline the methods of radiation safety.					✔	✔				✔		
REHABILITATION ENGINEERING	Gain adequate knowledge about the needs of rehabilitations and its future development.	✔						✔					✔
	Have an in depth idea about Engineering Concepts in Sensory & Motor rehabilitation. Apply the different types of Therapeutic Exercise Technique to benefit the society		✔	✔						✔		✔	
	Design and apply different types Hearing aids, visual aids and their application in biomedical field and hence the benefit of the society	✔		✔		✔	✔			✔	✔		✔
	Gain in-depth knowledge about different types of models of Hand and arm replacement.	✔			✔		✔			✔		✔	

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
DIGITAL IMAGE PROCESSING LABORATORY	Perform enhancing operations on the image using spatial filters and frequency domain filters.	✔	✔				✔						✔
	Use transforms and analyze the characteristics of the image.		✔	✔		✔					✔	✔	
	Perform segmentation operations in the images.		✔				✔						✔
	Estimate the efficiency of the compression technique on the images		✔		✔								✔
	Apply image processing technique to solve real health care problems.	✔	✔		✔	✔		✔	✔			✔	
HOSPITAL TRAINING	Advocate a patient-centred approach in healthcare				✔				✔				✔
	Communicate with other health professionals in a respectful and responsible manner		✔				✔		✔	✔	✔		
	Recognize the importance of inter-professional collaboration in healthcare.		✔		✔		✔				✔		✔
	Propose a patient-centred inter-professional health improvement plan based upon the patient's perceived need			✔		✔		✔	✔				
	Use the knowledge of one's own role and those of other professions to address the healthcare needs of populations and patients served.	✔		✔	✔			✔		✔	✔		

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
	Thorough knowledge of the general principles of physics, chemistry, electronics and biology that play a role on the nanometer scale	✔					✔	✔			✔		✔
	Understanding of materials and their properties at the atomic and nanometer level, including an understanding of the intimate relationship between material scale (nanostructure) and the properties/functionality of materials	✔	✔		✔				✔				✔
NANOTECHNOLOGY AND APPLICATIONS	Understanding the essential concepts used in nanotechnology, synthesis and fabrication	✔			✔			✔			✔	✔	
	Having a sound grounding knowledge in characterization of nanomaterials	✔			✔						✔		
	Demonstrate the socioeconomic impact of nanotechnology and ethical issues associated with it.					✔	✔	✔	✔			✔	

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
BIOMATERIALS	Analyze different types of Biomaterials and its classification and apply the concept of nanotechnology towards biomaterials use	✔	✔		✔	✔							✔
	Identify significant gap required to overcome challenges and further development in metallic and ceramic materials		✔		✔		✔			✔	✔		
	Identify significant gap required to overcome challenges and further development in polymeric materials		✔				✔		✔		✔		
	Create combinations of materials that could be used as a tissue replacement implant.	✔			✔	✔		✔					✔
	Understand the testing standards applied for biomaterials	✔			✔				✔			✔	✔
MEDICAL OPTICS	Demonstrate knowledge of the fundamentals of optical properties of tissues	✔			✔	✔			✔		✔		✔
	Analyze the components of instrumentation in Medical Photonics and Configurations		✔										
	Describe surgical applications of lasers.							✔					✔
	Describe photonics and its diagnostic applications.	✔				✔							✔
	Investigate emerging techniques in medical optics		✔		✔			✔	✔		✔	✔	

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
ARTIFICAL ORGANS AND IMPLANTS	Gain adequate knowledge about artificial organs & transplants	✔					✔	✔	✔			✔	
	Get clear idea about implant design and its parameters and solution		✔		✔				✔				✔
	Have in-depth knowledge about blood interfacing implants	✔		✔		✔			✔				✔
	Explain different types of soft tissue replacement and hard tissue replacement				✔	✔		✔	✔		✔		
TELEHEALTH TECHNOLOGY	Apply multimedia technologies in telemedicine	✔			✔	✔		✔		✔		✔	✔
	Explain protocols behind encryption techniques for secure transmission of data				✔						✔		✔
	Apply telehealth in healthcare.		✔	✔			✔	✔	✔		✔		
BIOFLUIDS AND DYNAMICS	Understand the basics of Fluid Mechanics	✔					✔						✔
	Construe the intracellular fluid mechanics and ocular mechanics.		✔		✔	✔			✔			✔	
	Describe the rheology of blood and mechanics of blood vessels.		✔			✔			✔				
	Elucidate on cardiorespiratory mechanics and space medicine.			✔		✔				✔			✔
	Develop mathematical models of biological systems with fluids	✔			✔			✔					

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
SOFT COMPUTING TECHNIQUES	Describe various neural, fuzzy and Genetic algorithms.	✔			✔	✔						✔	✔
	Implement Neural, Genetic and Fuzzy algorithms for various classification applications		✔	✔				✔			✔		✔
FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	Define, formulate and analyze a problem	✔		✔					✔				✔
	Solve specific problems independently or as part of a team		✔		✔	✔			✔				✔
	Gain knowledge of the Innovation & Product Development process in the Business Context			✔			✔	✔				✔	
	Work independently as well as in teams Manage a project from start to finish		✔			✔				✔		✔	
NEURAL ENGINEERING	Understand the physiology behind generation of nerve impulses	✔				✔			✔				✔
	Describe various techniques that are used to evaluate the functioning of central and peripheral nervous system.			✔	✔	✔						✔	✔

	Differentiate between a normal and abnormal signal coming from a healthy and a diseased nervous system respectively		✔	✔			✔		✔				

SUBJECT NAME	COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
BIOMETRIC SYSTEM	Demonstrate the knowledge and engineering principles underlying in biometric systems.	✔				✔		✔				✔	✔
	Analyze and design the basic biometric system applications		✔	✔	✔			✔	✔				
ELECTRICAL SAFETY AND QUALITY ASSURANCE	Develop knowledge and insight into the procedures used in quality control and assurance activities as well as safety measures to be followed in hospitals.	✔					✔	✔			✔	✔	
ERGONOMICS	Understand principles of ergonomics.	✔						✔	✔			✔	
	Design biomedical devices		✔	✔	✔	✔							✔
FUNDAMENTALS OF NANOSCIENCE	Will familiarize about the science of nanomaterials	✔						✔					✔
	Will demonstrate the preparation of nanomaterials		✔		✔	✔		✔				✔	
	Will develop knowledge in characteristic nanomaterial	✔		✔									✔

ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
B.E. BIOMEDICAL ENGINEERING
REGULATIONS – 2017
CHOICE BASED CREDIT SYSTEM
I - VIII SEMESTERS CURRICULA AND SYLLABI

SEMESTER I

SI. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	HS8151	Communicative English	HS	4	4	0	0	4
2.	MA8151	Engineering Mathematics - I	BS	4	4	0	0	4
3.	PH8151	Engineering Physics	BS	3	3	0	0	3
4.	CY8151	Engineering Chemistry	BS	3	3	0	0	3
5.	GE8151	Problem Solving and Python Programming	ES	3	3	0	0	3
6.	GE8152	Engineering Graphics	ES	6	2	0	4	4
PRACTICALS								
7.	GE8161	Problem Solving and Python Programming Laboratory	ES	4	0	0	4	2
8.	BS8161	Physics and Chemistry Laboratory	BS	4	0	0	4	2
			TOTAL	**31**	**19**	**0**	**12**	**25**

SEMESTER II

SI. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	HS8251	Technical English	HS	4	4	0	0	4
2.	MA8251	Engineering Mathematics - II	BS	4	4	0	0	4
3.	PH8253	Physics for Electronics Engineering	BS	3	3	0	0	3
4.	BM8251	Engineering Mechanics for Biomedical Engineers	ES	3	3	0	0	3
5.	BM8201	Fundamentals of Bio Chemistry	PC	3	3	0	0	3
6.	EC8251	Circuit Analysis	PC	4	4	0	0	4
PRACTICALS								
7.	GE8261	Engineering Practices Laboratory	ES	4	0	0	4	2
8.	BM8211	Bio Chemistry Laboratory	PC	4	0	0	4	2
			TOTAL	**29**	**21**	**0**	**8**	**25**

SI. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA8352	Linear Algebra and Partial Differential Equations	BS	4	4	0	0	4
2.	EC8352	Signals and Systems	PC	4	4	0	0	4
3.	BM8351	Anatomy and Human Physiology	PC	3	3	0	0	3
4.	BM8301	Sensors and Measurements	PC	4	2	0	2	3
5.	EC8353	Electron Devices and Circuits	PC	3	3	0	0	3
6.	BM8302	Pathology and Microbiology	PC	3	3	0	0	3
PRACTICALS								
7.	BM8311	Pathology and Microbiology Laboratory	PC	4	0	0	4	2
8.	BM8312	Devices and Circuits Laboratory	PC	4	0	0	4	2
9.	BM8313	Human Physiology Laboratory	PC	2	0	0	2	1
			TOTAL	**31**	**19**	**0**	**12**	**25**

SEMESTER IV

SI. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA8391	Probability and Statistics	BS	4	4	0	0	4
2.	BM8401	Medical Physics	PC	3	3	0	0	3
3.	EE8452	Basics of Electrical Engineering	ES	3	3	0	0	3
4.	EC8453	Linear Integrated Circuits	PC	3	3	0	0	3
5.	EC8393	Fundamentals of Data Structures In C	ES	3	3	0	0	3
6.	EC8392	Digital Electronics	PC	3	3	0	0	3
PRACTICALS								
7.	EC8381	Fundamentals of Data Structures In C Laboratory	ES	4	0	0	4	2
8.	BM8411	Integrated Circuits Laboratory	PC	4	0	0	4	2
			TOTAL	**27**	**19**	**0**	**8**	**23**

SEMESTER V

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	EC8394	Analog and Digital Communication	PC	3	3	0	0	3
2.	BM8501	Biocontrol Systems	PC	4	4	0	0	4
3.	BM8502	Biomedical Instrumentation	PC	3	3	0	0	3
4.	EC8553	Discrete-Time Signal Processing	PC	4	4	0	0	4
5.		Professional Elective - I	PE	3	3	0	0	3
6.		Open Elective -I	OE	3	3	0	0	3
PRACTICALS								
7.	EC8562	Digital Signal Processing Laboratory	PC	4	0	0	4	2
8.	BM8511	Biomedical Instrumentation Laboratory	PC	4	0	0	4	2
9.	HS8381	Interpersonal Skills/Listening & Speaking	EEC	2	0	0	2	1
			TOTAL	**30**	**20**	**0**	**10**	**25**

SEMESTER VI

Sl. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	EC8691	Microprocessors and Microcontrollers	PC	3	3	0	0	3
2.	BM8601	Diagnostic and Therapeutic Equipment - I	PC	3	3	0	0	3
3.	BM8651	Biomechanics	PC	3	3	0	0	3
4.	GE8291	Environmental Science and Engineering	HS	3	3	0	0	3
5.	MD8091	Hospital Management	PC	3	3	0	0	3
6.		Professional Elective - II	PE	3	3	0	0	3
PRACTICALS								
7.	EC8681	Microprocessors and Microcontrollers Laboratory	PC	4	0	0	4	2
8.	BM8611	Diagnostic and Therapeutic Equipment Laboratory	PC	4	0	0	4	2
9.	BM8612	Mini Project	EEC	2	0	0	2	1
10.	HS8581	Professional Communication	EEC	2	0	0	2	1
			TOTAL	**30**	**18**	**0**	**12**	**24**

SEMESTER VII

SI. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	BM8701	Diagnostic and Therapeutic Equipment - II	PC	3	3	0	0	3
2.	EC8093	Digital Image Processing	PC	3	3	0	0	3
3.	BM8702	Radiological Equipments	PC	3	3	0	0	3
4.	BM8703	Rehabilitation Engineering	PC	3	3	0	0	3
5.		Professional Elective III	PE	3	3	0	0	3
6.		Open Elective -II	OE	3	3	0	0	3
PRACTICALS								
7.	EC8762	Digital Image Processing Laboratory	PC	4	0	0	4	2
8.	MD8751	Hospital Training	EEC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**22**

SEMESTER VIII

SI. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Professional Elective IV	PE	3	3	0	0	3
2.		Professional Elective V	PE	3	3	0	0	3
PRACTICALS								
3.	BM8811	Project Work	EEC	20	0	0	20	10
			TOTAL	**26**	**6**	**0**	**20**	**16**

TOTAL NO. OF CREDITS:185

HUMANITIES AND SOCIAL SCIENCES (HS)

SI. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	HS8151	Communicative English	HS	4	4	0	0	4
2.	HS8251	Technical English	HS	4	4	0	0	4
3.	GE8291	Environmental Science and Engineering	HS	3	3	0	0	3

BASIC SCIENCES (BS)

SI. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA8151	Engineering Mathematics I	BS	4	4	0	0	4
2.	PH8151	Engineering Physics	BS	3	3	0	0	3
3.	CY8151	Engineering Chemistry	BS	3	3	0	0	3
4.	BS8161	Physics and Chemistry Laboratory	BS	4	0	0	4	2
5.	MA8251	Engineering Mathematics II	BS	4	4	0	0	4
6.	PH8253	Physics for Electronics Engineering	BS	3	3	0	0	3
7.	MA8352	Linear Algebra and Partial Differential Equations	BS	4	4	0	0	4
8.	MA8391	Probability and Statistics	BS	4	4	0	0	4

ENGINEERING SCIENCES (ES)

SI. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	GE8151	Problem Solving and Python Programming	ES	3	3	0	0	3
2.	GE8152	Engineering Graphics	ES	6	2	0	4	4
3.	GE8161	Problem Solving and Python Programming Laboratory	ES	4	0	0	4	2
4.	BM8251	Engineering Mechanics for Biomedical Engineers	ES	3	3	0	0	3
5.	GE8261	Engineering Practices Laboratory	ES	4	0	0	4	2
6.	EE8452	Basics of Electrical Engineering	ES	3	3	0	0	3
7.	EC8393	Fundamentals of Data Structures In C	ES	3	3	0	0	3
8.	EC8381	Fundamentals of Data Structures In C Laboratory	ES	4	0	0	4	2

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PROFESSIONAL CORE (PC)

SI. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	BM8201	Fundamentals of Bio Chemistry	PC	3	3	0	0	3
2.	EC8251	Circuit Analysis	PC	4	4	0	0	4
3.	BM8211	Bio Chemistry Laboratory	PC	4	0	0	4	2
4.	EC8352	Signals and Systems	PC	4	4	0	0	4
5.	BM8351	Anatomy and Human Physiology	PC	3	3	0	0	3
6.	BM8301	Sensors and Measurements	PC	4	2	0	2	3
7.	EC8353	Electron Devices and Circuits	PC	3	3	0	0	3
8.	BM8302	Pathology and Microbiology	PC	3	3	0	0	3
9.	BM8311	Pathology and Microbiology Laboratory	PC	4	0	0	4	2
10.	BM8312	Devices and Circuits Laboratory	PC	4	0	0	4	2
11.	BM8313	Human Physiology Laboratory	PC	2	0	0	2	1
12.	BM8401	Medical physics	PC	3	3	0	0	3
13.	EC8453	Linear Integrated Circuits	PC	3	3	0	0	3
14.	EC8392	Digital Electronics	PC	3	3	0	0	3
15.	BM8411	Integrated Circuits Laboratory	PC	4	0	0	4	2
16.	EC8394	Analog and Digital Communication	PC	3	3	0	0	3
17.	BM8501	Bio Control Systems	PC	4	4	0	0	4
18.	BM8502	Biomedical Instrumentation	PC	3	3	0	0	3
19.	EC8553	Discrete-Time Signal Processing	PC	4	4	0	0	4
20.	MD8091	Hospital Management	PC	3	3	0	0	3
21.	EC8562	Digital Signal Processing Laboratory	PC	4	0	0	4	2
22.	BM8511	Biomedical Instrumentation Laboratory	PC	4	0	0	4	2
23.	EC8691	Microprocessors and Microcontrollers	PC	3	3	0	0	3
24.	BM8601	Diagnostic and Therapeutic Equipment - I	PC	3	3	0	0	3
25.	BM8651	Biomechanics	PC	3	3	0	0	3
26.	EC8681	Microprocessors and Microcontrollers Laboratory	PC	4	0	0	4	2
27.	BM8611	Diagnostic and Therapeutic Equipment Laboratory	PC	4	0	0	4	2
28.	BM8701	Diagnostic and Therapeutic Equipment - II	PC	3	3	0	0	3
29.	EC8093	Digital Image Processing	PC	3	3	0	0	3
30.	BM8702	Radiological Equipments	PC	3	3	0	0	3
31.	BM8703	Rehabilitation Engineering	PC	3	3	0	0	3
32.	EC8762	Digital Image Processing Laboratory	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES (PE)*
SEMESTER V
ELECTIVE I

SI. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	BM8071	Bio MEMS	PE	3	3	0	0	3
2.	EC8075	Nano Technology and Applications	PE	3	3	0	0	3
3.	BM8072	Biomaterials	PE	3	3	0	0	3
4.	BM8001	Medical Optics	PE	3	3	0	0	3
5.	GE8074	Human Rights	PE	3	3	0	0	3
6.	GE8077	Total Quality Management	PE	3	3	0	0	3

SEMESTER VI
ELECTIVE II

SI. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	BM8074	Biosignal Processing	PE	3	3	0	0	3
2.	BM8002	Artificial organs and Implants	PE	3	3	0	0	3
3.	MD8071	Telehealth Technology	PE	3	3	0	0	3
4.	BM8003	Biofluids and Dynamics	PE	3	3	0	0	3
5.	GE8075	Intellectual Property Rights	PE	3	3	0	0	3

SEMESTER VII
ELECTIVE III

SI. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MD8752	Physiological Modeling	PE	3	3	0	0	3
2.	BM8004	Robotics in Medicine	PE	3	3	0	0	3
3.	CS8081	Internet of Things	PE	3	3	0	0	3
4.	BM8078	Soft Computing Techniques	PE	3	3	0	0	3
5.	GE8072	Foundation Skills in Integrated Product Development	PE	3	3	0	0	3
6.	GE8071	Disaster Management	PE	3	3	0	0	3

SEMESTER VIII
ELECTIVE IV

SI. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	BM8079	Virtual Reality and Augmented Reality	PE	3	3	0	0	3
2.	BM8077	Hospital Waste Management	PE	3	3	0	0	3
3.	BM8005	Neural Engineering	PE	3	3	0	0	3
4.	BM8073	Biometric Systems	PE	3	3	0	0	3
5.	GE8076	Professional Ethics in Engineering	PE	3	3	0	0	3

SEMESTER VIII
ELECTIVE - V

SI. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	BM8076	Electrical Safety and Quality Assurance	PE	3	3	0	0	3
2.	BM8006	Ergonomics	PE	3	3	0	0	3
3.	BM8075	Brain Computer Interface and its Applications	PE	3	3	0	0	3
4.	EC8791	Embedded and Real time Systems	PE	3	3	0	0	3
5.	GE8073	Fundamentals of Nano Science	PE	3	3	0	0	3

*Professional Electives are grouped according to elective number as was done previously.

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SI. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	HS8381	Interpersonal Skills/Listening & Speaking	EEC	2	0	0	2	1
2.	BM8612	Mini Project	EEC	2	0	0	2	1
3.	HS8581	Professional Communication	EEC	2	0	0	2	1
4.	MD8751	Hospital Training	EEC	4	0	0	4	2
5.	BM8811	Project Work	EEC	20	0	0	20	10

SUMMARY

S.NO.	SUBJECT AREA	CREDITS AS PER SEMESTER								CREDITS TOTAL	Percentage
		I	II	III	IV	V	VI	VII	VIII		
1.	HS	4	4				3			11	6%
2.	BS	12	7	4	4					27	14.67%
3.	ES	9	5		8					22	12%
4.	PC		9	21	11	18	16	14		89	48.36%
5.	PE					3	3	3	6	15	8.15%
6.	OE					3		3		6	3.2%
7.	EEC					1	2	2	10	15	7.6%
	Total	25	25	25	23	25	24	22	16	185	
8.	Non Credit / Mandatory										

	L	T	P	C
HS8151	**4**	**0**	**0**	**4**

HS8151   **COMMUNICATIVE ENGLISH**

OBJECTIVES:

- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will, enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills

UNIT I   SHARING INFORMATION RELATED TO ONESELF/FAMILY& FRIENDS   12

Reading- short comprehension passages, practice in skimming-scanning and predicting- **Writing**- completing sentences- - developing hints. **Listening**- short texts- short formal and informal conversations. **Speaking-** introducing oneself - exchanging personal information- **Language development**- Wh- Questions- asking and answering-yes or no questions- parts of speech. **Vocabulary development-**- prefixes- suffixes- articles.- count/ uncount nouns.

UNIT II   GENERAL READING AND   FREE WRITING   12

Reading - comprehension-pre-reading-post reading- comprehension questions (multiple choice questions and /or short questions/ open-ended questions)-inductive reading- short narratives and descriptions from newspapers including dialogues and conversations (also used as short Listening texts)- register- **Writing** – paragraph writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures –**Listening**- telephonic conversations. **Speaking –** sharing information of a personal kind—greeting – taking leave- **Language development** – prepositions, conjunctions **Vocabulary development-** guessing meanings of words in context.

UNIT III   GRAMMAR AND LANGUAGE DEVELOPMENT   12

Reading- short texts and longer passages (close reading) **Writing-** understanding text structure- use of reference words and discourse markers-coherence-jumbled sentences **Listening** – listening to longer texts and filling up the table- product description- narratives from different sources. **Speaking**- asking about routine actions and expressing opinions. **Language development**- degrees of comparison- pronouns- direct vs indirect questions- **Vocabulary development –** single word substitutes- adverbs.

UNIT IV   READING AND LANGUAGE DEVELOPMENT   12

Reading- comprehension-reading longer texts- reading different types of texts- magazines **Writing**- letter writing, informal or personal letters-e-mails-conventions of personal email- **Listening**- listening to dialogues or conversations and completing exercises based on them. **Speaking-** speaking about oneself- speaking about one's friend- **Language development-** Tenses- simple present-simple past-present continuous and past continuous- **Vocabulary development**- synonyms-antonyms- phrasal verbs.

UNIT V   EXTENDED WRITING   12

Reading- longer texts- close reading –**Writing**- brainstorming -writing short essays **–** developing an outline- identifying main and subordinate ideas- dialogue writing-**Listening** – listening to talks-conversations- **Speaking –** participating in conversations- short group conversations-**Language development**-modal verbs- present/ past perfect tense - **Vocabulary development**-collocations-fixed and semi-fixed expressions.

TOTAL: 60 PERIODS

OUTCOMES:
At the end of the course, learners will be able to:
- Read articles of a general kind in magazines and newspapers.
- Participate effectively in informal conversations; introduce themselves and their friends and express opinions in English.
- Comprehend conversations and short talks delivered in English
- Write short essays of a general kind and personal letters and emails in English.

TEXT BOOKS:
1. Board of Editors. **Using English** A Course book for Undergraduate Engineers and Technologists**.** Orient Black Swan Limited, Hyderabad: 2015
2. Richards, C. Jack. **Interchange Students' Book-2** New Delhi: CUP, 2015.

REFERENCES:
1. Bailey, Stephen. **Academic Writing: A practical guide for students**. New York: Rutledge,2011.
2. Means,L. Thomas and Elaine Langlois. **English & Communication For Colleges.** CengageLearning ,USA: 2007
3. Redston, Chris &Gillies Cunningham **Face2Face** (Pre-intermediate Student's Book& Workbook) Cambridge University Press, New Delhi: 2005
4. Comfort, Jeremy, et al. **Speaking Effectively: Developing Speaking Skills for Business English.** Cambridge University Press, Cambridge: Reprint 2011
5. Dutt P. Kiranmai and Rajeevan Geeta. **Basic Communication Skills,** Foundation Books: 2013.

MA8151   **ENGINEERING MATHEMATICS – I**   **L T P C**
                                                                        4 0 0 4

OBJECTIVES :
The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

UNIT I   DIFFERENTIAL CALCULUS   12
Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable.

UNIT II   FUNCTIONS OF SEVERAL VARIABLES   12
Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT III   INTEGRAL CALCULUS   12
Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

UNIT IV   MULTIPLE INTEGRALS   12
Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

UNIT V   DIFFERENTIAL EQUATIONS   12
Higher order linear differential equations with constant coefficients - Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients - Method of undetermined coefficients.

                                                              TOTAL: 60 PERIODS
OUTCOMES:
After completing this course, students should demonstrate competency in the following skills:
- Use both the limit definition and rules of differentiation to differentiate functions.
- Apply differentiation to solve maxima and minima problems.
- Evaluate integrals both by using Riemann sums and by using the Fundamental Theorem of Calculus.
- Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.
- Evaluate integrals using techniques of integration, such as substitution, partial fractions and integration by parts.
- Determine convergence/divergence of improper integrals and evaluate convergent improper integrals.
- Apply various techniques in solving differential equations.

TEXT BOOKS:
1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015. [For Units I & III - Sections 1.1, 2.2, 2.3, 2.5, 2.7(Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1(Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCES:
1. Anton, H, Bivens, I and Davis, S, "Calculus", Wiley, 10th Edition, 2016.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Narayanan, S. and Manicavachagom Pillai, T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
4. Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
5. Weir, M.D and Joel Hass, "Thomas Calculus", 12th Edition, Pearson India, 2016.

	L	T	P	C
PH8151 **ENGINEERING PHYSICS**	3	0	0	3

OBJECTIVES:
- To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT I   **PROPERTIES OF MATTER**   **9**

Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment - I-shaped girders - stress due to bending in beams.

UNIT II   **WAVES AND FIBER OPTICS**   **9**

Oscillatory motion – forced and damped oscillations: differential equation and its solution – plane progressive waves – wave equation. Lasers : population of energy levels, Einstein's A and B coefficients derivation – resonant cavity, optical amplification (qualitative) – Semiconductor lasers: homojunction and heterojunction – Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) – losses associated with optical fibers - fibre optic sensors: pressure and displacement.

UNIT III   **THERMAL PHYSICS**   **9**

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation – heat conductions in solids – thermal conductivity - Forbe's and Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

UNIT IV   QUANTUM PHYSICS   9
Black body radiation – Planck's theory (derivation) – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional rigid box – tunnelling (qualitative) - scanning tunnelling microscope.

UNIT V   CRYSTAL PHYSICS   9
Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - crystal imperfections: point defects, line defects – Burger vectors, stacking faults – role of imperfections in plastic deformation - growth of single crystals: solution and melt growth techniques.

TOTAL : 45 PERIODS

OUTCOMES:
Upon completion of this course:
- The students will gain knowledge on the basics of properties of matter and its applications,
- The students will acquire knowledge on the concepts of waves and optical devices and their applications in fibre optics,
- The students will have adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers,
- The students will get knowledge on advanced physics concepts of quantum theory and its applications in tunneling microscopes, and
- The students will understand the basics of crystals, their structures and different crystal growth techniques.

TEXT BOOKS:
1. Bhattacharya, D.K. & Poonam, T. "Engineering Physics". Oxford University Press, 2015.
2. Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, 2012.
3. Pandey, B.K. & Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2012.

REFERENCES:
1. Halliday, D., Resnick, R. & Walker, J. "Principles of Physics". Wiley, 2015.
2. Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers".   Cengage Learning, 2010.
3. Tipler, P.A. & Mosca, G. "Physics for Scientists and Engineers with Modern Physics'. W.H.Freeman, 2007.

CY8151   **ENGINEERING CHEMISTRY**   **L T P C**
                                                                           3 0 0 3

OBJECTIVES:
- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.

UNIT I   WATER AND ITS TREATMENT   9
Hardness of water – types – expression of hardness – units – estimation of hardness of water by EDTA – numerical problems – boiler troubles (scale and sludge) – treatment of boiler feed water – Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) external treatment – Ion exchange process, zeolite process – desalination of brackish water - Reverse Osmosis.

UNIT II   SURFACE CHEMISTRY AND CATALYSIS   9
Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms – Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – contact theory – kinetics of surface reactions, unimolecular reactions, Langmuir - applications of adsorption on pollution abatement.
Catalysis: Catalyst – types of catalysis – criteria – autocatalysis – catalytic poisoning and catalytic promoters - acid base catalysis – applications (catalytic convertor) – enzyme catalysis– Michaelis – Menten equation.

UNIT III   ALLOYS AND PHASE RULE   9
Alloys: Introduction- Definition- properties of alloys- significance of alloying, functions and effect of alloying elements- Nichrome and stainless steel (18/8) – heat treatment of steel. Phase rule: Introduction, definition of terms with examples, one component system -water system - reduced phase rule - thermal analysis and cooling curves - two component systems - lead-silver system - Pattinson process.

UNIT IV   FUELS AND COMBUSTION   9
Fuels: Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - manufacture of synthetic petrol (Bergius process) - knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) - power alcohol and biodiesel. Combustion of fuels: Introduction - calorific value - higher and lower calorific values- theoretical calculation of calorific value - ignition temperature - spontaneous ignition temperature - explosive range - flue gas analysis (ORSAT Method).

UNIT V   ENERGY SOURCES AND STORAGE DEVICES   9
Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant - breeder reactor - solar energy conversion - solar cells - wind energy. Batteries, fuel cells and supercapacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H_2-O_2 fuel cell.

TOTAL: 45 PERIODS

OUTCOMES:
- The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.

TEXT BOOKS:
1. S. S. Dara and S. S. Umare, "A Textbook of Engineering Chemistry", S. Chand & Company LTD, New Delhi, 2015
2. P. C. Jain and Monika Jain, "Engineering Chemistry" Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
3. S. Vairam, P. Kalyani and Suba Ramesh, "Engineering Chemistry", Wiley India PVT, LTD, New Delhi, 2013.

REFERENCES:
1. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
2. Prasanta Rath, "Engineering Chemistry", Cengage Learning India PVT, LTD, Delhi, 2015.
3. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015.

GE8151   **PROBLEM SOLVING AND PYTHON PROGRAMMING**   **L T P C**
                                                                       3 0 0 3

OBJECTIVES:
- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures –- lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT I   **ALGORITHMIC PROBLEM SOLVING**   **9**
Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II   **DATA, EXPRESSIONS, STATEMENTS**   **9**
Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III   **CONTROL FLOW, FUNCTIONS**   **9**
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV   LISTS, TUPLES, DICTIONARIES   9

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

UNIT V   FILES, MODULES, PACKAGES   9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

OUTCOMES:
Upon completion of the course, students will be able to
- Develop algorithmic solutions to simple computational problems
- Read, write, execute by hand simple Python programs.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python Programs.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

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

GE8152   **ENGINEERING GRAPHICS**   **L T P C**
                                                                                       2 0 4 4

OBJECTIVES:
- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination)   **1**
Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I   PLANE CURVES AND FREEHAND SKETCHING   7+12
Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.
Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT II   PROJECTION OF POINTS, LINES AND PLANE SURFACE   6+12
Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III   PROJECTION OF SOLIDS   5+12
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV   PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF
**   SURFACES   5+12**
Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT V   ISOMETRIC AND PERSPECTIVE PROJECTIONS   6+12
Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and   cylinders by visual ray method .

TOTAL: 90 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Familiarize with the fundamentals and standards of Engineering graphics
- Perform freehand sketching of basic geometrical constructions and multiple views of objects.
- Project orthographic projections of lines and plane surfaces.
- Draw projections and solids and development of surfaces.
- Visualize and to project isometric and perspective sections of simple solids.

TEXT BOOKS:
1. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

REFERENCES:
1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. N S Parthasarathy And Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson, 2nd Edition, 2009.

Publication of Bureau of Indian Standards:
1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:
1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only.
4. The Students will be permitted to use appropriate scale to fit solution within A3 size.
5. The examination will be conducted in appropriate sessions on the same day

GE8161   PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY   L T P C
0 0 4 2
OBJECTIVES
- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python.

LIST OF PROGRAMS
1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton's method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers

9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Simulate elliptical orbits in Pygame
13. Simulate bouncing ball using Pygame

PLATFORM NEEDED
Python 3 interpreter for Windows/Linux.

OUTCOMES
Upon completion of the course, students will be able to
- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.

TOTAL: 60 PERIODS.

BS8161	PHYSICS AND CHEMISTRY LABORATORY	L	T	P	C
	(Common to all branches of B.E. / B.Tech Programmes)	0	0	4	2

OBJECTIVES:
- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter and liquids.

LIST OF EXPERIMENTS: PHYSICS LABORATORY (Any 5 Experiments)
1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young's modulus by non-uniform bending method
3. (a) Determination of wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fiber.
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of band gap of a semiconductor
8. Determination of thickness of a thin wire – Air wedge method

TOTAL: 30 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able to
- Apply principles of elasticity, optics and thermal properties for engineering applications.

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

OBJECTIVES:
- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by viscometery.

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline / thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
11. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
12. Pseudo first order kinetics-ester hydrolysis.
13. Corrosion experiment-weight loss method.
14. Determination of CMC.
15. Phase change in a solid.
16. Conductometric titration of strong acid vs strong base.

OUTCOMES:
- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

TOTAL: 30 PERIODS

TEXTBOOKS:
1. Vogel's Textbook of Quantitative Chemical Analysis (8TH edition, 2014)

	L	T	P	C
HS8251 **TECHNICAL ENGLISH**	4	0	0	4

OBJECTIVES:
The Course prepares second semester engineering and Technology students to:

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Develop their speaking skills to make technical presentations, participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialisation.

UNIT I   INTRODUCTION TECHNICAL ENGLISH   12
Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises- **Speaking** –Asking for and giving directions- **Reading** – reading short technical texts from journals- newsapapers- **Writing**- purpose statements – extended definitions – issue- writing instructions – checklists-recommendations-**Vocabulary Development**- technical vocabulary **Language Development** –subject verb agreement - compound words.

UNIT II   READING AND STUDY SKILLS   12

Listening- Listening to longer technical talks and completing exercises based on them-**Speaking** – describing a process-**Reading** – reading longer technical texts- identifying the various transitions in a text- paragraphing- **Writing**- interpreting cgarts, graphs- **Vocabulary Development**- vocabulary used in formal letters/emails and reports   **Language Development-** impersonal passive voice, numerical adjectives.

UNIT III   TECHNICAL WRITING AND GRAMMAR   12

Listening- Listening to classroom lectures/ talkls on engineering/technology -**Speaking** – introduction to technical presentations-   **Reading** – longer texts both general and technical, practice in speed reading; **Writing**-Describing a process, use of sequence words- **Vocabulary Development-** sequence words- Misspelled words. **Language Development-** embedded sentences

UNIT IV   REPORT WRITING   12

Listening- Listening to documentaries and making notes. **Speaking** – mechanics of presentations- **Reading** – reading for detailed comprehension- **Writing**- email etiquette- job application – cover letter –Résumé preparation(via email and hard copy)- analytical essays and issue based essays--**Vocabulary Development**- finding suitable synonyms-paraphrasing-. **Language Development-** clauses- if conditionals.

UNIT V   GROUP DISCUSSION AND JOB APPLICATIONS   12

Listening- TED/Ink talks; **Speaking** –participating in a group discussion -**Reading**– reading and understanding technical articles **Writing**– Writing reports- minutes of a meeting- accident and survey-**Vocabulary Development- verbal analogies Language Development-** reported speech

                                        TOTAL :   60   PERIODS

OUTCOMES:
At the end of the course learners will be able to:
- Read technical texts and write area- specific texts effortlessly.
- Listen and comprehend lectures and talks in their area of specialization successfully.
- Speak appropriately and effectively in varied formal and informal contexts.
- Write reports and winning job applications.

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

REFERENCES:
1. Raman, Meenakshi and Sharma, Sangeetha- **Technical Communication Principles and Practice.**Oxford University Press: New Delhi,2014.
2. Kumar, Suresh. E. **Engineering English**. Orient Blackswan: Hyderabad,2015.
3. Booth-L. Diana**, Project Work,** Oxford University Press**,** Oxford: 2014.
4. Grussendorf, Marion, **English for Presentations,** Oxford University Press, Oxford: 2007.
5. Means, L. Thomas and Elaine Langlois, **English & Communication For Colleges.** Cengage Learning, USA: 2007.

Students can be asked to read Tagore, Chetan Bhagat and for supplementary reading.

MA8251   **ENGINEERING MATHEMATICS – II**   **L T P C**
                                                                         4 0 0 4

OBJECTIVES :
This course is designed to cover topics such as Matrix Algebra, Vector Calculus, Complex Analysis and Laplace Transform. Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering. Vector calculus can be widely used for modelling the various laws of physics. The various methods of complex analysis and Laplace transforms can be used for efficiently solving the problems that occur in various branches of engineering disciplines.

UNIT I   **MATRICES**   **12**
Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II   **VECTOR CALCULUS**   **12**
Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT III   **ANALYTIC FUNCTIONS**   **12**
Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal

mapping – Mapping by functions $w = z + c,\ cz, \dfrac{1}{z}, z^2$ - Bilinear transformation.

UNIT IV   **COMPLEX INTEGRATION**   **12**
Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

UNIT V   **LAPLACE TRANSFORMS**   **12**
Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

                                                            TOTAL: 60 PERIODS
OUTCOMES :
After successfully completing the course, the student will have a good understanding of the following topics and their applications:
- Eigenvalues and eigenvectors, diagonalization of a matrix, Symmetric matrices, Positive definite matrices and similar matrices.
- Gradient, divergence and curl of a vector point function and related identities.
- Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.
- Analytic functions, conformal mapping and complex integration.
- Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.

TEXT BOOKS:
1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.

REFERENCES:
1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain R.K. and Iyengar S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi , 3rd Edition, 2007.
3. O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.
4. Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.
5. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

PH8253	**PHYSICS FOR ELECTRONICS ENGINEERING** (Common to BME, ME, CC, ECE, EEE, E&I, ICE)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the essential principles of Physics of semiconductor device and Electron transport properties. Become proficient in magnetic, dielectric and optical properties of materials and nano devices.

UNIT I   ELECTRICAL PROPERTIES OF MATERIALS   9

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Wiedemann-Franz law – Success and failures - electrons in metals – Particle in a three dimensional box – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential: Bloch thorem – metals and insulators - Energy bands in solids– tight binding approximation - Electron effective mass – concept of hole.

UNIT II   SEMICONDUCTOR PHYSICS   9

Intrinsic Semiconductors – Energy band diagram – direct and indirect semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic   semiconductors - Carrier concentration in N-type & P-type semiconductors – Carrier transport: Velocity-electric field relations – drift and diffusion transport - Einstein's relation – Hall effect and devices – Zener and avalanche breakdown in p-n junctions - Ohmic contacts – tunnel diode - Schottky diode – MOS capacitor - power transistor.

UNIT III   MAGNETIC AND DIELECTRIC PROPERTIES OF MATERIALS   9

Magnetism in materials – magnetic field and induction – magnetization - magnetic permeability and susceptibility–types of magnetic materials – microscopic classification of magnetic materials - Ferromagnetism: origin and exchange interaction- saturation magnetization and Curie temperature – Domain Theory. Dielectric materials: Polarization processes – dielectric loss – internal field – Clausius-Mosotti relation- dielectric breakdown – high-k dielectrics.

UNIT IV   OPTICAL PROPERTIES OF MATERIALS   9

Classification of optical materials – carrier generation and recombination processes - Absorption emission and scattering of light in metals, insulators and Semiconductors (concepts only) - photo current in a P- N diode – solar cell –photo detectors - LED – Organic LED – Laser diodes – excitons - quantum confined Stark effect – quantum dot laser.

UNIT V   NANOELECTRONIC DEVICES   9

Introduction - electron density in bulk material – Size dependence of Fermi energy– quantum confinement – quantum structures - Density of states in quantum well, quantum wire and quantum dot structures –Zener-Bloch oscillations – resonant tunneling – quantum interference effects – mesoscopic structures: conductance fluctuations and coherent transport – Coulomb blockade effects - Single electron phenomena and Single electron Transistor – magnetic semiconductors– spintronics - Carbon nanotubes: Properties and applications.

TOTAL :45 PERIODS

OUTCOMES:
At the end of the course, the students will able to
- Gain knowledge on classical and quantum electron theories, and energy band structures,
- Acquire knowledge on basics of semiconductor physics and its applications in various devices,
- Get knowledge on magnetic and dielectric properties of materials,
- Have the necessary understanding on the functioning of optical materials for optoelectronics,
- Understand the basics of quantum structures and their applications in spintronics and carbon electronics..

TEXT BOOKS:
1. Kasap, S.O. "Principles of Electronic Materials and Devices", McGraw-Hill Education, 2007.
2. Umesh K Mishra & Jasprit Singh, "Semiconductor Device Physics and Design", Springer, 2008.
3. Wahab, M.A. "Solid State Physics: Structure and Properties of Materials". Narosa Publishing House, 2009.

REFERENCES:
1. Garcia, N. & Damask, A. "Physics for Computer Science Students". Springer-Verlag, 2012.
2. Hanson, G.W. "Fundamentals of Nanoelectronics". Pearson Education, 2009
3. Rogers, B., Adams, J. & Pennathur, S. "Nanotechnology: Understanding
Small Systems". CRC Press, 2014

BM8251   **ENGINEERING MECHANICS FOR BIOMEDICAL ENGINEERS**   **L T P C**
                                                                       3 0 0 3

OBJECTIVES:
- Be exposed to the fundamental principles of mechanics
- To learn effect of force on bodies
- To learn basics of fluid mechanics and relate it to bio-fluids
- To understand the action of friction and motion

UNIT I   BASICS AND STATICS OF PARTICLES   9
Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces —— Vectorial representation of forces – Vector operations of forces - additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility.

UNIT II   EQUILIBRIUM OF RIGID BODIES   9
Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions.

UNIT III   MECHANICS OF SOLIDS   9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of rigid and non rigid bodies - Centroids and centre of mass- Centroids of lines and areas - Rectangular, circular, triangular areas by integration –Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle.

UNIT IV   BASICS OF MECHANICS OF FLUIDS   9

Fluids – density – pressure – blood pressure and gravity – buoyancy – moments of force and stability – movement in water –Newton's laws of viscosity – Definitions and simple problems on Newtonian fluid, Non-Newtonian fluid, Euler equations and Navier Stoke's equations,Viscoelasticity, laminar flow, Couette flow, turbulent flow and Hagenpoiseuille equation.

UNIT V   DYNAMICS OF PARTICLES   9

Displacements, Velocity and acceleration, their relationship – Relative motion – Newton's laws of motion – Work Energy Equation– Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction.

TOTAL : 45 PERIODS

OUTCOMES:
At the end of the course students will be able to:
- Use scalar and vector analytical techniques for analysing forces in statically determinate structures
- Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems

TEXT BOOKS:
1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Dr. R. K. Bansal, A Text Book of Fluid Mechanics, Laxmin Publications (P) Ltd., New Delhi.

REFERENCES:
1. Vela Murali, "Engineering Mechanics", Oxford University Press (2010).
2. Frank Bell, "Principles of Mechanics and Biomechanics",Stanley Thorne (Publishers) Ltd., 1998.
3. Lee Waite, "Biofluid Mechanics in Cardiovascular Systems", The McGraw-Hill Companies, 2006.

BM8201   **FUNDAMENTALS OF BIO CHEMISTRY**   **L T P C**
3 0 0 3

OBJECTIVES:
The student should be:
- To study structural and functional properties of carbohydrates, proteins, lipids and nucleic acids
- To emphasize the role of these biomolecules by providing basic information on specific metabolic diseases and disorders of these biomolecules

UNIT I   INTRODUCTION TO BIOCHEMISTRY   9

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

UNIT II   CARBOHYDRATES   9

Classification of carbohydrates - mono, di, oligo and polysaccharides. Structure, physical and chemical properties of carbohydrates Isomerism, racemisation and mutarotation. Digestion and absorption of carbohydrates. Metabolic pathways and bioenergetics – Glycolysis, glycogenesis, glycogenolysis and its hormonal regulation. TCA cycle and electron transport chain. Oxidative phosphorylation. Biochemical aspect of Diabetes mellitus and Glycogen storage Disease.

UNIT III   LIPIDS   9

Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat..Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), hormonal regulation of fatty acid metabolism, ketogenesis, Biosynthesis of Cholesterol. Disorders of lipid metabolism.

UNIT IV   NUCLEIC ACID & PROTEIN   9

Structure of purines and pyrimidines, nucleoside, nucleotide, DNA act as a genetic material, chargoffs rule. Watson and crick model of DNA. Structure of RNA and its type. Metabolism and Disorder of purines and pyrimidines nucleotide Classification, structure and properties of proteins, structural organization of proteins, classification and properties of amino acids. Separation of protein, Inborn Metabolic error of amino acid metabolism

UNIT V   ENZYME AND ITS CLINICAL APPLICATION   9

Classification of enzymes, apoenzyme, coenzyme, holoenzyme and cofactors. Kinetics of enzymes - Michaelis-Menten equation.Factors affecting enzymatic activity: temperature, pH, substrate concentration and enzyme concentration. Inhibitors of enzyme action: Competitive, non-competitive, irreversible. Enzyme: Mode of action, allosteric and covalent regulation. Clinical enzymology. Measurement of enzyme activity and interpretation of units.

TOTAL: 45 PERIODS

OUTCOMES:
Upon Completion of the Course □the students will be able to
- Explain the fundamentals of biochemistry
- Clinical application of Biochemistry

TEXT BOOKS:
1. RAFI MD "Text book of biochemistry for Medical Student" Second Edition, University Press, 2014.
2. David.W.Martin, Peter.A.Mayes , Victor. W.Rodwell, "Harper's Review of Biochemistry", LANGE Medical Publications, 1981.

REFERENCES:
1. Keith Wilson & John Walker, "Practical Biochemistry - Principles & Techniques", Oxford University Press, 2009.
2. Pamela.C.Champe & Richard.A.Harvey, "Lippincott Biochemistry Lippincott's Illustrated Reviews", Raven publishers,1994.

EC8251	CIRCUIT ANALYSIS	L T P C
		4 0 0 4

OBJECTIVES:
- To introduce the basic concepts of DC and AC circuits behavior
- To study the transient and steady state response of the circuits subjected to step and sinusoidal excitations.
- To introduce different methods of circuit analysis using Network theorems, duality and topology.

UNIT I   BASIC CIRCUITS ANALYSIS AND NETWORK TOPOLOGY   12

Ohm's Law – Kirchhoff's laws – Mesh current and node voltage method of analysis for D.C and A.C. circuits - Network terminology - Graph of a network - Incidence and reduced incidence matrices – Trees –Cutsets - Fundamental cutsets - Cutset matrix – Tie sets - Link currents and Tie set schedules -Twig voltages and Cutset schedules, Duality and dual networks.

UNIT II   NETWORK THEOREMS FOR DC AND AC CIRCUITS   12

Network theorems -Superposition   theorem, Thevenin's   theorem,   Norton's   theorem, Reciprocity theorem, Millman's theorem, and Maximum power transfer theorem ,application of Network theorems- Network reduction: voltage and current division, source transformation – star delta conversion.

UNIT III   RESONANCE AND COUPLED CIRCUITS   12

Resonance - Series resonance - Parallel resonance - Variation of impedance with frequency - Variation in current through and voltage across L and C with frequency – Bandwidth - Q factor - Selectivity. Self inductance - Mutual inductance - Dot rule - Coefficient of coupling - Analysis of multiwinding coupled circuits - Series, Parallel connection of coupled inductors - Single tuned and double tuned coupled circuits.

UNIT IV   TRANSIENT ANALYSIS   12

Natural response-Forced response - Transient response of RC, RL and RLC circuits to excitation by Step Signal, Impulse Signal and exponential sources - Complete response of RC, RL and RLC Circuits to sinusoidal excitation.

UNIT V   TWO PORT NETWORKS   12

Two port networks, Z parameters, Y parameters, Transmission (ABCD) parameters, Hybrid(H) Parameters, Interconnection of two port networks, Symmetrical properties of T and π networks.

TOTAL:60 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Develop the capacity to analyze electrical circuits, apply the circuit theorems in real time
- Design and understand and evaluate the AC and DC circuits

TEXT BOOKS:
1. William H. Hayt, Jr. Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuit Analysis" , McGraw Hill Science Engineering, Eighth Edition, 11th Reprint 2016.
2. Joseph Edminister and Mahmood Nahvi, "Electric Circuits", Schaum's Outline Series, Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition Reprint 2016.

REFERENCES:
1. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Fifth Edition,
   McGraw Hill, 9th Reprint 2015.
2. A.Bruce Carlson, "Cicuits: Engineering Concepts and Analysis of Linear Electric Circuits", Cengage Learning, India Edition 2nd Indian Reprint 2009.
3. Allan H.Robbins, Wilhelm C.Miller, "Circuit Analysis Theory and Practice", Cengage Learning, Fifth Edition, 1st Indian Reprint 2013.

GE8261   **ENGINEERING PRACTICES LABORATORY**   **L T P C**
                                                                              0 0 4 2

OBJECTIVES:
>   To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

I   CIVIL ENGINEERING PRACTICE   13

Buildings:
(a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:
>   (a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers,
>   elbows in household fittings.
>   (b) Study of pipe connections requirements for pumps and turbines.
>   (c) Preparation of plumbing line sketches for water supply and sewage works.
>   (d) Hands-on-exercise:

>   Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

>   (e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:
>   (a) Study of the joints in roofs, doors, windows and furniture.
>   (b) Hands-on-exercise:
>   Wood work, joints by sawing, planing and cutting.

II   MECHANICAL ENGINEERING PRACTICE   18

Welding:
>   (a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
>   (b) Gas welding practice

Basic Machining:
>   (a) Simple Turning and Taper turning
>   (b) Drilling Practice

Sheet Metal Work:
>   (a) Forming & Bending:
>   (b) Model making – Trays and funnels.
>   (c) Different type of joints.

Machine assembly practice:
>   (a) Study of centrifugal pump
>   (b) Study of air conditioner

Demonstration on:
>   (a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.
>   (b) Foundry operations like mould preparation for gear and step cone pulley.
>   (c) Fitting – Exercises – Preparation of square fitting and V – fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

III   ELECTRICAL ENGINEERING PRACTICE

13

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

IV   ELECTRONICS ENGINEERING PRACTICE

16

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 60 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
* Fabricate carpentry components and pipe connections including plumbing works.
* Use welding equipments to join the structures.
* Carry out the basic machining operations
* Make the models using sheet metal works
* Illustrate on centrifugal pump, Air conditioner, operations of smithy, foundary and
* fittings
* Carry out basic home electrical works and appliances
* Measure the electrical quantities
* Elaborate on the components, gates, soldering practices.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	15 Sets.
2. Carpentry vice (fitted to work bench)	15 Nos.
3. Standard woodworking tools	15 Sets.
4. Models of industrial trusses, door joints, furniture joints	5 each
5. Power Tools: (a) Rotary Hammer	2 Nos
(b) Demolition Hammer	2 Nos
(c) Circular Saw	2 Nos
(d) Planer	2 Nos
(e) Hand Drilling Machine	2 Nos
(f) Jigsaw	2 Nos

MECHANICAL

1. Arc welding transformer with cables and holders	5 Nos.
2. Welding booth with exhaust facility	5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos.

5. Centre lathe	2 Nos.
6. Hearth furnace, anvil and smithy tools	2 Sets.
7. Moulding table, foundry tools	2 Sets.
8. Power Tool: Angle Grinder	2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner	One each.

ELECTRICAL

1. Assorted electrical components for house wiring	15 Sets
2. Electrical measuring instruments	10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp	1 each
4. Megger (250V/500V)	1 No.
5. Power Tools: (a) Range Finder	2 Nos
(b) Digital Live-wire detector	2 Nos

ELECTRONICS

1. Soldering guns	10 Nos.
2. Assorted electronic components for making circuits	50 Nos.
3. Small PCBs	10 Nos.
4. Multimeters	10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply	

BM8211 **BIOCHEMISTRY LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:
To provide practice on:
- Estimation and quantification of biomolecules.
- Separation of macromolecules.
- Estimation and interpretation of biochemical parameter.

LIST OF EXPERIMENTS:
1. General guidelines for working and functional component of biochemistry lab
2. Preparation of solutions: 1) percentage solutions, 2) molar solutions, 3) normal solutions
3. Standardization of pH meter, preparation of buffers, emulsions.
4. Spectroscopy: Determination of absorption maxima (λmax) of a given solution
5. General tests for carbohydrates, proteins and lipids.
6. Identification of Blood Collection Tubes and Phlebotomy equipments
7. Preparation of serum and plasma from blood.
8. Estimation of Haemoglobin
9. Estimation of blood glucose.
10. Estimation of creatinine.
11. Estimation of urea.
12. Estimation of Uric acid
13. Estimation of cholesterol
14. Assay of SGOT/SGPT.
15. ELISA test
16. Separation of proteins by SDS electrophoresis(Demo)
17. Separation of amino acids by thin layer chromatography (Demo).

TOTAL: 60 PERIODS

OUTCOMES:
Upon completion of the course, students will be able to:
- Understand the Biochemistry laboratory functional components
- Understand the basics principle of preparation of buffers.
- Have a sound knowledge of qualitative test of different biomolecules.
- Understand the basics knowledge of Biochemical parameter and their interpretation in Blood sample.
- Have a sound knowledge of separation technology of proteins and aminoacids.

LAB REQUIREMENT FOR A BATCH OF 30 STUDENTS:
Requirement for a batch of 30 students
Colorimeter 2 Nos
Spectrophotometer 1 No.
pH meter 1 No
Weighing balance 1 No
Refrigerator 1 No
SDS gel electrophoresis 1 No
TLC, ready TLC plates 1 No
Wintrobe's tube 2 Nos.
Centrifuge Normal 1 No
Microslides 2 packets
Lancet 5 boxes
Microscope 1 No
Neubaur's Chamber 2 Nos.
Heparinized Syringe 1box
Haemoglobinometer 1 No
Elisa reader.1 nos
Capillary tubes 1 box

MA8352   LINEAR ALGEBRA AND PARTIAL DIFFERENTIAL EQUATIONS   L   T   P   C
4   0   0   4
OBJECTIVES:
- To introduce the basic notions of groups, rings, fields which will then be used to solve related problems.
- To understand the concepts of vector space, linear transformations and diagonalization.
- To apply the concept of inner product spaces in orthogonalization.
- To understand the procedure to solve partial differential equations.
- To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject

UNIT I   VECTOR SPACES   12
Vector spaces – Subspaces – Linear combinations and linear system of equations – Linear independence and linear dependence – Bases and dimensions.

UNIT II   LINEAR TRANSFORMATION AND DIAGONALIZATION   12
Linear transformation - Null spaces and ranges - Dimension theorem - Matrix representation of a linear transformations - Eigenvalues and eigenvectors - Diagonalizability.

UNIT III   INNER PRODUCT SPACES   12
Inner product, norms - Gram Schmidt orthogonalization process - Adjoint of linear operations - Least square approximation.

UNIT IV   PARTIAL DIFFERENTIAL EQUATIONS   12

Formation – Solutions of first order equations – Standard types and equations reducible to standard types – Singular solutions – Lagrange's linear equation – Integral surface passing through a given curve – Classification of partial differential equations - Solution of linear equations of higher order with constant coefficients – Linear non-homogeneous partial differential equations.

UNIT V   FOURIER SERIES SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS   12

Dirichlet's conditions – General Fourier series – Half range sine and cosine series - Method of separation of variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two-dimensional heat equation – Fourier series solutions in Cartesian coordinates.

TOTAL: 60 PERIODS

OUTCOMES:
Upon successful completion of the course, students should be able to:
- Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
- Demonstrate accurate and efficient use of advanced algebraic techniques.
- Demonstrate their mastery by solving non - trivial problems related to the concepts and by proving simple theorems about the statements proven by the text.
- Able to solve various types of partial differential equations.
- Able to solve engineering problems using Fourier series

TEXT BOOKS:
1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Friedberg, A.H., Insel, A.J. and Spence, L., "Linear Algebra", Prentice Hall of India, New Delhi, 2004.

REFERENCES:
1. Burden, R.L. and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. James, G. "Advanced Modern Engineering Mathematics", Pearson Education, 2007.
3. Kolman, B. Hill, D.R., "Introductory Linear Algebra", Pearson Education, New Delhi, First Reprint, 2009.
4. Kumaresan, S., "Linear Algebra – A Geometric Approach", Prentice – Hall of India, New Delhi, Reprint, 2010.
5. Lay, D.C., "Linear Algebra and its Applications", 5th Edition, Pearson Education, 2015.
6. O'Neil, P.V., "Advanced Engineering Mathematics", Cengage Learning, 2007.
7. Strang, G., "Linear Algebra and its applications", Thomson (Brooks/Cole), New Delhi, 2005.
8. Sundarapandian, V. "Numerical Linear Algebra", Prentice Hall of India, New Delhi, 2008.

EC8352	SIGNALS AND SYSTEMS	L	T	P	C
		4	0	0	4

OBJECTIVES:
- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

UNIT I   CLASSIFICATION OF SIGNALS AND SYSTEMS   12
Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_ Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.

UNIT II   ANALYSIS OF CONTINUOUS TIME SIGNALS   12
Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and properties

UNIT III   LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS   12
Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

UNIT IV   ANALYSIS OF DISCRETE TIME SIGNALS   12
Baseband signal Sampling – Fourier Transform of discrete time signals (DTFT) – Properties of DTFT - Z Transform & Properties

UNIT V   LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS   12
Impulse response – Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

TOTAL: 60 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- To be able to determine if a given system is linear/causal/stable
- Capable of determining the frequency components present in a deterministic signal
- Capable of characterizing LTI systems in the time domain and frequency domain
- To be able to compute the output of an LTI system in the time and frequency domains

TEXT BOOK:
1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", Pearson, 2015.(Unit 1-V)

REFERENCES:
1. B. P. Lathi, "Principles of Linear Systems and Signals", Second Edition, Oxford, 2009.

2. R.E.Zeimer, W.H.Tranter and R.D.Fannin, "Signals & Systems - Continuous and Discrete", Pearson, 2007.
3. John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.

BM8351	ANATOMY AND HUMAN PHYSIOLOGY	L T P C
		3 0 0 3

OBJECTIVES
- To identify all the organelles of an animal cell and their function.
- To understand structure and functions of the various types of systems of human body.
- To demonstrate their knowledge of importance of anatomical features and physiology of human systems

UNIT I   CELL AND TISSUE STRUCTURE   9

Structure of Cell – structure and functions of sub organelles – Cell Membrane –Transport of Across Cell Membrane - Action Potential – Cell to Cell Signaling – Cell Division. Types of Specialized tissues – Functions

UNIT II   SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS   9

Skeletal::Types of Bone and function – Physiology of Bone formation – Division of Skeleton – Types of joints and function – Types of cartilage and function. **Muscular:** Parts of Muscle – Movements. **Respiratory:** Parts of Respiratory Systems – Types of respiration - Mechanisms of Breathing – Regulation of Respiration

UNIT III   CARDIOVASCULAR AND LYMPHATIC SYSTEMS   9

Cardiovascular: Components of Blood and functions.- Blood Groups and importance – Structure of Heart – Conducting System of Heart – Properties of Cardiac Muscle - Cardiac Cycle - Heart Beat – Types of Blood vessel – Regulation of Heart rate and Blood pressure. **Lymphatic:** Parts and Functions of Lymphatic systems – Types of Lymphatic organs and vessels

UNIT IV   NERVOUS AND ENDOCRINE SYSTEMS AND SENSE ORGANS   9

Nervous: Cells of Nervous systems – Types of Neuron and Synapses – Mechanisms of Nerve impulse – Brain : Parts of Brain – Spinal Cord – Tract and Pathways of Spines – Reflex Mechanism – Classification of Nerves - Autonomic Nervous systems and its functions. **Endocrine - Pituitary** and thyroid gland, Sense Organs: Eye and Ear

UNIT V   DIGESTIVE AND URINARY SYSTEMS   9

Digestive: Organs of Digestive system – Digestion and Absorption. **Urinary:** Structure of Kidney and Nephron – Mechanisms of Urine formation – Regulation of Blood pressure by Urinary System – Urinary reflex

TOTAL: 45 PERIODS

OUTCOMES:

At end of the course

- Students would be able to explain basic structure and functions of cell
- Students would be learnt about anatomy and physiology of various systems of human body
- Students would be able to explain interconnect of various systems

TEXT BOOKS:

1. Prabhjot Kaur. Text Book of Anatomy and Physiology. Lotus Publsihers. 2014
2. Elaine.N. Marieb , "Essential of Human Anatomy and Physiology", Eight Edition, Pearson Education, New Delhi, 2007

REFERENCES:

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy and Physiology. Pearson Publishers, 2014
2. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Oxford University Press, USA, 2013
3. William F.Ganong, "Review of Medical Physiology", 22nd Edition, Mc Graw Hill, New Delhi, 2010
4. Eldra Pearl Solomon, "Introduction to Human Anatomy and Physiology", W.B. Saunders Company, 2015
5. Guyton & Hall, "Medical Physiology", 13th Edition, Elsevier Saunders, 2015

BM8301   **SENSORS AND MEASUREMENTS**   **L T P C**
                                                                                2 0 2 3

OBJECTIVES:
The student should be made to:
- 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
- Know the different bridges for measurement.
- Know the different display and recording devices.

UNIT I   SCIENCE OF MEASUREMENT   6+6
Measurement System – Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis – Calibration - Primary and secondary standards.

UNIT II   DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS   6+6
Strain Gauge: Gauge factor, sensing elements, configuration, and unbounded strain gage. Capacitive transducer - various arrangements, Inductive transducer, LVDT, Passive types: RTD materials & range, relative resistance vs. temperature characteristics, thermistor characteristics, Active type: Thermocouple - characteristics.

UNIT III   PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS   6+6
Phototube, scintillation counter, photo multiplier tube (PMT), photovoltaic, photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers. Optical displacement sensors and optical encoders. Piezoelectric active transducer- Equivalent circuit and its characteristics.

UNIT IV   SIGNAL CONDITIONING CIRCUITS   6+6
Functions of signal conditioning circuits, Preamplifiers, Concepts of passive filters, Impedance matching circuits, AC and DC Bridges - wheat stone bridge, Kelvin, Maxwell, Hay, Schering

UNIT V   DISPLAY AND RECORDING DEVICES   6+6
Digital voltmeter – Multi meter – CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder.

LIST OF LABORATORY EXPERIMENTS TO DEMONSTRATE:
1. Characteristics of various temperature sensors – RTD, Thermistor and Thermocouple
2. Displacement measurement using LVDT.
3. Characteristics of various light sensors – LDR, Photodiode and Phototransistor
4. Measurement of resistance using DC bridges
5. Measurement of inductance using Maxwell bridge
6. Measurement of capacitance using Schering bridge
7. Measurement of amplitude, time, frequency using CRO

TOTAL: 60 PERIODS

OUTCOMES:
Upon completion of the course, the student should be able to:
- Measure various electrical parameters with accuracy, precision, resolution.
- Select appropriate passive or active transducers for measurement of physical phenomenon.
- Select appropriate light sensors for measurement of physical phenomenon.
- Use AC and DC bridges for relevant parameter measurement.
- Employ Multimeter, CRO and different types of recorders for appropriate measurement.

TEXT BOOKS:
1. A.K.Sawhney, "Electrical & Electronics Measurement and Instrumentation",10th edition, DhanpatRai& Co, New Delhi, 19th Revised edition 2011, Reprint 2014.
2. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt Ltd,New Delhi, 2015.

REFERENCES:
1. Ernest O Doebelin and Dhanesh N Manik, Measurement systems, Application and design, 6th edition, McGraw-Hill, 2012.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", 3rdedition,Tata McGraw-Hill, New Delhi, 2014.
3. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice hall of India, New Delhi, 2015.
4. Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall of India, 1stedition, 2016.

EC8353	ELECTRON DEVICES AND CIRCUITS	L T P C
		3 0 0 3

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

UNIT I   PN JUNCTION DEVICES   9
PN junction diode –structure, operation and V-I characteristics, diffusion and transition capacitance - Rectifiers – Half Wave and Full Wave Rectifier,– Display devices- LED, Laser diodes, Zener diodecharacteristics- Zener Reverse characteristics – Zener as regulator

UNIT II   TRANSISTORS AND THYRISTORS   9
BJT, JFET, MOSFET- structure, operation, characteristics and Biasing UJT, Thyristors and IGBT - Structure and characteristics.

UNIT III   AMPLIFIERS   9
BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response – MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

UNIT IV   MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER   9
BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FET input stages – Single tuned amplifiers – Gain and frequency response – Neutralization methods, power amplifiers –Types (Qualitative analysis).

UNIT V   FEEDBACK AMPLIFIERS AND OSCILLATORS   9
Advantages of negative feedback – voltage / current, series , Shunt feedback –positive feedback – Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

TOTAL: 45 PERIODS

OUTCOMES:
Upon Completion of the course, the students will be able to:
- Explain the structure and working operation of basic electronic devices.
- Able to identify and differentiate both active and passive elements
- Analyze the characteristics of different electronic devices such as diodes and transistors
- Choose and adapt the required components to construct an amplifier circuit.
- Employ the acquired knowledge in design and analysis of oscillators

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

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

BM8302   **PATHOLOGY AND MICROBIOLOGY**   L T P C
                                                                          3 0 0 3

OBJECTIVES:
The student should be made to:
- Gain a knowledge on the structural and functional aspects of living organisms.
- Know the etiology and remedy in treating the pathological diseases.
- Empower the importance of public health.

UNIT I   CELL DEGENERATION, REPAIR AND NEOPLASIA   9
Cell injury - Reversible cell injury and Irreversible cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification- Dystrophic and Metastatic. cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours Autopsy and biopsy.

UNIT II   FLUID AND HEMODYNAMIC DERANGEMENTS   9
Edema, Hyperemia/Ischemia, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock, Chronic venous congestion. Hematological disorders-Bleeding disorders, Leukaemias, Lymphomas Haemorrhage.
.
UNIT III   MICROBIOLOGY   9
Structure of Bacteria and Virus. Routes of infection and spread; endogenous and exogenous infections, Morphological features and structural organization of bacteria and virus, growth curve, identification of bacteria , culture media and its types , culture techniques and observation of culture. Disease caused by bacteria, fungi, protozoal, virus and helminthes.

UNIT IV   MICROSCOPES   9
Light microscope – bright field, dark field, phase contrast, fluorescence, Electron microscope (TEM & SEM). Preparation of samples for electron microscope. Staining methods – simple, gram staining and AFB staining.

UNIT V   IMMUNOPATHOLOGY   9
Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury: opsonization, phagocytosis, inflammation, Secondary immunodeficiency including HIV infection. Auto-immune disorders: Basic concepts and classification, SLE.Antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies.

TOTAL : 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Analyze structural and functional aspects of living organisms.
- Explain the function of microscope
- Discuss the importance of public health.
- Describe methods involved in treating the pathological diseases.

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

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

BM8311	PATHOLOGY AND MICROBIOLOGY LABORATORY	L T P C
		0 0 4 2

OBJECTIVES:
The student should be made to:
- Use Compound microscope
- Practice on chemical examinations, Cryoprocessing, Histopathological examinations etc

LIST OF EXPERIMENTS:
1. Urine physical and chemical examination (protein, reducing substances, ketones, bilirubin and blood)
2. Study of parts of compound microscope
3. Histopathological slides of benign and malignant tumours.
4. Manual paraffin tissue processing and section cutting (demonstration)
5. Cryo processing of tissue and cryosectioning (demonstration)
6. Basic staining – Hematoxylin and eosin staining.
7. Special stains – cresyl fast Blue (CFV)- Trichrome – oil red O – PAS
8. Capsule stain
10. Simple stain.
11. Gram stain.
12. AFB stain.
13.Antigen-Antibody reaction Immuno electrophoresis
14. Slides of malarial parasites, micro filaria and leishmania donovani.

15. Haematology slides of anemia and leukemia.
16. Study of bone marrow charts.

TOTAL: 60 PERIODS

OUTCOME:
- Student can perform practical experiments on tissue processing, cryoprocessing, staining Processes etc.

TEXT BOOK :
1.Textbook of Medical Laboratory Technology, Ramnik Sood, 6thEdition, Jaypee Brothers Medical Publishers, 2009

BM8312	DEVICES AND CIRCUITS LABORATORY	L T P C
		0 0 4 2

OBJECTIVES:
- To learn the characteristics of basic electronic devices such as Diode, BJT,FET, SCR
- To understand the working of RL,RC and RLC circuits
- To gain hand on experience in Thevinin & Norton theorem, KVL & KCL, and Super Position Theorems

LIST OF EXPERIMENTS
1. Characteristics of PN Junction Diode
2. Zener diode Characteristics & Regulator using Zener diode
3. Common Emitter input-output Characteristics
4. Common Base input-output Characteristics
5. FET Characteristics
6. SCR Characteristics
7. Clipper and Clamper & FWR
8. Verifications of Thevinin & Norton theorem
 9. Verifications of KVL & KCL
10. Verifications Of Super Position Theorem
11. Verifications of maximum power transfer & reciprocity theorem
12. Determination Of Resonance Frequency of Series & Parallel RLC Circuits
13. Transient analysis of RL and RC circuits

LABORATORY REQUIREMENTS
BC 107, BC 148,2N2646,BFW10 - 25 each
1N4007, Zener diodes - 25 each
Resistors, Capacitors, Inductors - sufficient quantities
Bread Boards - 15 Nos
CRO (30MHz) – 10 Nos.
Function Generators (3MHz) – 10 Nos.
Dual Regulated Power Supplies (0 – 30V) – 10 Nos

OUTCOMES:
At the end of the course, the student should be able to:
- Analyze the characteristics of basic electronic devices
- Design RL and RC circuits
- Verify Thevinin & Norton theorem KVL & KCL, and Super Position Theorems

TOTAL: 60 PERIODS

BM8313   **HUMAN PHYSIOLOGY LABORATORY**   **L T P C**
                                                                                      0 0 2 1

OBJECTIVES:
- To estimation and quantification of blood cells
- To learnt methods for identification of blood groups
- To estimation of haematological parameters
- To learnt the analysis of visual and hearing test

LIST OF EXPERIMENTS
1. Collection of Blood Samples
2. Identification of Blood groups (Forward and Reverse)
3. Bleeding and Clotting time
4. Estimation of Hemoglobin
5. Total RBC Count
6. Total WBC Count
7. Differential count of Blood cells
8. Estimation of ESR
9. PCV, MCH, MCV, MCHC
10. Hearing test – Tuning fork
11. Visual Activity – Snellen's Chart and Jaeger's Chart

                                                                  TOTAL: 30 PERIODS

OUTCOMES:
At end of the course, Students would be able to
- Identification and enumeration of blood cells
- Enumeration of haematological parameters
- Analysis of special sensory organs test

LAB REQUIREMENT FOR A BATCH OF 30 STUDENTS:
Requirement for a batch of 30 students
Microscope   2 Nos
Centrifuge Normal   1 No
Wintrobe's tube   2 Nos.
PCV tube   2 Nos
Neubaur's Chamber   2 Nos.
Heparinized Syringe   1box
Haemoglobinometer   1 No
Blood grouping kit   1 No
Capillary tubes   1 box
Ophthalmoscope   1 No
Tuning fork   (256Hz to 512Hz) 5 Nos.
Microslides   2 packets
Lancet   5 boxes

MA8391   **PROBABILITY AND STATISTICS**   **L   T   P   C**
                                                                          4   0   0   4

OBJECTIVES:
- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control

UNIT I   PROBABILITY AND RANDOM VARIABLES   12
Probability – The axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II   TWO - DIMENSIONAL RANDOM VARIABLES   12
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III   TESTING OF HYPOTHESIS   12
Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT IV   DESIGN OF EXPERIMENTS   12
One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design - 2^2 factorial design.

UNIT V   STATISTICAL QUALITY CONTROL   12
Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

                                                              TOTAL : 60 PERIODS
OUTCOMES:
Upon successful completion of the course, students will be able to:
- Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
- Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

TEXT BOOKS:
1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.

REFERENCES:
1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
2. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
4. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.

BM8401   **MEDICAL PHYSICS**   **L T P C**
                                                                          3 0 0 3

OBJECTIVES:
The student should be made to:
- To study principles and effects of ionizing and non-ionizing radiation in human body
- To discuss the physics of the senses
- To explore the effects of radiation in matter and how isotopes are produced
- To understand various detectors for detecting the presence of ionizing radiation.

UNIT I   NON-IONIZING RADIATION AND ITS MEDICAL APPLICATIONS   9

Introduction and objectives - Tissue as a leaky dielectric - Relaxation processes, Debye model, Cole–Cole model, Overview of non-ionizing radiation effects-Low Frequency Effects- Higher frequency effects. Physics of light, Measurement of light and its unit- limits of vision and color vision an overview, Ultraviolet

UNIT II   PHYSICS OF THE SENSES   7

Introduction and objectives - Cutaneous sensation - The chemical senses – Audition –Vision - Psychophysics

UNIT III   PRINCIPLES OF RADIOACTIVE NUCLIDES   10

Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture, Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology ,Decay series, Production of radionuclides – Cyclotron produced Radionuclide- Reactor produced Radio- nuclide-fission and electron Capture reaction, Target and Its Processing Equation for Production of Radionuclides, radionuclide Generator-Technetium generator.

UNIT IV   RADIOACTIVE DECAY AND INTERACTIONOF RADIATION WITH MATTER   11

Spontaneous Fission- Isomeric Transition-Alpha Decay-Beta Decay-PositronDecay-Electron Capture-Interaction of charged particles with matter –Specific ionization, Linear energy transfer range, Bremsstrahlung, Annihilation,Interaction of X and Gamma radiation with matter-Photoelectric effect, Compton Scattering , Pair production, Attenuation of Gamma Radiation ,Interaction of neutron with matter and their clinical significance.

UNIT V   SCINTILLATION, SEMICONDUCTOR and GAS FILLED DETECTORS   8

Scintillation Detectors - Solid Scintillation Counters - Gamma-Ray Spectrometry-Liquid Scintillation Counters-Characteristics of Counting Systems-Gamma Well Counters-Thyroid Probe-Principles of Gas-Filled Detectors - Ionization Chambers-Geiger–Müller Counters

                                                          TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Explain about non-ionizing radiation, interaction with tissue and its effects.
- Define and compare intensities of sensory stimuli
- Summarizes how ionizing radiation interacts with the human body, how to quantify it and its levels seen in the environment and healthcare
- Explain the fundamentals of radioactivity and radioactive isotopes
- Illustrates the methods of detecting and recording the ionizing radiation and its interaction with matter

TEXT BOOKS:
1. Gopal B. Saha, "Physics and Radiobiology of Nuclear Medicine", 4th Edition, Springer, 2013.
2. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, "Medical Physics and Biomedical Engineering", 2nd Edition, IOP Publishers.2001.

REFERENCES:
1. S.Webb " The Physics of Medical Imaging", Taylor and Francis, 1988
2. J.P.Woodcock, "Ultrasonic,Medical Physics Handbook series 1", Adam Hilger, Bristol, 2002
3. HyltonB.Meire and Pat Farrant "Basic Ultrasound" John Wiley & Sons, 1995

EE8452   **BASICS OF ELECTRICAL ENGINEERING**   **L T P C**
                                                                            3 0 0 3

AIM
To make the students understand the basics of electrical engineering required for incorporating the knowledge for smart application development.

OBJECTIVES:
- To introduce the fundamental concepts of electrical circuits connections with load.
- To understand the basic theory, operational characteristics of AC and DC machines
- To study the operating principles of measuring instrument for V, I, energy, power.
- To create awareness on the methods for electrical safety, load protection.
- To observe the electricity supply sources based on classical and standalone systems.

UNIT I   ELECTRICAL CIRCUITS AND ANALYSIS   9
Ohm's law,DC and AC circuits fundamentals, Energy sources,Kirchhoff's laws,Mesh and Nodal analysis, Star -delta and Delta -star transformation; theorems and simple problems :Superposition, Thevenins's, Maximum power transfer theorem.

UNIT II   ELECTRICAL MACHINES   9
DC Machines: D.C generators &D.C motors: Principle of operation, constructions, types, Applications -A.C Machines: Types-Introduction to Alternators-Single Phase and Three phase induction motors: principle of operation, Types and Applications-Transformers : Principles of operation, Constructional Details, Types and Applications.

UNIT III   BASIC ELECTRICAL INSTRUMENTATION   9
Introduction, classification of instruments, operating principles, essential features of measuring instruments(elementary Treatment only)- Moving coil , permanent magnet (PMMC) instruments, Moving Iron of Ammeters and Voltmeters Energy meter, Current Transformer, Potential Transformer.

UNIT IV   ELECTRICAL WIRING AND SAFETY   9

Cable and wire types and applications, Service mains, meter board and distribution board. Brief discussion on concealed conduit wiring. Two-way and three-way control. Elementary discussion on Circuit protective devices: fuse and Miniature Circuit Breaker (MCB's). Electric shock, precautions against shock, Objectives for Neutral and Earthing, types of earthing; pipe and plate earthing, Residual current circuit breaker.

UNIT V   ELECTRICAL POWER SYSTEM AND ITS APPLICATION   9

Introduction to Power generation, distribution and Transmission. Power supply circuits with SMPS, UPS, Batteries : Types, Principle of operation. Smart Grid based on solar and wind energy systems- Electrical vehicle charging, Application of Computer in Electrical Grid, Power Tariffs.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, students will be able to
- Design simple electrical circuits and understand through nodal, mesh analysis about constructing series and parallel configuration of circuits with sources and variable loads.
- Get knowledge on electrical machines and on its efficient operating principle.
- Understand metering principles, safety measures while working with electrical circuits.
- Analyse existing power distribution and hence apply technology in electrical applications

TEXT BOOKS:
1. Dr. D P Kothari, Prof I J Nagrath, "Basic Electrical Engineering" , 3rd Edition, Tata McGraw-Hill, 2009.
2. P.C. Sen,Principles of Electrical Machines and Power Electronics,Wiley,2016(Reprint)

REFERENCES:
1. Joseph Edminister, Mahmood Nahvi, "Schaum's Outline of Electromagnetics, 4th Edition, Tata McGraw-Hill, 2013
2. Vijay kumar Garg,Basic Electrical Engineering(A complete Solution),Wiley Reprint 2015.

		L	T	P	C
EC8453	**LINEAR INTEGRATED CIRCUITS**	**3**	**0**	**0**	**3**

OBJECTIVES:
- To introduce the basic building blocks of linear integrated circuits
- To learn the linear and non-linear applications of operational amplifiers
- To introduce the theory and applications of analog multipliers and PLL
- To learn the theory of ADC and DAC
- To introduce the concepts of waveform generation and introduce some special function ICs

UNIT I   BASICS OF OPERATIONAL AMPLIFIERS   9

Current mirror and current sources, Current sources as active loads, Voltage sources, Voltage References, BJT Differential amplifier with active loads, Basic information about op-amps – Ideal Operational Amplifier - General operational amplifier stages -and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate, Open and closed loop configurations – JFET Operational Amplifiers – LF155 and TL082.

UNIT II   APPLICATIONS OF OPERATIONAL AMPLIFIERS   9

Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters.

UNIT III   ANALOG MULTIPLIER AND PLL   9

Analog Multiplier using Emitter Coupled Transistor Pair - Gilbert Multiplier cell – Variable transconductance technique, analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing and clock synchronisation.

UNIT IV   ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS   9

Analog and Digital Data Conversions, D/A converter – specifications - weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode *R - 2R* Ladder types - switches for D/A converters, high speed sample-and-hold circuits, A/D Converters – specifications - Flash type - Successive Approximation type - Single Slope type – Dual Slope type - A/D Converter using Voltage-to-Time Conversion - Over-sampling A/D Converters, Sigma – Delta converters.

UNIT V   WAVEFORM GENERATORS AND SPECIAL FUNCTION ICS   9

Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator - Monolithic switching regulator, Low Drop – Out(LDO) Regulators - Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Opto-couplers and fibre optic IC.

TOTAL:45 PERIODS

OUTCOMES:
Upon completion of the course, the student should be able to:
- Design linear and non linear applications of OP – AMPS
- Design applications using analog multiplier and PLL
- Design ADC and DAC using OP – AMPS
- Generate waveforms using OP – AMP Circuits
- Analyze special function ICs

TEXT BOOKS:
1. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2018, Fifth Edition. (Unit I – V)
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 4th Edition, Tata Mc Graw-Hill, 2016 (Unit I – V)

REFERENCES:
1. Ramakant A. Gayakwad, "OP-AMP and Linear ICs", 4th Edition, Prentice Hall / Pearson Education, 2015.
2. Robert F.Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Sixth Edition, PHI, 2001.
3. B.S.Sonde, "System design using Integrated Circuits" , 2nd Edition, New Age Pub, 2001.
4. Gray and Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley International,5th Edition, 2009.
5. William D.Stanley, "Operational Amplifiers with Linear Integrated Circuits", Pearson Education,4th Edition,2001.
6. S.Salivahanan & V.S. Kanchana Bhaskaran, "Linear Integrated Circuits", TMH,2nd Edition, 4th Reprint, 2016..

EC8393   **FUNDAMENTALS OF DATA STRUCTURES IN C**   **L T P C**
                                                                          3 0 0 3

OBJECTIVES:
- To learn the features of C
- To learn the linear and non-linear data structures
- To explore the applications of linear and non-linear data structures
- To learn to represent data using graph data structure
- To learn the basic sorting and searching algorithms

UNIT I   C PROGRAMMING BASICS   9
Structure of a Cprogram – compilation and linking processes – Constants, Variables – Data Types – Expressions using operators in C – Managing Input and Output operations – Decision Making and Branching – Looping statements. Arrays – Initialization – Declaration – One dimensional and Two dimensional arrays. Strings- String operations – String Arrays. Simple programs- sorting-searching – matrix operations.

UNIT II   FUNCTIONS, POINTERS, STRUCTURES AND UNIONS   9
Functions – Pass by value – Pass by reference – Recursion – Pointers - Definition – Initialization – Pointers arithmetic . Structures and unions - definition – Structure within a structure - Union - Programs using structures and Unions – Storage classes, Pre-processor directives.

UNIT III   LINEAR DATA STRUCTURES   9
Arrays and its representations – Stacks and Queues – Linked lists – Linked list based implementation of Stacks and Queues – Evaluation of Expressions – Linked list based polynomial addition.

UNIT IV   NON-LINEAR DATA STRUCTURES   9
Trees – Binary Trees – Binary tree representation and traversals –Binary Search Trees – Applications of trees. Set representations - Union-Find operations. Graph and its representations – Graph Traversals.

UNIT V   SEARCHING AND SORTING ALGORITHMS   9
Linear Search – Binary Search. Bubble Sort, Insertion sort – Merge sort – Quick sort - Hash tables – Overflow handling.

                                                                 TOTAL: 45 PERIODS
OUTCOMES:
Upon completion of the course, students will be able to:

- Implement linear and non-linear data structure operations using C
- Suggest appropriate linear / non-linear data structure for any given data set.
- Apply hashing concepts for a given problem
- Modify or suggest new data structure for an application
- Appropriately choose the sorting algorithm for an application

TEXTBOOKS:
1. Pradip Dey and Manas Ghosh, ―Programming in C, Second Edition, Oxford University Press, 2011.
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, ―Fundamentals of Data Structures in C, Second Edition, University Press, 2008.

REFERENCES:
1. Mark Allen Weiss, ―Data Structures and Algorithm Analysis in C, Second Edition, Pearson Education, 1996
2. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, ―Data Structures and Algorithms, Pearson Education, 1983.
3. Robert Kruse, C.L.Tondo, Bruce Leung, Shashi Mogalla , ― Data Structures and Program Design in C, Second Edition, Pearson Education, 2007
4. Jean-Paul Tremblay and Paul G. Sorenson, ―An Introduction to Data Structures with Applications, Second Edition, Tata McGraw-Hill, 1991.

EC8392	**DIGITAL ELECTRONICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:
- To present the Digital fundamentals, Boolean algebra and its applications in digital systems
- To familiarize with the design of various combinational digital circuits using logic gates
- To introduce the analysis and design procedures for synchronous and asynchronous sequential circuits
- To explain the various semiconductor memories and related technology
- To introduce the electronic circuits involved in the making of logic gates

UNIT I   DIGITAL FUNDAMENTALS   9
Number Systems – Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization.

UNIT II   COMBINATIONAL CIRCUIT DESIGN   9
Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder.

UNIT III   SYNCHRONOUS SEQUENTIAL CIRCUITS   9
Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits – Design - Moore/Mealy models, state minimization, state assignment, circuit implementation – Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.

UNIT IV   ASYNCHRONOUS SEQUENTIAL CIRCUITS   9
Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits.

UNIT V   MEMORY DEVICES AND DIGITAL INTEGRATED CIRCUITS   9
Basic memory structure – ROM -PROM – EPROM – EEPROM –EAPROM, RAM – Static and dynamic RAM - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) - Implementation of combinational logic circuits using PLA, PAL.
Digital integrated circuits: Logic levels, propagation delay, power dissipation, fan-out and fan-in, noise margin, logic families and their characteristics-RTL, TTL, ECL, CMOS

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course:

- Use digital electronics in the present contemporary world
- Design various combinational digital circuits using logic gates
- Do the analysis and design procedures for synchronous and asynchronous sequential circuits
- Use the semiconductor memories and related technology
- Use electronic circuits involved in the design of logic gates

TEXT BOOK:

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", 5th Edition, Pearson, 2014.

REFERENCES

1. Charles H.Roth. "Fundamentals of Logic Design", 6th Edition, Thomson Learning, 2013.
2. Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011
3. S.Salivahanan and S.Arivazhagan"Digital Electronics", Ist Edition, Vikas Publishing House pvt Ltd, 2012.
4. Anil K.Maini "Digital Electronics", Wiley, 2014.
5. A.Anand Kumar "Fundamentals of Digital Circuits", 4th Edition, PHI Learning Private Limited, 2016.
6. Soumitra Kumar Mandal " Digital Electronics", McGraw Hill Education Private Limited, 2016.

		L T P C
EC8381	**FUNDAMENTALS OF DATA STRUCTURES IN C LABORATORY**	0 0 4 2

OBJECTIVES:

- To understand and implement basic data structures using C
- To apply linear and non-linear data structures in problem solving.
- To learn to implement functions and recursive functions by means of data structures
- To implement searching and sorting algorithms

LIST OF EXERCISES:

1. Basic C Programs – looping, data manipulations, arrays
2. Programs using strings – string function implementation
3. Programs using structures and pointers
4. Programs involving dynamic memory allocations
5. Array implementation of stacks and queues
6. Linked list implementation of stacks and queues
7. Application of Stacks and Queues
8. Implementation of Trees, Tree Traversals
9. Implementation of Binary Search trees
10. Implementation of Linear search and binary search
11. Implementation Insertion sort, Bubble sort, Quick sort and Merge Sort
12. Implementation Hash functions, collision resolution technique

TOTAL:60 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able to:
- Write basic and advanced programs in C
- Implement functions and recursive functions in C
- Implement data structures using C
- Choose appropriate sorting algorithm for an application and implement it in a modularized way

BM8411	INTEGRATED CIRCUITS LABORATORY	L T P C
		0 0 4 2

OBJECTIVES:
- To expose the students to linear and integrated circuits
- To understand the basics of linear integrated circuits and available ICs
- To understand characteristics of operational amplifier.
- To apply operational amplifiers in linear and nonlinear applications.
- To acquire the basic knowledge of special function IC.
- To use SPICE software for circuit design

LIST OF EXPERIMENTS

DESIGN AND TESTING OF
1. Inverting, Non inverting and Differential amplifiers.
2. Integrator and Differentiator.
3. Instrumentation amplifier
4. Active low-pass, High-pass and band-pass filters.
5. Astable & Monostable multivibrators and Schmitt Trigger using op-amp.
6. RC Phase shift and Wien bridge oscillators using op-amp.
7. Astable and monostable multivibrators using NE555 Timer.
8. PLL characteristics and its use as Frequency Multiplier.
9. DC power supply using LM317 and LM723.

LIST OF DIGITAL EXPERIMENTS
10. Design and implementation of code converters using logic gates
(i) BCD to excess-3 code and vice versa (ii) Binary to gray and vice-versa
11. Design and implementation of 4 bit binary Adder/ Subtractor and BCD adder using IC 7483
12. Design and implementation of Multiplexer and De-multiplexer using logic gates
13. Design and implementation of encoder and decoder using logic gates
14. Construction and verification of 4 bit ripple counter and Mod-10 / Mod-12 Ripple counters
15. Design and implementation of 3-bit synchronous up/down counter
16. Implementation of SISO, SIPO, PISO and PIPO shift registers using Flip- flops.
17. SPICE Simulation studies.

TOTAL : 60 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Design oscillators and amplifiers using operational amplifiers.
- Design filters using Opamp and perform experiment on frequency response.
- Analyse the working of PLL and use PLL as frequency multiplier.
- Design DC power supply using ICs.
- Aquire knowledge in using SPICE

EC8394   **ANALOG AND DIGITAL COMMUNICATION**   **L T P C**
                                                                     3 0 0 3

OBJECTIVES:
The student should be made to:
- Understand analog and digital communication techniques.
- Learn data and pulse communication techniques.
- Be familiarized with source and Error control coding.
- Gain knowledge on multi-user radio communication.

UNIT I   ANALOG COMMUNICATION   9
Introduction to Communication Systems - Modulation – Types - Need for Modulation. Theory of Amplitude Modulation - Evolution and Description of SSB Techniques - Theory of Frequency and Phase Modulation – Comparison of Analog Communication Systems (AM – FM – PM).

UNIT II   PULSE AND DATA COMMUNICATION   9
Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM) - Comparison of various Pulse Communication System (PAM – PTM – PCM).

Data Communication: History of Data Communication - Standards Organizations for Data Communication- Data Communication Circuits - Data Communication Codes - Data communication Hardware - serial and parallel interfaces.

UNIT III   DIGITAL COMMUNICATION   9
Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK)–Phase Shift Keying (PSK) – BPSK – QPSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).

UNIT IV   SOURCE AND ERROR CONTROL CODING   9
Entropy, Source encoding theorem, Shannon fano coding, Huffman coding, mutual information, channel capacity, Error Control Coding, linear block codes, cyclic codes - ARQ Techniques.

UNIT V   MULTI-USER RADIO COMMUNICATION   9
Global System for Mobile Communications (GSM) - Code division multiple access (CDMA) – Cellular Concept and Frequency Reuse - Channel Assignment and Handover Techniques - Overview of Multiple Access Schemes - Satellite Communication - Bluetooth.

                                                             TOTAL: 45 PERIODS
OUTCOMES:
At the end of the course, the student should be able to:
- Apply analog and digital communication techniques.
- Use data and pulse communication techniques.
- Analyze Source and Error control coding.
- Utilize multi-user radio communication.

TEXT BOOK:
1. Wayne Tomasi, "Advanced Electronic Communication Systems", 6th Edition, Pearson Education, 2009.

REFERENCES:
1. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, 2004
2. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, 2007
3. H.Taub, D L Schilling and G Saha, "Principles of Communication", 3rd Edition, Pearson Education, 2007.
4. B. P.Lathi, "Modern Analog and Digital Communication Systems", 3rd Edition, Oxford University Press, 2007.
5. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002.
6. Martin S.Roden, "Analog and Digital Communication System", 3rd Edition, Prentice Hall of India, 2002.
7. B.Sklar, "Digital Communication Fundamentals and Applications" 2nd Edition Pearson Education 2007.

BM8501	BIOCONTROL SYSTEMS	L T P C
		4 0 0 4

OBJECTIVES
The student should be made:
- To understand the concept behind feedback and continuum in various systems and subsystems.
- To analyse the systems in time and frequency domain and to understand the concept of stability
- To apply mathematical modelling principles in understanding the various fundamental biological systems
- To analyse biological system models using MATLAB

UNIT I   INTRODUCTION   12
Open and Closed loop Systems, Modeling and Block Diagrams, Block diagram and signal flow graph representation of systems, reduction of block diagram and signal flow graph, Introduction to Physiological control systems- Illustration, Linear models of physiological systems, Difference between engineering and physiological control system.

UNIT II   TIME RESPONSE ANALYSIS   12
Step and impulse responses of first order and second order systems, time domain specifications of first and second order systems, steady state error constants, Definition of stability, Routh- Hurwitz criteria of stability, root locus technique, construction of root locus and study of stability.

UNIT III   FREQUENCY RESPONSE ANALYSIS   12
Frequency domain specifications - Polar plots, Bode plots, Nyquist plot, Nyquist stability criterion, closed loop stability, Constant M and N circles, Nichol's chart.

UNIT IV   BIOLOGICAL SYSTEM MODELS   12
Distributed parameter versus lumped parameter models, Model development of Cardiovascular system- Heart model-circulatory model, Pulmonary mechanics- Lung tissue visco-elastance-chest wall- airways, Interaction of Pulmonary and Cardiovascular models, Static analysis of physiological systems – Regulation of cardiac output, Regulation of ventilation.

UNIT V   BIOLOGICAL CONTROL SYSTEM ANALYSIS   12
Simple models of muscle stretch reflex action, Study of steady state analysis of muscle stretch reflex action, Study of transient response analysis of neuromuscular reflex model action, Study of frequency response of circulatory control model, Stability analysis of Pupillary light reflex.

TOTAL: 60 PERIODS

OUTCOMES:
Upon completion of this subject, the student will be able to:
- Understand the need for mathematical modeling of various systems, representation of systems in block diagrams and signal flow graphs and are introduced to biological control systems
- Analyze the time response of various systems and discuss the concept of system stability
- Analyze the frequency response characteristics of various systems using different charts
- Understand the concept of modeling basic physiological systems
- Comprehend the application aspects of time and frequency response analysis in physiological control systems.

TEXT BOOKS:
1. I.J. Nagarath and M. Gopal "Control Systems Engineering", Fifth Edition, Anshan Publishers, 2008.(UNIT
2. Michael C K Khoo, "Physiological Control Systems", IEEE Press, Prentice Hall of India, 2005

REFERENCES:
1. Benjamin C. Kuo, "Automatic Control Systems", Prentice Hall of India, 1995.
2. John Enderle Susan Blanchard, Joseph Bronzino "Introduction to Biomedical Engineering", second edition, Academic Press, 2005.
3. Richard C. Dorf, Robert H. Bishop, "Modern control systems", Pearson, 2004.

BM8502	BIOMEDICAL INSTRUMENTATION	L T P C
		3 0 0 3

OBJECTIVES:
The student should be made to
- To Illustrateorigin of bio potentials and its propagations
- To understand the different types of electrodes and its placement for various recordings
- To design bio amplifier for various physiological recordings
- To learn the different measurement techniques for non-physiological parameters.
- To Summarizedifferent biochemical measurements.

UNIT I   BIOPOTENTIAL ELECTRODES   9
Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell potential, Contact impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - motion artifacts, measurement with two electrodes.

UNIT II   BIOPOTENTIAL MEASUREMENTS   9
Bio signals characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system, Principles of vector cardiography.EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. Recording of ERG, EOG and EGG

UNIT III   SIGNAL CONDITIONING CIRCUITS   9
Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering

UNIT IV   MEASUREMENT OF NON-ELECTRICAL PARAMETERS   9

Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers, Systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.

UNIT V   BIOCHEMICAL MEASUREMENT AND BIOSENSORS   9

Biochemical sensors - pH, pO_2 and pCO_2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors, Blood gas analyzers - colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description) – Bio Sensors – Principles – amperometric and voltometric techniques.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Differentiate different bio potentials and its propagations.
- Illustrate different electrode placement for various physiological recordings
- Design bio amplifier for various physiological recordings
- Explain various technique for non-electrical physiogical measurements
- Demonstrate different biochemical measurement techniques.

TEXT BOOK:
1. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice hall of India, New Delhi, 2015.

REFERENCES:
1. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt Ltd,New Delhi, 2015.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.
3. Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", McGraw Hill Publisher, 2003.
4. Khandpur R.S, "Handbook of Biomedical Instrumentation", 3rd edition, Tata McGraw-Hill New Delhi, 2014

EC8553	DISCRETE-TIME SIGNAL PROCESSING	L	T	P	C
		4	0	0	4

 OBJECTIVES:
- To learn discrete fourier transform, properties of DFT and its application to linear filtering
- To understand the characteristics of digital filters, design digital IIR and FIR filters and apply these filters to filter undesirable signals in various frequency bands
- To understand the effects of finite precision representation on digital filters
- To understand the fundamental concepts of multi rate signal processing and its applications
- To introduce the concepts of adaptive filters and its application to communication engineering

UNIT I   DISCRETE FOURIER TRANSFORM   12

Review of signals and systems, concept of frequency in discrete-time signals, summary of analysis & synthesis equations for FT & DTFT, frequency domain sampling, Discrete Fourier transform (DFT) - deriving DFT from DTFT, properties of DFT - periodicity, symmetry, circular convolution. Linear filtering using DFT. Filtering long data sequences - overlap save and overlap add method. Fast computation of DFT - Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT), Decimation-in-frequency (DIF) Fast Fourier transform (FFT). Linear filtering using FFT.

UNIT II   INFINITE IMPULSE RESPONSE FILTERS   12

Characteristics of practical frequency selective filters. characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Approximation of derivatives, Impulse invariance method, Bilinear transformation. Frequency transformation in the analog domain. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.

UNIT III   FINITE IMPULSE RESPONSE FILTERS   12

Design of FIR filters - symmetric and Anti-symmetric FIR filters - design of linear phase FIR filters using Fourier series method - FIR filter design using windows (Rectangular, Hamming and Hanning window), Frequency sampling method. FIR filter structures - linear phase structure, direct form realizations

                                                                               12
UNIT IV   FINITE WORD LENGTH EFFECTS

Fixed point and floating point number representation - ADC - quantization - truncation and rounding - quantization noise - input / output quantization - coefficient quantization error - product quantization error - overflow error - limit cycle oscillations due to product quantization and summation - scaling to prevent overflow.

UNIT V   INTRODUCTION TO DIGITAL SIGNAL PROCESSORS   12

DSP functionalities - circular buffering – DSP architecture – Fixed and Floating point architecture principles – Programming – Application examples.

                                                                      TOTAL:60PERIODS

OUTCOMES:
At the end of the course, the student should be able to
- Apply DFT for the analysis of digital signals and systems
- Design IIR and FIR filters
- Characterize the effects of finite precision representation on digital filters
- Design multirate filters
- Apply adaptive filters appropriately in communication systems

TEXT BOOK:
1. John G. Proakis & Dimitris G.Manolakis, "Digital Signal Processing – Principles, Algorithms & Applications", Fourth Edition, Pearson Education / Prentice Hall, 2007. (UNIT I – V)

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

EC8562	DIGITAL SIGNAL PROCESSING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:
The student should be made:
- To perform basic signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation and Frequency analysis in MATLAB
- To implement FIR and IIR filters in MATLAB and DSP Processor
- To study the architecture of DSP processor
- To design a DSP system to demonstrate the Multi-rate and Adaptive signal processing concepts

LIST OF EXPERIMENTS: MATLAB / EQUIVALENT SOFTWARE PACKAGE

1. Generation of elementary Discrete-Time sequences
2. Linear and Circular convolutions
3. Auto correlation and Cross Correlation
4. Frequency Analysis using DFT
5. Design of FIR filters (LPF/HPF/BPF/BSF) and demonstrates the filtering operation
6. Design of Butterworth and Chebyshev IIR filters (LPF/HPF/BPF/BSF) and demonstrate the filtering operations

DSP PROCESSOR BASED IMPLEMENTATION
1. Study of architecture of Digital Signal Processor
2. Perform MAC operation using various addressing modes
3. Generation of various signals and random noise
4. Design and demonstration of FIR Filter for Low pass, High pass, Band pass and Band stop filtering
5. Design and demonstration of Butter worth and Chebyshev IIR Filters for Low pass, High pass, Band pass and Band stop filtering
6. Implement an Up-sampling and Down-sampling operation in DSP Processor

TOTAL: 60 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Carryout basic signal processing operations
- Demonstrate their abilities towards MATLAB based implementation of various DSP systems
- Analyze the architecture of a DSP Processor
- Design and Implement the FIR and IIR Filters in DSP Processor for performing filtering operation over real-time signals
- Design a DSP system for various applications of DSP

BM8511   **BIO MEDICAL INSTRUMENTATION LABORATORY**   **L T P C**
                                                                               0 0 4 2

OBJECTIVES:

- To provide hands-on training on designing of bio signal acquisition system and measurement of physiological parameters, biochemical parameters.

LIST OF EXPERIMENTS:

1. Design of pre amplifiers to acquire bio signals along with impedance matching circuit using suitable IC's
2. Design of ECG Amplifiers with appropriate filter to remove power line and other artifacts.
3. Design of EMG amplifier
4. Design a suitable circuit to detect QRS complex and measure heart rate
5. Design of frontal EEG amplifier
6. Design of EOG amplifier to detect eye blink
7. Design a right leg driven ECG amplifier.
8. Design and study the characteristics of optical Isolation amplifier
9. Design a Multiplexer and Demultiplexer for any two biosignals.
10. Measurement of pulse-rate using Photo transducer.
11. Measurement of pH and conductivity.
12. Measurement of blood pressure using sphygmomanometer.
13. Measurement and recording of peripheral blood flow
14. Design a PCB layout for any bio amplifier using suitable software tool.

TOTAL: 60 PERIODS

OUTCOMES:
At the end of the lab, the student should be able to:

- Design preamplifiers and amplifiers for various bio signal recordings.
- Measure various non-electrical parameters using suitable sensors/transducers
- Design PCB layout for any bio amplifier.

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS:

pH meter and conductivity meter: 1 No.
Photo transducer for pulse measurement: 1 No.
Sphygmomanometer and Stethoscope: 1 No.
Blood flow measurement system: 1 No.
Multiparameter (ECG, EMG, EEG) Simulator: 2 No.
Function generator, DSO, Regulated Power supplies, Bread boards – 8 each
IC LM 324, AD 620, INA series (126,128 etc.), 555 Timer: 20 each
Opto Isolator IC: MCT2E – 1 No.
Software tool for PCB design: 1

	L	**T**	**P**	**C**
HS8381 **INTERPERSONAL SKILLS/LISTENING&SPEAKING**	**0**	**0**	**2**	**1**

OBJECTIVES:
The Course will enable learners to:
- Equip students with the English language skills required for the successful undertaking of academic studies with primary emphasis on academic speaking and listening skills.
- Provide guidance and practice in basic general and classroom conversation and to engage in specific academic speaking activities.
- improve general and academic listening skills
- Make effective presentations.

UNIT I

Listening as a key skill- its importance- speaking - give personal information - ask for personal information - express ability - enquire about ability - ask for clarification Improving pronunciation - pronunciation basics taking lecture notes - preparing to listen to a lecture - articulate a complete idea as opposed to producing fragmented utterances.

UNIT II
Listen to a process information- give information, as part of a simple explanation - conversation starters: small talk - stressing syllables and speaking clearly - intonation patterns - compare and contrast information and ideas from multiple sources- converse with reasonable accuracy over a wide range of everyday topics.

UNIT III
Lexical chunking for accuracy and fluency- factors influence fluency, deliver a five-minute informal talk - greet - respond to greetings - describe health and symptoms - invite and offer - accept - decline - take leave - listen for and follow the gist- listen for detail

UNIT IV
Being an active listener: giving verbal and non-verbal feedback - participating in a group discussion - summarizing academic readings and lectures conversational speech listening to and participating in conversations - persuade.

UNIT V
Formal and informal talk - listen to follow and respond to explanations, directions and instructions in academic and business contexts - strategies for presentations and interactive communication - group/pair presentations - negotiate disagreement in group work.

TOTAL :   30   PERIODS

OUTCOMES:
At the end of the course Learners will be able to:
- Listen and respond appropriately.
- Participate in group discussions
- Make effective presentations
- Participate confidently and appropriately in conversations both formal and informal

TEXT BOOKS:

1. Brooks,Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford: 2011.
2. Richards,C. Jack. & David Bholke. Speak Now Level 3. Oxford University Press, Oxford: 2010

REFERENCES:

1. Bhatnagar, Nitin and MamtaBhatnagar. Communicative English for Engineers and Professionals. Pearson: New Delhi, 2010.
2. Hughes, Glyn and Josephine Moate. Practical English Classroom. Oxford University Press: Oxford, 2014.
3. Vargo, Mari. Speak Now Level 4. Oxford University Press: Oxford, 2013.
4. Richards C. Jack. Person to Person (Starter). Oxford University Press: Oxford, 2006.
5. Ladousse, Gillian Porter. Role Play. Oxford University Press: Oxford, 2014

EC8691   **MICROPROCESSORS AND MICROCONTROLLERS**   **L T P C**
                                                                     3 0 0 3
OBJECTIVES:
- To understand the Architecture of 8086 microprocessor.
- To learn the design aspects of I/O and Memory Interfacing circuits.
- To interface microprocessors with supporting chips.
- To study the Architecture of 8051 microcontroller.
- To design a microcontroller based system

UNIT I   THE 8086 MICROPROCESSOR   9
Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set and assembler directives – Assembly language programming – Modular Programming - Linking and Relocation - Stacks - Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.

UNIT II   8086 SYSTEM BUS STRUCTURE   9
8086 signals – Basic configurations – System bus timing –System design using 8086 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.

UNIT III   I/O INTERFACING   9
Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – D/A and A/D Interface - Timer – Keyboard /display controller – Interrupt controller – DMA controller – Programming and applications Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller.

UNIT IV   MICROCONTROLLER   9
Architecture of 8051 – Special Function Registers(SFRs) - I/O Pins Ports and Circuits - Instruction set - Addressing modes - Assembly language programming.

UNIT V   INTERFACING MICROCONTROLLER   9
Programming 8051 Timers - Serial Port Programming - Interrupts Programming – LCD & Keyboard Interfacing - ADC, DAC & Sensor Interfacing - External Memory Interface- Stepper Motor and Waveform generation - Comparison of Microprocessor, Microcontroller, PIC and ARM processors

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the students should be able to:

- Understand and execute programs based on 8086 microprocessor.
- Design Memory Interfacing circuits.
- Design and interface I/O circuits.
- Design and implement 8051 microcontroller based systems.

TEXT BOOKS:

1. Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design", Second Edition, Prentice Hall of India, 2007. (UNITI-III)
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson education, 2011.(UNIT IV-V)

REFERENCES:

1. Doughlas V.Hall, "Microprocessors and Interfacing, Programming and Hardware",TMH,2012
2. A.K.Ray,K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3rd edition, Tata McGrawHill, 2012

BM8601	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT- I	L T P C
		3 0 0 3

OBJECTIVES:

The student should be made to:

- Understand the devices for measurement of parameters related to cardiology.
- Illustrate the recording and measurement of EEG
- Demonstrate EMG recording unit and its uses.
- Explain diagnostic and therapeutic devices related to respiratory parameters.
- Understand the various sensory measurements that hold clinical importance.

UNIT I   CARDIAC EQUIPMENT   9

Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, ECG machine maintenance and troubleshooting, Cardiac Pacemaker-Internal and External Pacemaker– Batteries, AC and DC Defibrillator- Internal and External,Defibrillator Protection Circuit, Cardiac ablation catheter.

UNIT II   NEUROLOGICAL EQUIPMENT   8

Clinical significance of EEG, Multi-channel EEG recording system, Epilepsy, Evoked Potential– Visual, Auditory and Somatosensory, MEG (Magneto Encephalo Graph). EEG Bio Feedback Instrumentation. EEG system maintenance and troubleshooting.

UNIT III   MUSCULAR AND BIOMECHANICAL MEASUREMENTS   10

Recording and analysis of EMG waveforms, fatigue characteristics, Muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation. Static Measurement – Load Cell, Pedobarograph. Dynamic Measurement – Velocity, Acceleration, GAIT, Limb position.

UNIT IV   RESPIRATORY MEASUREMENT SYSTEM   10

Instrumentation for measuring the mechanics of breathing – Spirometer -Lung Volume and vital capacity, measurements of residual volume, Pneumotachometer – Airway resistance measurement, Whole body Plethysmograph, Intra-Alveolar and Thoracic pressure measurements, Apnoea Monitor. Types of Ventilators – Pressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.

UNIT V   **SENSORY MEASUREMENT**   **8**

Psychophysiological Measurements – polygraph, basal skin resistance (BSR), galvanic skin resistance (GSR), Sensory responses - Audiometer-Pure tone, Speech, Eye Tonometer, Applanation Tonometer, slit lamp, auto refractometer.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Describe the working and recording setup of all basic cardiac equipment.
- Understand the working and recording of all basic neurological equipment's.
- Discuss the recording of diagnostic and therapeutic equipment's related to EMG.
- Explain about measurements of parameters related to respiratory system.
- Describe the measurement techniques of sensory responses.

TEXT BOOKS:
1. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India PvtLtd,New Delhi, 2015.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012.

REFERENCES:
1. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw Hill, 2003.
2. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008
3. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.
4. Antony Y.K.Chan,"Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
5. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, "Medical Physics and Biomedical Engineering", 2nd Edition, IOP Publishers. 2001.

BM8651   **BIOMECHANICS**   **L T P C**
                                                            3 0 0 3

OBJECTIVES:
The student should be made to:
- Explain the principles of mechanics.
- Discuss the mechanics of physiological systems.
- Explain the mechanics of joints.
- Illustrate the mathematical models used in the analysis of biomechanical systems

UNIT I   **INTRODUCTION TO MECHANICS**   **9**

Introduction – Scalars and vectors, Statics – Force types, Resolution and composition of forces, Moments of force and couple, Resultant force determination, parallel forces in space, equilibrium of coplanar forces, Dynamics, Basic principles – Linear motion, Newton's laws of motion, Impulse and Momentum, Work and Energy Kinetics – Velocity and acceleration, Kinematics – Link segment models, Force transducers, Force plates, Introduction to Constitutive equations – Constitutive equations of Nonviscous fluid, Newtonian Viscous fluid and Hookean Elastic solid

UNIT II BIOFLUID MECHANICS 9

Intrinsic fluid properties – Density, Viscosity, Compressibility and Surface Tension, Viscometers – Capillary, Coaxial cylinder and cone and plate, Rheological properties of blood, Pressure-flow relationship for Non-Newtonian Fluids, Fluid mechanics in straight tube – Steady Laminar flow, Turbulent flow, Flow development, Viscous and Turbulent Sheer Stress, Effect of pulsatility, Boundary Layer Separation, Structure of blood vessels, Material properties and modeling of Blood vessels, Heart –Cardiac muscle characterisation, Native heart valves – Mechanical properties and valve dynamics, Prosthetic heart valve fluid dynamics.

UNIT III BIOSOLID MECHANICS 9

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

UNIT IV BIOMECHANICS OF JOINTS 9

Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, Free body diagrams, Structure of joints, Types of joints, Biomechanical analysis of elbow, shoulder, spinal column, hip, knee and ankle, Lubrication of synovial joints, Gait analysis, Motion analysis using video.

UNIT V MODELING AND ERGONOMICS 9

Introduction to Finite Element Analysis, finite element analysis of lumbar spine; Ergonomics – Musculoskeletal disorders, Ergonomic principles contributing to good workplace design, Design of a Computer work station, Whole body vibrations, Hand transmitted vibrations.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Understand the principles of mechanics
- Outline the principles of biofluid dynamics.
- Explain the fundamentals of bio-solid mechanics.
- Apply the knowledge of joint mechanics.
- Give Examples of computational mathematical modelling applied in biomechanics.

TEXT BOOKS:
1. Y.C. Fung, "Bio-Mechanics- Mechanical Properties of Tissues", Springer-Verlag, 1998.
2. Subrata Pal, "Textbook of Biomechanics", Viva Books Private Limited, 2009.

REFERENCES:
1. Krishna B. Chandran, Ajit P. Yoganathan and Stanley E. Rittgers, "Biofluid Mechanics: The Human Circulation", Taylor and Francis, 2007.
2. Sheraz S. Malik and Shahbaz S. Malik, "Orthopaedic Biomechanics Made Easy", Cambridge University Press, 2015.
3. Jay D. Humphrey, Sherry De Lange, "An Introduction to Biomechanics: Solids and Fluids, Analysis and Design", Springer Science Business Media, 2004.
4. Shrawan Kumar, "Biomechanics in Ergonomics", Second Edition, CRC Press 2007.
5. Neil J. Mansfeild, "Human Response to Vibration", CRC Press, 2005.
6. Carl J. Payton, "Biomechanical Evaluation of movement in sports and Exercise", 2008.

GE8291 **ENVIRONMENTAL SCIENCE AND ENGINEERING** **L T P C**
 3 0 0 3
OBJECTIVES:
- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth"s interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I   ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY   14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II   ENVIRONMENTAL POLLUTION   8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III   NATURAL RESOURCES   10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV   SOCIAL ISSUES AND THE ENVIRONMENT   7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V   HUMAN POPULATION AND THE ENVIRONMENT   6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

OUTCOMES:
- Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.
- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions
- Development and improvement in std. of living has lead to serious environmental disasters

TEXTBOOKS:
1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.

REFERENCES :
1. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi, 2007.
2. Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) PVT, LTD, Hydrabad, 2015.
3. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
4. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.

MD8091   **HOSPITAL MANAGEMENT**   **L T P C**
                                                                      3 0 0 3
OBJECTIVES:
- To understand the fundamentals of hospital administration and management.
- To know the market related research process
- To explore various information management systems and relative supportive services.
- To learn the quality and safety aspects in hospital.

UNIT I   OVERVIEW OF HOSPITAL ADMINISTRATION   9

Distinction between Hospital and Industry, Challenges in Hospital Administration – Hospital Planning- Equipment Planning – Functional Planning - Current Issues in Hospital Management – Telemedicine - Bio-Medical Waste Management.

UNIT II **HUMAN RESOURCE MANAGEMENT IN HOSPITAL** **9**
Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer, Communication – nature, scope, barriers, styles and modes of communication.

UNIT III **MARKETING RESEARCH PROCESS** **9**
Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research considerations – Consumer Markets & Consumer Buyer Behaviour - Model of consumer behaviour - The buyer decision process - Model of business buyer behavior – Major types of buying situations - WTO and its implications.

UNIT IV **HOSPITAL INFORMATION SYSTEMS & SUPPORTIVE SERVICES** **9**
Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information Systems - Support Service Technical Information Systems – Medical Transcription, Medical Records Department – Central Sterilization and Supply Department – Pharmacy– Food Services - Laundry Services.

UNIT V **QUALITY AND SAFETY ASPECTS IN HOSPITAL** **9**
Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – Environment Management Systems. NABA, JCI, NABL. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care – Medical Audit – Hazard and Safety in a hospital Setup.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Explain the principles of Hospital administration.
- Identify the importance of Human resource management.
- List various marketing research techniques.
- Identify Information management systems and its uses.
- Understand safety procedures followed in hospitals.

TEXT BOOKS:
1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006.
2. G.D.Kunders, "Hospitals – Facilities Planning and Management – TMH, New Delhi – Fifth Reprint 2007.

REFERENCES:
1. Cesar A.Caceres and Albert Zara, "The Practice of Clinical Engineering, Academic Press, New York, 1977.
2. Norman Metzger, "Handbook of Health Care Human Resources Management", 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.
3. Peter Berman "Health Sector Reform in Developing Countries" - Harvard University Press, 1995.
4. William A. Reinke "Health Planning For Effective Management" - Oxford University Press.1988
5. Blane, David, Brunner, "Health and SOCIAL Organization: Towards a Health Policy for the 21st Century", Eric Calrendon Press 2002.
6. Arnold D. Kalcizony & Stephen M. Shortell, "Health Care Management", 6th Edition Cengage Learning, 2011.

EC8681   MICROPROCESSORS AND MICROCONTROLLERS LABORATORY   L T P C
                                                                    0 0 4 2

OBJECTIVES:
- To Introduce ALP concepts, features and Coding methods
- Write ALP for arithmetic and logical operations in 8086 and 8051
- Differentiate Serial and Parallel Interface
- Interface different I/Os with Microprocessors
- Be familiar with MASM

LIST OF EXPERIMENTS:
8086 Programs using kits and MASM
1. Basic arithmetic and Logical operations
2. Move a data block without overlap
3. Code conversion, decimal arithmetic and Matrix operations.
4. Floating point operations, string manipulations, sorting and searching
5. Password checking, Print RAM size and system date
6. Counters and Time Delay

Peripherals and Interfacing Experiments
7. Traffic light controller
8. Stepper motor control
9. Digital clock
10. Key board and Display
11. Printer status
12. Serial interface and Parallel interface
13. A/D and D/A interface and Waveform Generation

8051 Experiments using kits and MASM
14. Basic arithmetic and Logical operations
15. Square and Cube program, Find 2's complement of a number
16. Unpacked BCD to ASCII

                                                    TOTAL: 60 PERIODS
OUTCOMES:
At the end of the course, the student should be able to:
- Write ALP Programmes for fixed and Floating Point and Arithmetic operations
- Interface different I/Os with processor
- Generate waveforms using Microprocessors
- Execute Programs in 8051
- Explain the difference between simulator and Emulator

LAB EQUIPMENT FOR A BATCH OF 30 STUDENTS:
HARDWARE:
8086 development kits - 30 nos
Interfacing Units - Each 10 nos
Microcontroller - 30 nos

SOFTWARE:
Intel Desktop Systems with MASM - 30 nos
8086 Assembler
8051 Cross Assembler

BM8611   DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY   L   T   P   C

**   0   0   4   2**

OBJECTIVES:
The student should be made to
- To demonstrate recording and analysis of different Bio potentials
- To examine different therapeutic modalities.

LIST OF EXPERIMENTS:
1. Measurement of visually evoked potential
2. Galvanic skin resistance (GSR) measurement
3. Study of shortwave and ultrasonic diathermy
4. Measurement of various physiological signals using biotelemetry
5. Study of hemodialysis model
6. Electrical safety measurements
7. Measurement of Respiratory parameters using spirometry.
8. Study of medical stimulator
9. Analyze the working of ESU – cutting and coagulation modes
10. Recording of Audiogram
11. Study the working of Defibrillator and pacemakers
12. Analysis of ECG, EEG and EMG signals
13. Study of ventilators
14. Study of Ultrasound Scanners
15. Study of heart lung machine model

**   TOTAL: 60 PERIODS**
OUTCOMES:
At the end of the lab, the student should be able to:
- Measure different bioelectrical signals using various methods
- Assess different non-electrical parameters using various methodologies
- Illustrate various diagnostic and therapeutic techniques
- Examine the electrical safety measurements
- Analyze the different bio signals using suitable tools.

LAB REQUIREMENTS FOR 30 STUDENTS
Visually evoked potential setup: 1 No.
GSR setup: 1 No.
Multi-output power supply (+15v, -15v, +30V variable, +5V, 2A): 2 Nos.
Short wave Diathermy 1 No.
Ultrasound diathermy 1 No.
Multiparameter biotelemetry system 1 No.
Electrical Safety Analyser 1 No.
Spirometry with associated analysis system: 1 No.
ECG Simulator 1 No.
Medical stimulator 1 No
Surgical diathermy with analyzer 1 No
Audiometer 1No
Pacemaker and Defibrillator: 1 No. each
Haemodialysis model and Heart lung Model: 1 No. each
Ventilator: 1 No.
Ultrasound Scanner: 1 No.
Software to Analyze ECG,EEG and EMG: 1 No.

BM8612   **MINI PROJECT**   **L T P C**
                                                                  0 0 2 1

OBJECTIVES
- To develop skills to formulate a technical project.
- To estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model of a Biomedical/ Electronics/ Mechatronic/ Instrumentation system.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyze the cost effectiveness.
- For enabling the students to gain experience in organization and implementation of a small project and thus acquire the necessary confidence to carry out main project in the final year.
- To provide guidelines to prepare technical report of the project.

                                                              TOTAL: 30 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Formulate a real world problem, identify the requirement and develop the design solutions.
- Express the technical ideas, strategies and methodologies.
- Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
- Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
- Prepare report and present the oral demonstrations.

HS8581   **PROFESSIONAL COMMUNICATION**   **L   T   P   C**
                                                                  0   0   2   1

OBJECTIVES:
 The course aims to:
- Enhance the Employability and Career Skills of students
- Orient the students towards grooming as a professional
- Make them Employable Graduates
- Develop their confidence and help them attend interviews successfully.

UNIT I
Introduction to Soft Skills-- Hard skills & soft skills - employability and career Skills—Grooming as a professional with values—Time Management—General awareness of Current Affairs

UNIT II
 Self-Introduction-organizing the material - Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice— presenting the visuals effectively – 5 minute presentations

UNIT III
Introduction to Group Discussion— Participating in group discussions – understanding group dynamics - brainstorming the topic -– questioning and clarifying –GD strategies- activities to improve GD skills

UNIT IV
Interview etiquette – dress code – body language – attending job interviews– telephone/skype interview -one to one interview &panel interview – FAQs related to job interviews

UNIT V
Recognizing differences between groups and teams- managing time-managing stress- networking professionally- respecting social protocols-understanding career management-developing a long-term career plan-making career changes

                              TOTAL :   30   PERIODS

OUTCOMES:
At the end of the course Learners will be able to:
- Make effective presentations
- Participate confidently in Group Discussions.
- Attend job interviews and be successful in them.
- Develop adequate Soft Skills required for the workplace

Recommended Software
1. Globearena
2. Win English

REFERENCES:
1. Butterfield, Jeff   Soft Skills for Everyone. Cengage Learning: New Delhi, 2015
2. E. Suresh Kumar et al. Communication for Professional Success. Orient Blackswan: Hyderabad, 2015
3. Interact English Lab Manual for Undergraduate Students,. OrientBalckSwan: Hyderabad, 2016.
4. Raman, Meenakshi and Sangeeta Sharma. Professional Communication. Oxford University Press: Oxford, 2014
5. S. Hariharanetal. Soft Skills. MJP Publishers: Chennai, 2010.

BM8701	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT – II	L T P C
		3 0 0 3

OBJECTIVES:
The student should be made to:
- Understand the devices used in ICU and principles of Telemetry.
- Describe types of diathermy and its uses
- Demonstrate applications of ultrasound in medicine
- Explain extracorporeal devices used in critical care
- Discuss the importance of patient safety against electrical hazard

UNIT I   PATIENT MONITORING AND BIOTELEMETRY   9
Patient monitoring systems, ICU/CCU Equipments, bed side monitors, Infusion pumps, Central consoling controls. Radio Telemetry (single, multi), Portable and Landline Telemetry unit, Applications in ECG and EEG Transmission.

UNIT II   DIATHERMY   9
IR and UV lamp and its application. Short wave diathermy, ultrasonic diathermy, Microwave diathermy, Electro surgery machine - Current waveforms, Tissue Responses, Electro surgical current level, Hazards and safety procedures.

UNIT III   ULTRASONIC EQUIPMENTS   9
Diagnosis: Tissue Reaction, Basic principles of Echo technique, display techniques A, B and M mode, B Scan, Application of ultrasound as diagnostic tool – Echocardiogram, Echoencephalogram, abdomen, obstetrics and gynecology, ophthalmology.

UNIT IV   EXTRA CORPOREAL DEVICES AND SPECIAL DIAGNOSTIC TECHNIQUES   9

Need for heart lung machine, functioning of bubble, disc type and membrane type oxygenators, finger pump, roller pump, electronic monitoring of functional parameters. Hemo Dialyser unit, Lithotripsy, Principles of Cryogenic technique and application, Endoscopy, Laproscopy, Otoscopes. Thermography – Recording and clinical application.

UNIT V   PATIENT SAFETY   9

Physiological effects of electricity – important susceptibility parameters – Macro shock – Micro shock hazards – Patient's electrical environment – Isolated Power system – Conductive surfaces – Electrical safety codes and standards – IEC 60601-1 2005 standard, Basic Approaches to Protection against shock, Protection equipment design, Electrical safety analyzer – Testing the Electric system

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Discuss the various equipment used in ICU and applications of telemetry.
- Explain the types of diathermy and its applications.
- Express the basics of ultrasound and its application in medicine
- Discuss the various extracorporeal and special diagnostic devices used in hospitals
- Outline the importance of patient safety against electrical hazard

TEXT BOOKS:
1. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India PvtLtd,New Delhi, 2015
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012.

REFERENCES:
1. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice hall of India, New Delhi, 2015.
2. Richard Aston "Principles of Biomedical Instrumentation and Measurement", Merril Publishing Company, 1990.
3. L.A Geddas and L.E.Baker "Principles of Applied Biomedical Instrumentation" 2004.
4. Myer Kutz "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill Publisher, 2003.
5. Khandpur R.S, "Handbook of Biomedical Instrumentation", 3rdedition,Tata McGraw-Hill, New Delhi, 2014.

EC8093	DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To become familiar with digital image fundamentals
- To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study the image segmentation and representation techniques.
- To become familiar with image compression and recognition methods

UNIT I   DIGITAL IMAGE FUNDAMENTALS   9

Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - Color image fundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.

UNIT II   IMAGE ENHANCEMENT   9

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

UNIT III   IMAGE RESTORATION   9

Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering

UNIT IV   IMAGE SEGMENTATION   9

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

UNIT V   IMAGE COMPRESSION AND RECOGNITION   9

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.

TOTAL   45   PERIODS

OUTCOMES:
At the end of the course, the students should be able to:
- Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.
- Operate on images using the techniques of smoothing, sharpening and enhancement.
- Understand the restoration concepts and filtering techniques.
- Learn the basics of segmentation, features extraction, compression and recognition methods for color models.

TEXT BOOKS:
1. Rafael C. Gonzalez, Richard E. Woods, 'Digital Image Processing', Pearson, Third Edition, 2010.
2. Anil K. Jain, 'Fundamentals of Digital Image Processing', Pearson, 2002.

REFERENCES:
1. Kenneth R. Castleman, 'Digital Image Processing', Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, 'Digital Image Processing using MATLAB', Pearson Education, Inc., 2011.
3. D,E. Dudgeon and RM. Mersereau, 'Multidimensional Digital Signal Processing', Prentice Hall Professional Technical Reference, 1990.
4. William K. Pratt, 'Digital Image Processing', John Wiley, New York, 2002
5. Milan Sonka et al 'Image processing, analysis and machine vision', Brookes/Cole, Vikas Publishing House, 2nd edition, 1999

BM8702	**RADIOLOGICAL EQUIPMENTS**	**L T P C**
		3 0 0 3

OBJECTIVES:
The student should be made
- To understand the generation of X-ray and its uses in imaging
- To describe the principle of Computed Tomography.
- To know the techniques used for visualizing various sections of the body.
- To learn the principles of different radio diagnostic equipment in Imaging
- To discuss the radiation therapy techniques and radiation safety.

UNIT I   MEDICAL X-RAY EQUIPMENT   9
Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, the collimator, Bucky Grid, power supply, Cathode and filament currents, Focusing cup, Thermionic emission, Electromagnetic induction, Line focus principle and the heel effect, Causes of x-ray tube failure: Electron arcing/filament burn out, Failure to warm up tube, High temp due to over exposure, x-ray tube rating charts.X-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, Cine Angiography, Digital subtraction Angiography. Mammography and Dental x-ray unit.

UNIT II   COMPUTED TOMOGRAPHY   9
Principles of tomography, CT Generations, X- Ray sources- collimation- X- Ray detectors-Viewing systems- spiral CT scanning – Ultra fast CT scanners. Advantages of computed radiography over film screen radiography: Time, Image quality, Lower patient dose, Differences between conventional imaging equipment and digital imaging equipment: Image plate, Plate readers, Image characteristics, Image reconstruction techniques- back projection and iterative method. Spiral CT, 3D Imaging and its application.

UNIT III   MAGNETIC RESONANCE IMAGING   9
Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system- system magnet (Permanent, Electromagnet and Super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), and shim coils, Electronic components, fMRI.

UNIT IV   NUCLEAR MEDICINE TECHNIQUES   9
Nuclear imaging – Anger scintillation camera –Nuclear tomography – single photon emission computer tomography, positron emission tomography – Recent advances .Radionuclide imaging- Bone imaging, dynamic renal function, myocardial perfusion. Non imaging techniques- hematological measurements, Glomerular filtration rate, volume measurements, clearance measurement, whole -body counting, surface counting

UNIT V   RADIATION THERAPY AND RADIATION SAFETY   9
Radiation therapy – linear accelerator, Telegamma Machine. SRS –SRT,-Recent Techniques in radiation therapy - 3DCRT – IMRT – IGRT and Cyber knife- radiation measuring instruments- Dosimeter, film badges, Thermo Luminescent dosimeters- electronic dosimeter- Radiation protection in medicine- radiation protection principles.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course, the student should be able to
- Describe the working principle of X ray machine and its application.
- Illustrate the principle computed tomography.
- Interpret the technique used for visualizing various sections of the body using magnetic resonance imaging
- Demonstrate the applications of radio nuclide imaging.
- Outline the methods of radiation safety.

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

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

BM8703	REHABILITATION ENGINEERING	L T P C
		3 0 0 3

OBJECTIVES:
- To understand the rehabilitation concepts and Rehabilitation team members for future development and applications.
- To study various Principles of Rehabilitation Engineering.
- To understand different types of Therapeutic Exercise Technique.
- To understand the tests to assess the hearing loss, development of electronic devices to compensate for the loss and various assist devices for visually and auditory impaired.
- To study the various orthotic devices and prosthetic devices to overcome orthopedic problems.

UNIT I   INTRODUCTION TO REHABILITATION   9
What is Rehabilitation, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Rehabilitation team Classification of members, The Role of Psychiatrist, Occupational therapist, Physical therapist, Recreation therapist, Prosthetist - Orthotist, Speech pathologist, Rehabilitation nurse, Social worker, Corrective therapist, Psychologist, Music therapist, Dance therapist & Biomedical engineer.

UNIT II   PRINCIPLES OF REHABILITATION   9
Introduction, The Human Component, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering- Key Engineering Principles, Key Ergonomic Principles - Practice of Rehabilitation and Assistive Technology.

UNIT III   THERAPEUTIC EXERCISE TECHNIQUE   9
Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilisation exercises, Endurance exercises.

UNIT IV   MANAGEMENT OF COMMUNICATION & VIRTUAL REALITY   9
Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids. Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.

UNIT V   ORTHOTIC, PROSTHETIC DEVICES & RESTORATION TECHNIQUES   9

General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Calipers- FO, AFO, KAFO, HKAFO. Prosthetic devices: Hand and arm replacement, Body powered prosthetics, Myoelectric controlled prosthetics and Externally powered limb prosthetics. Functional Electrical Stimulation systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).

TOTAL : 45 PERIODS

OUTCOMES
Students will be able to
- Gain adequate knowledge about the needs of rehabilitations and its future development.
- Have an in depth idea about Engineering Concepts in Sensory & Motor rehabilitation.
  Apply the different types of Therapeutic Exercise Technique to benefit the society.
- Design and apply different types Hearing aids, visual aids and their application in biomedical field and hence the benefit of the society.
- Gain in-depth knowledge about different types of models of Hand and arm replacement.

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

REFERENCES:
1. Horia- Nocholai Teodorecu, L.C.Jain ,Intelligent systems and technologies in rehabilitation Engineering; CRC; December 2000.
2. Keswick. J., What is Rehabilitation Engineering, Annual Reviews of Rehabilitation- Springer-Verlag, New York, 1982.
3. Warren E. Finn,Peter G. LoPresti; Handbook of Neuroprosthetic Methods CRC; edition 2002.
4. Rory A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), 'An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering' CRC Press, 2006.

EC8762   DIGITAL IMAGE PROCESSING LABORATORY   L T P C
0 0 4 2

OBJECTIVES:
- To practice the basic image processing techniques.
- To compute magnitude and phasor representation of images.
- To understand the concepts of image restoration and segmentation.
- To explore the applications of image processing techniques.

LIST OF EXPERIMENTS
Simulation using MATLAB
1. Image sampling and quantization
2. Analysis of spatial and intensity resolution of images.
3. Intensity transformation of images.
4. DFT analysis of images
5. Transforms (Walsh, Hadamard, DCT, Haar)
6. Histogram Processing and Basic Thresholding functions
7. Image Enhancement-Spatial filtering
8. Image Enhancement- Filtering in frequency domain
9. Image segmentation – Edge detection, line detection and point detection.
10. Basic Morphological operations.

11. Region based Segmentation
12. Segmentation using watershed transformation
13. Analysis of images with different color models.
14. Study of DICOM standards
15. Image compression techniques
16. Image restoration
17. A mini project based on medical image processing

TOTAL : 60 PERIODS

OUTCOMES
At the end of the course, the student should be able to:
- Perform enhancing operations on the image using spatial filters and frequency domain filters.
- Use transforms and analyse the characteristics of the image.
- Perform segmentation operations in the images.
- Estimate theefficiency of the compression technique on the images.
- Apply image processing technique to solve real health care problems.

REFERENCE:
1. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins,' Digital Image Processing using MATLAB', Pearson Education, Inc., 2004.

MD8751	HOSPITAL TRAINING	L T P C
		0 0 4 2

OBJECTIVES:
The student should be made to
- Observe medical professionals at work in the wards and the roles of Allied Health Professionals;
- Provide access to healthcare Professionals to get a better understanding of their work;
- Demonstrate patient-care in a hospital setting.

ASSESSMENT:
- Students need to complete training in any leading Multi-speciality hospital for a period of 15 days. They need to prepare an extensive report and submit to their respective course in-charges during the session.
- Out of the following departments, it is mandatory to complete training in any 10. The students can give a presentation of the remaining departments during laboratory hours.

S.No.	Departments for visit
1	Cardiology
2	ENT
3	Ophthalmology
4	Orthopaedic and Physiotherapy
5	ICU/CCU
6	Operation Theatre
7	Neurology
8	Nephrology
9	Radiology
10	Nuclear Medicine
11	Pulmonology
12	Urology
13	Obstetrics and Gynaecology

14	Emergency Medicine
15	Biomedical Engineering Department
16	Histo Pathology
17	Biochemistry
18	Paediatric/Neonatal
19	Dental
20	Oncology
21	PAC's
22	Medical Records / Telemetry

TOTAL : 60 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Advocate a patient-centred approach in healthcare
- Communicate with other health professionals in a respectful and responsible manner
- Recognize the importance of inter-professional collaboration in healthcare.
- Propose a patient-centred inter-professional health improvement plan based upon the patient's perceived needs
- Use the knowledge of one's own role and those of other professions to address the healthcare needs of populations and patients served.

BM8811   **PROJECT WORK**   **L T P C**
                                                           0 0 20 10
OBJECTIV ES:
To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports
and to face reviews and viva voce examination.

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department.

A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Headof the Department.

TOTAL: 300 PERIODS
OUTCOMES:
On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

BM8071   **BIO MEMS**   **L T P C**
                                                                                3 0 0 3

OBJECTIVES:
The student should be made to:
- Learn various MEMS fabrication techniques.
- Understand different types of sensors and actuators and their principles of operation at the micro scale level.
- Know the application of MEMS in different field of medicine.

UNIT I   MEMS MATERIALS AND FABRICATION   9
Typical MEMs and Microsystems, materials for MEMS - active substrate materials-Silicon and its compounds, Silicon piezoresistors, Gallium Arsenide, quartz, polymers. Micromachining photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA.

UNIT II   MECHANICAL AND THERMAL SENSORS AND ACTUATORS   9
Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermomechanics, fracture and thin film mechanics. Mechanical sensors and actuators – beam and cantilever –microplates, strain, pressure and flow measurements, Thermal sensors and actuators- actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flow sensor

UNIT III   ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATORS   9
Parallel plate capacitor, pull in effect, Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Properties of piezoelectric materials, Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.

UNIT IV   MICROFLUIDIC SYSTEMS   9
Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in microconduits, in submicrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, dielectrophoresis, microfluid dispenser, microneedle, micropumps-continuous flow system, micromixers

UNIT V   APPLICATIONS OF BIOMEMS   9
CAD for MEMS, Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR),DNA sensor, MEMS based drug delivery, Biosensors- sensors for glucose, uric acid, urea and triglyceride sensor.

                                                                  TOTAL: 45 PERIODS
OUTCOMES:
At the end of the course, the student should be able to:
- Discuss various MEMS fabrication techniques.
- Explain different types of sensors and actuators and their principles of operation at the micro Scale level.
- Apply MEMS in different field of medicine.

TEXT BOOKS:
1. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002. (Unit I, II, III & IV).
2. Wanjun Wang, Stephen A.Soper, "BioMEMS: Technologies and Applications", CRC Press, New York, 2007.(Unit V).

REFERENCES:
1. Marc J. Madou "Fundamentals of Microfabrication: the Science of Miniaturization", CRC Press,2002.
2. Nadim Maluf, Kirt Williams. "An introduction to Microelectro Mechancial Systems Engineering", Second Edition, Artech House Inc, MA, 2004.
3. Chang Liu,' Foundations of MEMS', Pearson Education International, New Jersey, USA,2006
4. Nitaigour Premchand Mahalik, "MEMS", Tata McGraw Hill Publishing Company, New Delhi, 2007

EC8075	NANOTECHNOLOGY AND APPLICATIONS	L T P C
		3 0 0 3

OBJECTIVES
- To provide a broad view of the nascent field of nanoscience and nanotechnology to undergraduates
- To explore the basics of nanomaterial synthesis and characterization.
- To introduce the applications of nanotechnology

UINI I   INTRODUCTION TO NANOTECHNOLOGY   9
Basic Structure of Nanoparticles- Kinetics in Nanostructured Materials- Zero dimensional, size and shape of nanoparticles; one-dimensional and two dimensional nanostructures- clusters of metals and semiconductors, bionano-particles.

UNIT II   FABRICATION AND CHARACTERIZATION OF NANOMATERIALS   9
Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Buckyballs, Nanotubes); Gas, liquid, and solid –phase synthesis of nanomaterials; Lithography techniques (Photolithography, Dip-pen and Electron beam lithography); Thin film deposition; Electrospinning. Bio-synthesis of nanomaterials.

UNIT III   PROPERTIES AND MEASUREMENT OF NANOMATERIALS   9
Optical Properties: Absorption, Fluorescence, and Resonance; Methods for the measurement of nanomaterials; Microscopy measurements: SEM, TEM, AFM and STM. Confocal and TIRF imaging.

UNIT IV   NANO STRUCTURES   9
Carbon Nanotubes, Fullerenes, Nanowires, Quantum Dots. Applications of nanostructures. Reinforcement in Ceramics, Drug delivery, Giant magnetoresistance, etc. Cells response to Nanostructures.

UNIT V   APPLICATIONS OF NANOTECHNOLOGY   9
Nano electronics, Nanosensors, Nanotechnology in Diagnostics applications, Environmental and Agricultural Applications of nanotechnology, Nano technology for energy systems

TOTAL : 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Describe the basic science behind the properties of materials.
- Interpret the creation, characterization, and manipulation of nanoscale materials.
- Comprehend the exciting applications of nanotechnology at the leading edge of scientific research
- Apply their knowledge of nanotechnology to identify how they can be exploited for new applications.

TEXT BOOKS:
1. Springer Handbook of Nanotechnology by Bharat Bhushan 2004.(Unit I – V)
2. Encyclopedia of Nanotechnology - Hari Singh Nalwa 2004. (Unit I – V)

REFERENCES:
1. Nanomaterials, Nanotechnologies and Design: an Introduction to Engineers and Architects, D. Michael Ashby, Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinemann, 2009.
2. Handbook of Nanophase and Nanostructured Materials (in four volumes), Eds: Z.L. Wang, Y. Liu, Z. Zhang, Kluwer Academic/Plenum Publishers, 2003.
3. Handbook of Nanoceramics and their Based Nanodevices (Vol. 2) Edited by Tseung-Yuen Tseng and Hari Singh Nalwa, American Scientific Publishers.

BM8072   **BIOMATERIALS**   **L T P C**
                                                                                           3 0 0 3

OBJECTIVES

The student should be made to:
- Learn characteristics and classification of Biomaterials
- Understand different metals, ceramics and its nanomaterial's characteristics as biomaterials
- Learn polymeric materials and its combinations that could be used as a tissue replacement implants
- Get familiarized with the concepts of Nano Science and Technology
- Understand the concept of biocompatibility and the methods for biomaterials testing

UNIT I   INTRODUCTION TO BIO-MATERIALS   9
Definition and classification of bio-materials, mechanical properties, visco elasticity, biomaterial performance, body response to implants, wound healing, blood compatibility, Nano scale phenomena.

UNIT II   METALLIC AND CERAMIC MATERIALS   9
Metallic implants - Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion, ceramic implant – bio inert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bio ceramics.

UNIT III   POLYMERIC IMPLANT MATERIALS   9
Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, Bio polymers: Collagen, Elastin and chitin. Medical Textiles, Materials for ophthalmology: contact lens, intraocular lens. Membranes for plasma separation and Blood oxygenation, electro spinning: a new approach.

UNIT IV   TISSUE REPLACEMENT IMPLANTS   9
Small intestinal sub mucosa and other decullarized matrix biomaterials for tissue repair: Extra cellular Matrix. Softtissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, tissue scaffolding and engineering using Nano biomaterials.

UNIT V   TESTING OF BIOMATERIALS: 9
Biocompatibility, blood compatibility and tissue compatibility tests, Toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests, Invitro and Invivo testing; Sterilisation of implants and devices: ETO, gamma radiation, autoclaving. Effects of sterilization.

                                                                      TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Analyze different types of Biomaterials and its classification and apply the concept of nanotechnology towards biomaterials use.
- Identify significant gap required to overcome challenges and further development in metallic and ceramic materials
- Identify significant gap required to overcome challenges and further development in polymeric materials
- Create combinations of materials that could be used as a tissue replacement implant.
- Understand the testing standards applied for biomaterials.

TEXT BOOKS:
1. Sujata V. Bhatt, "Biomaterials", Second Edition, Narosa Publishing House, 2005.
2. Sreeram Ramakrishna, MuruganRamalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, "Biomaterials: A Nano Approach", CRC Press, 2010.

REFERENCES:
1. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw Hill, 2003
2. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, "Introduction to Biomedical Engineering", Elsevier, 2005.
3. Park J.B., "Biomaterials Science and Engineering", Plenum Press, 1984.
4. A.C Anand, J F Kennedy, M.Miraftab, S.Rajendran,"Woodhead Medical Textiles and Biomaterials for Healthcare", Publishing Limited 2006.
5. D F Williams, "Materials Science and Technology: Volume 14, Medical and Dental Materials: A comprehensive Treatment Volume", VCH Publishers 1992.
6. Monika Saini, Yashpal Singh, Pooja Arora, Vipin Arora, and KratiJain. "Implant biomaterials: A comprehensive review", World Journal of Clinical Cases, 2015.

| BM8001 | MEDICAL OPTICS | L T P C |
| | | 3 0 0 3 |

OBJECTIVES:
To Study about:
- The optical properties of the tissues and the interactions of light with tissues.
- The instrumentation and components in Medical Optics.
- The Medical Lasers and their applications
- The optical diagnostic applications
- The emerging optical diagnostic and therapeutic techniques

UNIT I   OPTICAL PROPERTIES OF THE TISSUES   9
Fundamental Properties of light - Refraction, Reflection, Laws (Snell's law and Fresnel law) Scattering, Absorption, Light transport inside the tissue, Tissue properties, Laser Characteristics as applied to medicine and biology, Laser tissue Interactions – Photo chemical, Photo thermal and Photo mechanical interactions, Fluorescence, Speckles, Photo ablative processes.

UNIT II   INSTRUMENTATION IN PHOTONICS   9
Instrumentation for absorption, Scattering and emission measurements, Excitation light sources – high pressure arc lamps, LEDs, Lasers, Optical filters – Prism and Monochromators, Polarizers, Optical detectors – Single Channel and Multichannel detectors, Time resolved and phase resolved detection methods, Optical fibers – Total Internal Reflection.

UNIT III   SURGICAL THERAPEUTIC APPLICATIONS OF LASERS   9

Lasers in ophthalmology, Dermatology, Dentistry, Urology, Otolaryngology, Tissue welding and Soldering.

UNIT IV   NON THERMAL DIAGNOSTIC APPLICATIONS   9

Optical coherence tomography, Elastography, Laser Induced Fluorescence (LIF)-Imaging, FLIM Raman Spectroscopy and Imaging, FLIM – Holographic and Speckle applications of lasers in biology and medicine.

UNIT V   DIAGNOSTIC AND THERAPEUTIC TECHNIQUES   9

Near field imaging of biological structures, *In vitro* clinical diagnostics, Phototherapy, Photodynamic therapy (PDT) - Principles and mechanisms - Oncological and non-oncological applications of PDT - Biostimulation effect – applications - Laser Safety Procedures.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the students should be able to:

- Demonstrate knowledge of the fundamentals of optical properties of tissues
- Analyze the components of instrumentation in Medical Photonics and Configurations
- Describe surgical applications of lasers.
- Describe photonics and its diagnostic applications.
- Investigate emerging techniques in medical optics

TEXT BOOKS:

1. Tuan Vo Dirh, "Biomedical Photonics – Handbook", CRC Press, Bocaraton, 2014.
2. Paras N. Prasad, "Introduction to Biophotonics", A. John Wiley and Sons, Inc. Publications, 2003

REFERENCES:

1. Markolf H.Niemz, "Laser-Tissue Interaction Fundamentals and Applications", Springer, 2007
2. G.David Baxter "Therapeutic Lasers – Theory and practice", Churchill Livingstone publications Edition- 2001.
3. Leon Goldman, M.D., & R.James Rockwell, Jr., "Lasers in Medicine", Gordon and Breach, Science Publishers Inc., 1975.

GE8074	HUMAN RIGHTS	L T P C
		3 0 0 3

OBJECTIVE :

- To sensitize the Engineering students to various aspects of Human Rights.

UNIT I   9

Human Rights – Meaning, origin and Development.   Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

UNIT II   9

Evolution of the concept of Human Rights Magana carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

UNIT III   9

Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.

UNIT IV   **9**

Human Rights in India – Constitutional Provisions / Guarantees.

UNIT V   **9**

Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.

TOTAL: 45 PERIODS

OUTCOME:

- Engineering students will acquire the basic knowledge of human rights.

REFERENCES:

1. Kapoor S.K., "Human Rights under International law and Indian Laws", Central Law Agency, Allahabad, 2014.
2. Chandra U., "Human Rights", Allahabad Law Agency, Allahabad, 2014.
3. Upendra Baxi, The Future of Human Rights, Oxford University Press, New Delhi.

GE8077   **TOTAL QUALITY MANAGEMENT**   **L T P C**
                                                        3 0 0 3

OBJECTIVE:

- To facilitate the understanding of Quality Management principles and process.

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

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT II   **TQM PRINCIPLES**   **9**

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III   **TQM TOOLS AND TECHNIQUES I**   **9**

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV   **TQM TOOLS AND TECHNIQUES II**   **9**

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V   **QUALITY MANAGEMENT SYSTEM**   **9**

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration- ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.

TOTAL: 45 PERIODS

OUTCOME:
- The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

TEXT BOOK:
1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

REFERENCES:
1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
4. ISO9001-2015 standards

BM8074	**BIOSIGNAL PROCESSING**	**L T P C**
		3 0 0 3

OBJECTIVES

The student should be made to
- Understand characteristics of some of the most commonly used biomedical signals, including ECG, EEG, EOG, and EMG.
- Understand choice of filters to remove noise and artifacts from biomedical signals.
- Apply established engineering methods to analyse ECG signal problems.
- Apply established engineering methods to analyse neurological signals.
- Analyse various biomedical signals through advanced techniques.

UNIT I   INTRODUCTION TO BIOMEDICAL SIGNALS   9
Biosignal Characteristics of Electro Cardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Electrogastrogram (EGG), Electroneurogram (ENG), Event related potentials (ERPs), Phonocardiogram (PCG), Speech signal, Objectives of Biomedical signal analysis, Difficulties in Biomedical signal analysis, Computer-aided diagnosis.

UNIT II   FILTERING FOR REMOVAL OF ARTIFACTS   9
Time-domain Filters - synchronized averaging, Moving Average Filters, Derivative-based operators to remove low-frequency artifacts. Frequency-domain filters - Removal of High Frequency noise, Removal of low frequency noise, Removal of periodic artifacts, optimal filter- Wiener filter, Adaptive filters for removal of interference.

UNIT III   CARDIOVASCULAR APPLICATIONS   9
Noise & Artifacts, ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection, 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. Computation of diagnostic signal parameters of ECG like Heart rate and QRS detection using Multivariate analysis (PCA and ICA). Segmentation of PCG, intensity patterns, Spectral modeling and analysis of PCG signals.

UNIT IV NEUROLOGICAL APPLICATIONS 9

EEG rhythms & waveforms, EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models - Nonlinear modeling of EEG - artifacts in EEG & their characteristics and processing – Nonparametric spectral analysis, Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis - correlation analysis of EEG channels - coherence analysis of EEG channels. Evoked potentials- noise characteristics, Noise reduction by linear filtering.

UNIT V ANALYSIS ON WAVESHAPE, SIGNAL CLASSIFICATION AND
RECOGNITION 9

Modeling intramuscular EMG-Intramuscular signal decomposition-Fractal analysis of EMG signals. Statistical analysis of VAG signals. Analysis on amplitude and latency of MEG signals. Analysis of ERP effect. Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Analysis of EEG using Empirical mode decomposition (EMD).

TOTAL: 45 PERIODS

OUTCOMES
At the end of the course student should be able to
- Draw different types of biomedical signals and identify their spectral components.
- Use different filters on biomedical signals and judge filter performance.
- Identify physiological interferences and artifacts affecting ECG signal.
- Compute power and correlation spectra of EEG signal.
- Propose an algorithm to classify biomedical signals.

TEXT BOOKS:
1. Rangayyan, "Biomedical Signal Analysis", Wiley 2002.
2. Semmlow, "Biosignal and Biomedical Image Processing", Marcel Dekker, 2004

REFERENCES:
1. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida 1999.
2. D.C.Reddy, "Biomedical Signal Processing: Principles and techniques" , Tata McGraw Hill, New Delhi, 2005
3. Willis J Tompkins, "Biomedical Digital Signal Processing", Prentice Hall, 1993
4. Bruce, "Biomedical Signal Processing & Signal Modeling," Wiley, 2001
5. Sörnmo, "Bioelectrical Signal Processing in Cardiac & Neurological Applications", Elsevier 2005.

BM8002 ARTIFICIAL ORGANS AND IMPLANTS L T P C
3 0 0 3

OBJECTIVES
- To have an overview of artificial organs & transplants
- To describe the principles of implant design with a case study
- To explain the implant design parameters and solution in use
- To study about various blood interfacing implants
- To study about soft tissue replacement and hard tissue replacement

UNIT I   ARTIFICIAL ORGANS & TRANSPLANTS   9
ARTIFICIAL ORGANS:-Introduction, outlook for organ replacements, design consideration, evaluation process.

TRANSPLANTS:-Overview, Immunological considerations, Blood transfusions, individual organs – kidney, liver, heart and lung, bone marrow, cornea.

UNIT II   PRINCIPLES OF IMPLANT DESIGN   9
Principles of implant design, Clinical problems requiring implants for solution, Permanent versus absorbable devices, the missing organ and its replacement, Tissue engineering, scaffolds, cells and regulators criteria for materials selection, Case study of organ regeneration.

UNIT III   IMPLANT DESIGN PARAMETERS AND ITS SOLUTION   9
Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and tear, Implants for Bone, Devices for nerve regeneration.

UNIT IV   BLOOD INTERFACING IMPLANTS   9
Neural and neuromuscular implants, heart valve implants, heart and lung assist devices, artificial heart, cardiac pacemakers, artificial kidney- dialysis membrane and artificial blood.

UNIT V   IMPLANTABLE MEDICAL DEVICES AND ORGANS   9
Gastrointestinal system, Dentistry, Maxillofacial and craniofacial replacement, Soft tissue repair, replacement and augmentation, recent advancement and future directions.

TOTAL : 45 PERIODS

OUTCOMES:
Students will be able to
- Gain adequate knowledge about artificial organs & transplants
- Get clear idea about implant design and its parameters and solution
- Have in-depth knowledge about blood interfacing implants
- Explain different types of soft tissue replacement and hard tissue replacement

TEXT BOOKS:
1. Kopff W.J, Artificial Organs, John Wiley and sons, New York, 1st edition, 1976.
2. Park J.B., "Biomaterials Science and Engineering", Plenum Press, 1984.

REFERENCES:
1. J D Bronzino, Biomedical Engineering handbook Volume II, (CRC Press / IEEE Press), 2000.
2. R S Khandpur, Handbook of Biomedical Instrumentation,Tata McGraw Hill, 2003
3. Joon B Park, Biomaterials – An Introduction, Plenum press, New York, 1992.
4. Yannas, I. V, "Tissue and Organ Regeneration in Adults", New York, NY: Springer, 2001. ISBN:9780387952147.
5. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, "Clinical Engineering", CRC Press, 1st edition,2010.
6. Standard Handbook of Biomedical Engineering & Design – Myer Kutz, McGraw- Hill, 2003

MD8071   **TELEHEALTH TECHNOLOGY**   **L T P C**
                                                                                              3 0 0 3

OBJECTIVES:
The students should be made to
- Learn the key principles for telemedicine and health
- Understand telemedical technology.
- Know telemedical standards, mobile telemedicine and it applications.

UNIT I   FUNDAMENTALS OF TELEMEDICINE   9
History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.

UNIT II   TYPE OF INFORMATION & COMMUNICATION INFRASTRUCTURE FOR
                 TELEMEDICINE   9
Audio, video, still images, text and data, fax-type of communications and network: PSTN, POTS, ANT, ISDN, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.

UNIT III   ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE   9
Confidentiality, patient rights and consent: confidentiality and the law, the patient-doctor relationship, access to medical records, consent treatment - data protection & security, jurisdictional issues, intellectual property rights.

UNIT IV   PICTURE ARCHIVING AND COMMUNICATION SYSTEM   9
Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical Issues, PACS architecture.

UNIT V   APPLICATIONS OF TELEMEDICINE   9
Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e Health and Cyber Medicine.

                                                                   TOTAL : 45 PERIODS
OUTCOMES:
The students will be able to
- Apply multimedia technologies in telemedicine
- Explain protocols behind encryption techniques for secure transmission of data
- Apply telehealth in healthcare.

TEXTBOOKS:
1. Norris A C, "Essentials of Telemedicine and Telecare", John Wiley, New York, 2002.
2. H K Huang, "PACS and Imaging Informatics: Basic Principles and Applications" Wiley, New Jersey, 2010.

REFERENCES:
1. Olga Ferrer Roca, Marcelo Sosa Iudicissa, "Handbook of Telemedicine", IOS Press, Netherland, 2002.
2. Khandpur R S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003.
3. Keith J Dreyer, Amit Mehta, James H Thrall, "Pacs: A Guide to the Digital Revolution", Springer, New York, 2002.
4. Khandpur R S, "TELEMEDICINE – Technology and Applications", PHI Learning Pvt Ltd., New Delhi, 2017.

BM8003   **BIOFLUIDS AND DYNAMICS**   **L T P C**
                                                                            3 0 0 3

OBJECTIVES:
The student should be made
   - To understand the basics of fluid mechanics,
   - To analyze cellular, ocular, cardiovascular and respiratory fluid mechanics
   - To learn mathematical modelling of fluid biological systems.

UNIT I   BIOFLUID MECHANICS   8
Intrinsic fluid properties - Density, Viscosity, Compressibility, Surface tension, Hydrostatics Fluid characteristics and viscosity – Displacement and velocity, Sheer stress and viscosity Bernoulli equation, Introduction to pipe flow – Reynolds number, Poiseuille's law, Flow Rate, Womersley number, Constitutive equations – Newtonian fluid, Non-Newtonian viscous fluid, Diameter, velocity and pressure of blood flow relationship, Resistance against flow, Viscoelasticity – Viscoelastic models, Response to Harmonic variation, Use of viscoelastic models, Bio-Viscoelastic fluids – Protoplasm, Mucus, Saliva, Synovial fluids.

UNIT II   CELLULAR AND OCCULAR MECHANICS   8
Cellular Biomechanics – Eukaryotic cell architecture, Cytoskeleton, Cell-matrix interactions, Mechanical property measurement – Atomic Force microscopy, Optical Trapping, Magnetic bead microrheometry, Micropipette aspiration, Models of cellular biomechanical behavior, Computational model of a chondrocyte in its matrix, Mechanotransduction, Techniques for mechanical stimulation of the cells, Tissue cell mechanobiology – Endothelial, smooth muscle cells, Chondrocytes, Osteoblasts, Ocular Biomechanics – Occular anatomy, Biomechanics of Glaucoma, Ocular blood flow.

UNIT III   BLOOD RHEOLOGY AND BLOOD VESSEL MECHANICS   10
Viscometry, Elements of Blood, Blood characteristics – Viscosity of blood, Einstein's equation, Biomechanics of red cell membrane, Apparent and relative viscosity, Blood viscosity variation,Casson"s equation, Rheology of Blood In Micro vessels – Fahraeus-Lindquist effect and its inversion, Anatomy and physiology of blood vessels, Arterial wall as membrane – Uniaxial loading, Biaxial loading, Torsion, Hemodynamics of Large arteries – Ventricular outflow and the aorta, Pressure-flow relations and Vascular Impedance, Wave propagation and reflection.

UNIT IV   CARDIO RESPIRATORY MECHANICS AND SPACE MEDICINE   9
Cardiac cycle – Pressure volume diagrams, Changes in contractility, Ventricular performance, Congestive heart failure, Pulsality index, Physics of valvular diseases, Prosthetic heart valves and replacements, Respiratory System – Alveolar ventilation-lung volumes and capacities, Mechanics of breathing, Work of breathing – Lung compliance, Airway resistance, Gas exchange and transport, Oxygen dissociation curve, Lung surfactant, Pulmonary pathologies, Space Medicine – Hypoxia, Physiology of decompressive sickness, Human response to acceleration, Thermal Stress.

UNIT V   COMPUTATIONAL FLUID DYNAMICS   10
Computational fluid dynamics – CFD Code, Problem solving with CFD, Conservation Laws of Fluid Motion and Boundary Conditions, Turbulence and its modelling, The Finite Volume Method for Diffusion Problems and Convection-Diffusion Problems, Solution Algorithms for Pressure-Velocity Coupling in steady flows, Solution of Discretized Equations, The Finite Volume Method for Unsteady flows, Implementation of Boundary Conditions Application – Multiphysics computational models for cardiac flow and virtual cardiography.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Understand the basics of Fluid Mechanics
- Construe the intracellular fluid mechanics and ocular mechanics.
- Describe the rheology of blood and mechanics of blood vessels.
- Elucidate on cardiorespiratory mechanics and space medicine.
- Develop mathematical models of biological systems with fluids

TEXT BOOKS:
1. Krishnan B. Chandran, Ajit P. Yoganathan, Stanley E. Rittgers, "Biofluid Mechanics- The human circulation", CRC Taylor and Francis, 2007.
2. Y.C Fung, "Biomechanics- Mechanical properties of living tissues", 2nd Edition, Springer-Verlag, 1993.
3. Jeffery R. Davis et. Al., "Fundamentals of Aerospace Medicine", Wolter Kluwer Health, Lippincott Williams and Wilkins, 2008

REFERENCES:
1. Jung HeeSeo, Vijay Vedula, Theodore Abraham and Rajat Mittal, "Multiphysics computational models for cardiac flow and virtual cardiography", Int. J. Numer. Meth. Biomed. Engng. (2013) Published online in Wiley Online Library
2. Lee Waite, Jerry Fine, "Applied Biofluid Mechanics", McGraw Hill, 2007
3. John K-J Li, "Dynamics of Vascular System", World Scientific, 2004
4. C. Ross Ethier, Craig A Simmons, "Introduction to Biomechanics- From Cells to Organisms", Cambridge Texts in Biomedical Engineering, 2007
5. H K Versteeg, W Malalasekera, "An Introduction to Computational Fluid Dynamics The Finite Volume Method", Longman Scientific and Technical, 1995

GE8075   **INTELLECTUAL PROPERTY RIGHTS**   **L T P C**
                                                                      3 0 0 3

OBJECTIVE:
- To give an idea about IPR, registration and its enforcement.

UNIT I   **INTRODUCTION**   **9**
Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II   **REGISTRATION OF IPRs**   **10**
Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III   **AGREEMENTS AND LEGISLATIONS**   **10**
International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT IV   **DIGITAL PRODUCTS AND LAW**   **9**
Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT V ENFORCEMENT OF IPRs   7
Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

TOTAL : 45 PERIODS

OUTCOME:
- Ability to manage Intellectual Property portfolio to enhance the value of the firm.

TEXT BOOKS:
1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012
2. S. V. Satakar, "Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.

REFERENCES
1. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.
2. Prabuddha Ganguli,"Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.
3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

MD8752	PHYSIOLOGICAL MODELING	L T P C
		3 0 0 3

OBJECTIVES:
The student should be made to:
- To explain the application of Physiological models and vital organs.
- To Formulate the methods and techniques for analysis and synthesis of dynamic models
- To describe the dynamic models, simulate and visualize, dynamic responses of physiological models using software.
- To describe nonlinear models of physiological systems
- To compute the Simulation of physiological systems

UNIT I INTRODUCTION TO PHYSIOLOGICAL MODELING   9
Approaches to modeling: The technique of mathematical modeling, classification of models, characteristics of models. Time invariant and time varying systems for physiological modeling.Introduction to physiology (homeostasis, cell biology) Modeling physicalsystems, linearmodels of physiological systems,the Laplace transform, Transfer functions and block diagram analysis Physiology.

UNIT II MODELING OF DYNAMIC PHYSIOLOGICAL SYSTEM   9
Dynamic systems and their control, modeling and block diagrams, the pupil control systems(Human Eye), general structure of control systems, the dynamic response characteristics of the pupil control system, open &close loop systems instability, automatic aperture control.

UNIT III NONLINEAR MODELS OF PHYSIOLOGICAL SYSTEMS   9
Nonparametric Modeling-Volterra Models.Wiener Models. Efficient Volterra Kernel Estimation.Parametric Modeling- Basic Parametric Model Forms and Estimation Procedures-Volterra Kernels of Nonlinear Differential Equations. Discrete-Time Volterra Kernels of NARMAX Models.

UNIT IV COMPARTMENTENTAL PHYSIOLOGICAL MODEL 9

Modeling the body as compartments, behaviour in simple compartmental system, pharmacokinetic model, and multi compartmental system. Physiological modeling: Electrical analogy of blood vessels, model of systematic blood flow and model of coronary circulation.Mathematical modeling of the system: Thermo regulation, Thermoregulation of cold bloodedness& warm bloodedness, the anatomy of thermo regulation, lumping & partial differential equations, heat transfer examples, mathematical model of the controlled process of the body.

UNIT V SIMULATION OF PHYSIOLOGICALSYSTEMS 9

Simulation of physiologicalsystemsusing Open CV / MATLAB software. Biological receptors: - Introduction, receptor characteristics, transfer function models of receptors, receptor and perceived intensity. Neuromuscular model, Renal System, Drug Delivery Model.

TOTAL : 45 PERIODS

OUTCOMES:
At the end of this course, the student should be able to
- Explain the application of Physiological models
- Describe the methods and techniques for analysis and synthesis of Linear and dynamic system
- Develop differential equations to describe the compartmental physiological model
- Describe Nonlinear models of physiological systems
- Illustrate the Simulation of physiological systems

TEXT BOOKS:
1. Michel C Khoo, "Physiological Control Systems -Analysis, simulation and estimation", Prentice Hall of India, 2001.
2. Marmarelis, "Nonlinear Dynamic Modeling of Physiological Systems", Wiley-IEEE Press,2004.

REFERENCES:
1. Benjamin C Kuo, "Automatic control systems", Tenth Edition, McGraw-Hill Education, 2017.
2. DavidTWestwick, Robert E. Kearney, Identification of Nonlinear PhysiologicalSystems, Wiley-IEEE Press, 2003.
3. V.Z. Marmarelis, "Advanced methods of physiological modeling" , *Springer*, 1989
4. L.Stark," Neurological Control System, Plenum Press",1968.
5. John H Milsum , "Biological control systems", McGraw Hill 1966
6. MinruiFei, Shiwei Ma, Xin Li, Xin Sun, Li Jia and Zhou Su,"Advanced Computational Methods in Life System Modeling and Simulation", *Springer*,2017

BM8004   **ROBOTICS IN MEDICINE**   **L T P C**
                                                                     3 0 0 3

OBJECTIVES
The student should be made to
- Understand the basics of Robotics, Kinematics.
- Understand the basics of Inverse Kinematics.
- Explore various kinematic motion planning solutions for various Robotic configurations.
- Explore various applications of Robots in Medicine.

UNIT I INTRODUCTION 9
Introduction Automation and Robots, Classification, Application, Specification, Notations, Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation – Five-axis robot, Four-axis robot, Six-axis robot

UNIT II KINEMATICS 9
Inverse Kinematics – General properties of solutions tool configuration, Five axis robots, Three-Four axis, Six axis Robot, Workspace analysis and trajectory planning work envelope and examples, workspace fixtures, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.

UNIT III ROBOT VISION 9
Robot Vision Image representation, Template matching, Polyhedral objects, Shane analysis, Segmentation – Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration.

UNIT IV PLANNING 9
Task Planning Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation.

UNIT V APPLICATIONS 9
Applications in Biomedical Engineering – Bio Engineering Biologically Inspired Robots, Neural Engineering, Application in Rehabilitation – Interactive Therapy, Bionic Arm, Clinical and Surgical – Gynaecology, Orthopaedics, Neurosurgery

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course student should be able to
- Understand the basics of robotic systems.
- Design basic Robotics system and formulate Kinematics.
- Construct Inverse Kinematic motion planning solutions for various Robotic configurations.
- Design Robotic systems for Medical application.

TEXT BOOKS:
1. Robert Schilling, "Fundamentals of Robotics-Analysis and control", Prentice Hall, 2003.
2. J.J.Craig, "Introduction to Robotics", Pearson Education, 2005.

REFERENCES:
1. Staugaard, Andrew C,"Robotics and Artificial Intelligence: An Introduction to Applied Machine Learning", Prentice Hall Of India, 1987
2. Grover, Wiess, Nagel, Oderey, "Industrial Robotics: Technology, Programming and Applications", McGraw Hill, 1986.
3. Wolfram Stadler, "Analytical Robotics and Mechatronics", McGraw Hill, 1995.
4. Saeed B. Niku, "Introduction to Robotics: Analysis, Systems, Applications", Prentice Hall, 2001.
5. K. S. Fu, R. C. Gonzales and C. S. G. Lee, "Robotics", McGraw Hill, 2008.

CS8081   **INTERNET OF THINGS**   **L T P C**
                                                                          3 0 0 3

OBJECTIVES:
- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I   FUNDAMENTALS OF IoT   9
Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects

UNIT II   IoT PROTOCOLS   9
IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT

UNIT III   DESIGN AND DEVELOPMENT   9
Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.

UNIT IV   DATA ANALYTICS AND SUPPORTING SERVICES   9
Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG

UNIT V   CASE STUDIES/INDUSTRIAL APPLICATIONS   9
Cisco IoT system - IBM Watson IoT platform – Manufacturing - Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control

TOTAL : 45 PERIODS

OUTCOMES:
Upon completion of the course, the student should be able to:
- Explain the concept of IoT.
- Analyze various protocols for IoT.
- Design a PoC of an IoT system using Rasperry Pi/Arduino
- Apply data analytics and use cloud offerings related to IoT.
- Analyze applications of IoT in real time scenario

TEXTBOOK:
1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017

REFERENCES:
1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012 (for Unit 2).
3. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
5. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.
   https://www.arduino.cc/
   https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet

BM8078	SOFT COMPUTING TECHNIQUES	L T P C
		3 0 0 3

OBJECTIVES:
The student should be made to
- Understand the different soft computing techniques.
- Understand neural network architectures and learning algorithms, for different applications
- Explore the use of Fuzzy and Genetic Algorithm
- Understand different Optimization techniques in soft computing
- To introduce Hybrid and Other advanced model in soft computing.

UNIT I   FROM BIOLOGY TO ARTIFICIAL NEURAL NETWORKS –INTRODUCTION   9
Biological Neural Networks, Components of Artificial Neural Networks – Connections, Propagation function and Network Inputs, Common Activation Functions, Threshold, Network Topologies, Learning - Supervised, Unsupervised, Reinforcement. Backpropagation, Radial Basis Function, Self-Organizing Maps, Counter Propagation Networks, Adaptive Resonant Theory (ART).

UNIT II   FUZZY SET THEORY   10
Introduction to Fuzzy – Fuzzy Sets – Basic Definition and Terminology – Set-theoretic Operations – Member Function Formulation and Parameterization – Fuzzy Rules and Fuzzy Reasoning – Extension Principle and Fuzzy Relations – Fuzzy If-Then Rules – Fuzzy Reasoning – Fuzzy Inference Systems – Mamdani Fuzzy Models – Sugeno Fuzzy Models – Tsukamoto Fuzzy Models – Input Space Partitioning and Fuzzy Modelling.

UNIT III   GENETIC ALGORITHM   9
Genetic Algorithms: Introduction to Genetic Algorithms (GA), Representation, Operators in GA, Fitness function, population, building block hypothesis and schema theorem.; Genetic algorithms operators methods of selection, crossover and mutation, simple GA (SGA), other types of GA, generation gap, steady state GA.

UNIT IV   OPTIMIZATION USING SOFT COMPUTING   9
Single variable optimization - Region Elimination Methods, Fibonacci Search Method, Multivariable Optimization - Cauchy's Steepest Descent Method, Newton's method, Swarm Intelligence-Particle Swarm Optimization, ANT Intelligence – ANT Colony Optimization, Artificial Bee Colony Algorithm, Jumping Frog Optimization.

UNIT V   HYBRID AND ADVANCED MODEL IN SOFT COMPUTING   8

Genetic Algorithm based Back propagation Network, Fuzzy Logic Controlled Genetic Algorithms, Neuro-fuzzy hybrid systems, Support Vector Machine, Extreme Learning Machine (ELM), Extended ELM, Random Forest Algorithm.

TOTAL : 45 PERIODS

OUTCOMES:
Upon successful completion of the course student should be able to
- Describe various neural, fuzzy and Genetic algorithms.
- Implement Neural, Genetic and Fuzzy algorithms for various classification applications

TEXT BOOKS:
1. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, 2004, Pearson Education 2004.
2. James A Freeman and David M.Skapra, "Neural Networks: Algorithms, Applications, and Programming Techniques", Addison-Wesley, 1991, Digital Version 2007.
3. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and MachineLearning", Addison Wesley, N.Y., 1989

REFERENCES:
1. LaureneFausett, "Fundamentals of neural networks- Architectures, algorithms and applications", Prentice Hall, 1994.
2. Simon O. Haykins,"Neural Networks: A Comprehensive Foundation", 2nd Edition, Pearson 1994
3. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.

GE8072	FOUNDATION SKILLS IN INTEGRATED PRODUCT	L	T	P	C
	DEVELOPMENT	3	0	0	3

OBJECTIVES:
- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I   FUNDAMENTALS OF PRODUCT DEVELOPMENT   9
Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends **- Introduction to Product Development Methodologies and Management -** Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies **-** Product Life Cycle – Product Development Planning and Management.

UNIT II   REQUIREMENTS AND SYSTEM DESIGN   9
Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - **System Design & Modeling -** Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

UNIT III   DESIGN AND TESTING   9
Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – **Challenges in Integration of Engineering Disciplines** - Concept Screening & Evaluation - **Detailed Design -** Component Design and Verification – **Mechanical, Electronics and Software Subsystems** - High Level Design/Low Level Design of S/W Program **-** Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – **Prototyping -** Introduction to Rapid Prototyping and Rapid Manufacturing - **System Integration, Testing, Certification and Documentation**

UNIT IV   SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT   9
Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - **Sustenance -** Maintenance and Repair – Enhancements - **Product EoL -** Obsolescence Management – Configuration Management - EoL Disposal

UNIT V   BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY   9
The Industry - Engineering Services Industry - Product Development in Industry versus Academia – **The IPD Essentials -** Introduction to Vertical Specific Product Development processes -Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able to:
- Define, formulate and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

TEXTBOOKS:
1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

REFERENCES:
1. Hiriyappa B, "Corporate Strategy – Managing the Business", Author House, 2013.
2. Peter F Drucker, "People and Performance", Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, "Enterprise Resource Planning – Concepts", Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013

GE8071   **DISASTER MANAGEMENT**   **LT P C**
                                                                          3 0 0 3

OBJECTIVES:
- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I   INTRODUCTION TO DISASTERS   9
Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II   APPROACHES TO DISASTER RISK REDUCTION (DRR)   9
Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj
Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processess and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III   INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT   9
Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV   DISASTER RISK MANAGEMENT IN INDIA   9
Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to
- Differentiate the types of disasters, causes and their impact on environment and society
- Assess vulnerability and various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India, Scenarious in the Indian context, Disaster damage assessment and management.

TEXTBOOKS:

1. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011
4. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.

REFERENCES

1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2. Government of India, National Disaster Management Policy,2009.

BM8079   VIRTUAL REALITY AND AUGMENTED REALITY   L T P C
                                                                    3 0 0 3

OBJECTIVES:

The student should be made:
- To introduce the relevance of this course to the existing technology through demonstrations, case studies and applications with a futuristic vision along with socio-economic impact and issues
- To understand virtual reality, augmented reality and using them to build Biomedical engineering applications
- To know the intricacies of these platform to develop PDA applications with better optimality

UNIT I   INTRODUCTION   9

The three I's of virtual reality-commercial VR technology and the five classic components of a VR system - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation-interfaces and gesture interfaces-Output Devices: Graphics displays-sound displays & haptic feedback.

UNIT II   VR DEVELOPMENT PROCESS   9

Geometric modeling - kinematics modeling- physical modeling - behaviour modeling - model Management.

UNIT III   CONTENT CREATION CONSIDERATIONS FOR VR   9

Methodology and terminology-user performance studies-VR health and safety issues-Usability of virtual reality system- cyber sickness -side effects of exposures to virtual reality environment

UNIT IV   VR ON THE WEB & VR ON THE MOBILE   10

JS-pros and cons-building blocks (WebVR, WebGL, Three.js, device orientation events)- frameworks (A-frame, React VR)-Google VR for Android-Scripts, mobile device configuration, building to android-cameras and interaction-teleporting-spatial audio-Assessing human parameters-device development and drivers-Design Haptics

UNIT V   APPLICATIONS   8

Medical applications-military applications-robotics applications- Advanced Real time Tracking-other applications- games, movies, simulations, therapy

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Analyse & Design a system or process to meet given specifications with realistic engineering constraints.
- Identify problem statements and function as a member of an engineering design team.
- Utilize technical resources
- Propose technical documents and give technical oral presentations related to design mini project results.

TEXT BOOKS:
1. C. Burdea & Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley & Sons, Inc.,2008
2. Jason Jerald. 2015. The VR Book: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA.

REFERENCES:
1. Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg & Tobias Hollerer, Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575
2. Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability),Steve Aukstakalnis, Addison-Wesley Professional; 1 edition, 2016.
3. The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything, Robert Scoble & Shel Israel, Patrick Brewster Press; 1 edition, 2016.
4. Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, Tony Parisi, O'Reilly Media; 1 edition, 2015.
5. Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages, Tony Parisi, O'Reilly Media; 1 edition, 2014.
6. Learning Three.js: The JavaScript 3D Library for WebGL - Second Edition, Jos Dirksen, Packt Publishing - ebooks Account; 2nd Revised ed. Edition 2015.

BM8077   **HOSPITAL WASTE MANAGEMENT**   **L T P C**
                                                                       3 0 0 3

OBJECTIVES:
The student should be made to:
- Understand the hazardous materials used in hospital and its impact on health
- Understand various waste disposal procedures and management.

UNIT I   HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS   9
Healthcare Hazard Control : Introduction, Hazard Control, Hazard Control Management, Hazard Control Responsibilities, Addressing Behaviors, Hazard Control Practice, Understanding Hazards, Hazard Analysis, Hazard Control and Correction, Personal Protective Equipment, Hazard Control Committees, Hazard Control Evaluation, Hazards, System Safety, Ergonomics. Understanding Accidents: Accident Causation Theories, Human Factors, Accident Deviation Models, Accident Reporting, Accident Investigations, Accident Analysis, Organizational Functions That Support Accident Prevention, Workers' Compensation, Orientation, Education, and Training.

UNIT II   BIOMEDICAL WASTE MANAGEMENT   9
Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labeling, waste handling, collection, storage and transportation, treatment and disposal.

UNIT III   HAZARDOUS MATERIALS   9
Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Hazardous Waste Operations and Emergency Response Standard, Respiratory Protection.

UNIT IV   FACILITY SAFETY   9
Facility Safety : Introduction, Facility Guidelines Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Scaffolding, Fall Protection, Tool Safety, Machine Guarding, Compressed Air Safety, Electrical Safety, Control of Hazardous Energy, Permit Confined Spaces, OSHA Hearing Conservation Standard, Heating, Ventilating, and Air-Conditioning Systems, Assessing IAQ, Landscape and Grounds Maintenance, Fleet and Vehicle Safety.

UNIT V   INFECTION CONTROL, PREVENTION AND PATIENT SAFETY   9
Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Bloodborne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Medical Waste. Patient Safety: An Organizational Function, Errors and Adverse Events, Safety Cultures, Patient-Centered Healthcare, Quality Improvement Tools and Strategies, Healthcare-Associated Infections, Medication Safety.

                                                            TOTAL : 45 PERIODS
OUTCOMES:
At the end of the course, the student should be able to
- Analyse various hazards, accidents and its control
- Design waste disposal procedures for different biowastes
- Categorise different biowastes based on its properties
- Design different safety facility in hospitals
- Propose various regulations and safety norms

TEXT BOOKS:
1. Tweedy, James T., Healthcare hazard control and safety management-CRC Press_Taylor and Francis (2014).

2. Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012).

REFERENCE:
1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006
2. V.J. Landrum, "Medical Waste Management and disposal", Elsevier, 1991

BM8005	NEURAL ENGINEERING	L T P C
		3 0 0 3

OBJECTIVES:
The student should be made
- To discuss the physiological concepts of nerve impulse generation and Electromyography
- To discuss about EEG and its various applications
- To Explore Evoked potentials and its importance in medicine
- To introduce various techniques to study central and peripheral nerve function
- To discuss the electrophysiological evaluation in special situations .

UNIT I   NERVE EXCITABILITY AND ELECTROMYOGRAPHY   8
Nerve Excitability: Functional insights derived from axonal structures, Nerve excitability findings in Neurologic diseases: Chemotherapy induced neurotoxicity, Porphyric Neuropathy, Inflammatory Neuropathy and its Treatment, Spinal Cord Injury; Nerve conduction studies, Microneurography and its potential clinical applications.Clinical Electromyography (EMG), Quantitative EMG,Neuromuscular Ultrasound as a compliment to the electrodiagnostic evaluation, Electrophysiologic study of Disorders of Neuromuscular Junction:, H-Reflex and F-Reflex, Blink reflex and other cranial nerve reflexes, Electrophysiological evaluation of movement disorders, Evaluation of autonomic nervous system.

UNIT II   ELECTROENCEPHALOGRAPHY   10
Electroencephalography (EEG): General Principles and Clinical Applications, Neonatal and Paediatric EEG, EEG Artefacts and Benign Variants, Video EEG monitoring for epilepsy, Invasive Clinical Neurophysiology in Epilepsy and movement disorders, Topographic mapping, Frequency analysis and other quantitative techniques in EEG, Intraoperative EEG monitoring during carotid endarterectomy and cardiac surgery, Magnetoencephalography.

UNIT III   EVOKED POTENTIALS   9
Evoked Potentials and Related Techniques: Visual Evoked potentials (VEPs), Electroretinography and other diagnostic approaches to the Visual System, VEPs in infants and children, Brainstem Auditory Evoked Potentials (AEPs), Brainstem AEPs in infants and children, Somatosensory evoked potentials, Diagnostic and therapeutic role of Magnetic stimulation in neurology.

UNIT IV   FUNCTIONAL NEUROIMAGING AND COGNITION   9
Historical and physiological perspective, Functional neuroimaging methods: PET and fMRI, Network analyses, Functional neuroimaging of: Attention, Visual recognition, Semantic memory, Language, Episodic memory, Working memory, Cognitive aging, Neuro-psychologically impaired patients

UNIT V   ELECTROPHYSIOLOGICAL EVALUATION IN SPECIAL SITUATIONS   9

Electrophysiological evaluation of sacral function: Bladder, bowel and sexual function, Vestibular laboratory testing, Polysomnographic evaluation of sleep disorders, Electrophysiologic evaluation of: brain death, patients in the intensive care unit, patients with suspected neurotoxic disorders.

TOTAL : 45 PERIODS

OUTCOMES:
At the end of the course learner will be able to,
- Understand the physiology behind generation of nerve impulses.
- Describe various techniques that are used to evaluate the functioning of central and peripheral nervous system.
- Differentiate between a normal and abnormal signal coming from a healthy and a diseased nervous system respectively.

TEXT BOOKS:
1. Michael J. Aminoff, et. al., "Aminoff'selectrodiagnosis in Clinical Neurology", Sixth Edition, Elsevier Saunders, 2012.
2. Kim E. Baretteet. al., "Ganong's review of Medical Physiology", 23rd Edition, McGraw Hill Medical, 2010.

REFERENCES:
1. Eric R. Kandelet. al., "Principles of Neural Science" ,McGraw-Hill, New York, 2012.
2. R. Cooper, et. al, "Techniques in Clinical Neurophysiology: A Practical Manual , Elsevier, Amsterdam, The Netherlands, 2005.
3. Holodny, Andrei I., et al, "Functional neuroimaging: a clinical approach". Informa Health Care, 2008.

BM8073   BIOMETRIC SYSTEMS   L T P C
3 0 0 3

OBJECTIVES:

- To understand the technologies of fingerprint, iris, face and speech recognition
- To understand the general principles of design of biometric systems and the underlying trade-offs.
- To recognize personal privacy and security implications of biometrics based identification technology.
- To identify issues in the realistic evaluation of biometrics based systems.

UNIT I   INTRODUCTION TO BIOMETRICS   9
Introduction and back ground – biometric technologies – passive biometrics – active biometrics - Biometrics Vs traditional techniques – Benefits of biometrics - Operation of a biometric system– Key biometric processes: verification, identification and biometric matching – Performance measures in biometric systems: FAR, FRR, FTE rate, FTA rate and rate- Need for strong authentication – Protecting privacy and biometrics and policy – Biometric applications

UNIT II   FINGERPRINT IDENTIFICATION TECHNOLOGY   9
Fingerprint Patterns, Fingerprint Features, Fingerprint Image, width between two ridges - Fingerprint Image Processing - Minutiae Determination - Fingerprint Matching: Fingerprint Classification, Matching policies.

UNIT III FACE RECOGNITION 9

Introduction, components, Facial Scan Technologies, Face Detection, Face Recognition, Representation and Classification, Kernel- based Methods and 3D Models, Learning the Face Spare, Facial Scan Strengths and Weaknesses, Methods for assessing progress in Face Recognition.

UNIT IV VOICE SCAN 9

Introduction, Components, Features and Models, Addition Method for managing Variability, Measuring Performance, Alternative Approaches, Voice Scan Strengths and Weaknesses, NIST Speaker Recognition Evaluation Program, Biometric System Integration.

UNIT V FUSION IN BIOMETRICS 9

Introduction to Multibiometric - Information Fusion in Biometrics - Issues in Designing a Multibiometric System - Sources of Multiple Evidence - Levels of Fusion in Biometrics - Sensor level, Feature level, Rank level, Decision level fusion - Score level Fusion.
Examples – biopotential and gait based biometric systems.

TOTAL : 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Demonstrate knowledge engineering principles underlying biometric systems.
- Analyze design basic biometric system applications.

TEXT BOOKS:
1. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, "Biometric Systems, Technology Design and Performance Evaluation", Springer, 2005.
2. David D. Zhang, "Automated Biometrics: Technologies and Systems", Kluwer Academic Publishers, New Delhi, 2000.
3. Arun A. Ross , Karthik Nandakumar, A.K.Jain, "Handbook of Multibiometrics", Springer, New Delhi, 2006.

REFERENCES:
1. Paul Reid, "Biometrics for Network Security", Pearson Education, 2004.
2. Nalini K Ratha, Ruud Bolle, "Automatic fingerprint Recognition System", Springer, 2003
3. L C Jain, I Hayashi, S B Lee, U Halici, "Intelligent Biometric Techniques in Fingerprint and Face Recognition" CRC Press, 1999.
4. John Chirillo, Scott Blaul, "Implementing Biometric Security", John Wiley, 2003.
5. S.Y. Kung, S.H. Lin, M.W.Mak, "Biometric Authentication: A Machine Learning Approach"Prentice Hall, 2005

GE8076   PROFESSIONAL ETHICS IN ENGINEERING   LT P C
                                                              3 0 0 3
OBJECTIVE:
- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES 10

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II   ENGINEERING ETHICS   9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT III   ENGINEERING AS SOCIAL EXPERIMENTATION   9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV   SAFETY, RESPONSIBILITIES AND RIGHTS   9
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V   GLOBAL ISSUES   8
Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 PERIODS

OUTCOME:
- Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

TEXT BOOKS:
1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCES:
1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.
5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013.
6. World Community Service Centre, ' Value Education', Vethathiri publications, Erode, 2011.

Web sources:
1.   www.onlineethics.org
2.   www.nspe.org
3.   www.globalethics.org
4.   www.ethics.org

BM8076   **ELECTRICAL SAFETY AND QUALITY ASSURANCE**   **L T P C**
                                                                         3 0 0 3

OBJECTIVE
To provide electrical protection and maintenance in working environment and ensure that electrical safety.

UNIT I   ELECTRICAL HAZARDS   12
Review of Electrical concept, Electrostatic – Electro magnetism – Electrical Hazards – Energy leakage – Clearance and insulation– Current surges – Electrical causes of fire and explosion – Human interface with electricity – Human resistance to electricity

UNIT II   STANDARDS AND REQUIREMENTS   12
National electrical Safety code - Standards and statutory requirements – Indian electricity acts and rules – statutory requirements from Electrical inspectorate. Hazardous area classification and classification of electrical equipments for hazardous areas (IS, NFPA, API and OSHA standards).

UNIT III   ELECTRICAL PROTECTION AND MAINTENANCE   9
Selection of Environment, Protection and Interlock – Discharge rods and earthing device – Safety in the use of portable tools - Preventive maintenance. First aid-cardio pulmonary resuscitation(CPR).

UNIT IV   STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS   6
Define Quality- Need for Standarization & Quality Management, QM in Health care organization- Quality assurance methods ,QA in (Medical Imaging & Nuclear medicine) Diagnostic services – Classification of equipments

UNIT V   REGULATORY REQUIREMENT FOR HEALTH CARE   6
CE and FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, Other regulatory Codes.
                                                          TOTAL :45 PERIODS
OUTCOME:
  • The purpose of this course is to help students to develop knowledge and insight into the procedures used in quality control and assurance activities as well as safety measures to be followed in hospitals.

TEXT BOOKS:
1. B.M.Sakharkar, Principles of Hospital administration and Planning, JAYPEE Brothers, Medical Publishers (P) Ltd. 24
2. K.Shridhara Bhat, Quality Management, Himalaya Publishing House Cesar A. Cacere & Albert Zana, The Practice of Clinical Engg. Academic press, New York, 1977.

REFERENCES:
1. Webster J.G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentice Hall Inc., Engle wood Cliffs, New Jersy, 1979.
2. Karen Parsley, Karen Parsley Philomena Corrigan" Quality improvement in Healthcare, 2nd edition ,Nelson Thrones Pub, 2002
3. Sharon Myers "Patient Safety & Hospital Accreditation - A Model for Ensuring Success" Springer Publishers 2012 7. Joseph F Dyro "Clinical Engineering Handbook" Elsevier Publishers, 2004

BM8006   **ERGONOMICS**   **L T P C**
                                                                         3 0 0 3

OBJECTIVES:
The student should be made to:
- Be exposed to principles of ergonomics.
- Learn the mechanics of muscle physiology.
- Be familiar with the mathematical models, analysis and design of biomedical devices using case studies.

UNIT I   VISUAL AND AUDITORY ERGONOMICS   9
Process of seeing – visual capabilities-factors affecting visual acuity and contrast sensitivity – human factor aspects of hard copy text and computer screen text, factors in selecting graphic representations symbols, qualitative visual display-process of hearing-principles of auditory display.

UNIT II   MUSCLE PHYSIOLOGY   9
Muscle physiology -muscle metabolism-respiratory response-joint motion study- measure of physiological in-efficiency and energy consumption-work rest cycles-aspects of manual and posture study, materialhandling (MMH) Bio-mechanical recommended limits of MMH.

UNIT III   CONTROLS AND DISPLAYS   9
Spatial compatibility physical arrangement of displays and controls- movement capability- rotary controls and rotar displays movement of displays orientation of the operator and movement relationships control orders and control responses- human limitations in tracking task.

UNIT IV   ANTHROPOMETRY   9
Anthropometry- anthropometric design principles –work space envelope- factors in design of work space surfaces- principles of seat design –principles of control panel. Organization classification of human errorstheories of accident causation-reducing accidents by altering behavior.

UNIT V   CASE STUDIES   9
Case Study 1: computer design, control panel design of an electronic instrument, computer key board, hand drill etc. Case Study 2: Biomedical Application, Design optimization of Medical Equipments.

                                                       TOTAL: 45 PERIODS
OUTCOMES:
At the end of the course, the student should be able to:
- Understand principles of ergonomics.
- Design biomedical devices.

TEXT BOOKS:
1. Pascale Carayon, Handbook of Human Factors and Engineering, Second Edition, CRC Press, 2011
2. Robert.N. Bailey, Human Performance Engineering, Third Edition, 1996
3. Martin Helander, Guide to Human Factors and Ergonomics, Second Edition, CRC Press, 2005

REFERENCES:
1. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press 2007.
2. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, Third Edition, 2016.

BM8075   **BRAIN COMPUTER INTERFACE AND ITS APPLICATIONS**   **L T P C**
                                                                              3 0 0 3

OBJECTIVES:
The student should be made to:
- Understand the basic concepts of brain computer interface
- Study the various signal acquisition methods
- Learn about the signal processing methods used in BCI
- Understand the various machine learning methods of BCI.
- Learn the various applications of BCI

UNIT I   INTRODUCTION TO BCI   9
Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI.

UNIT II   BRAIN ACTIVATION   9
Brain activation patterns - Spikes, Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.

UNIT III   FEATURE EXTRACTION METHODS   9
Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction - Phase synchronization and coherence

UNIT IV   MACHINE LEARNING METHODS FOR BCI   9
Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis

UNIT V   APPLICATIONS OF BCI   9
Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Noninvasive BCIs:P300 Mind Speller, Visual cognitive BCI, Emotion detection. Ethics of Brain Computer Interfacing.

TOTAL : 45 PERIODS

OUTCOMES:
At the end of the course, the student should be able to:
- Comprehend and appreciate the significance and role of this course in the present contemporary world.
- Evaluate concept of BCI.
- Assign functions appropriately to the human and to the machine.
- Select appropriate feature extraction methods
- Use machine learning algorithms for translation.

TEXT BOOKS:

1. Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, First edition, 2013.

2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, Edition 1, January 2012.

REFERENCES:

1. Ella Hassianien, A &Azar.A.T (Editors), "Brain-Computer Interfaces Current Trends and Applications", Springer, 2015.
2. Bernhard Graimann, Brendan Allison, GertPfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010
3. Ali Bashashati, MehrdadFatourechi, Rabab K Ward, Gary E Birch," A survey of signal Processing algorithms in brain–computer interfaces based on electrical brain signals" Journal of Neural Engineering, Vol.4, 2007, PP.32-57
4. Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida.
5. Bishop C.M., "Neural networks for Pattern Recognition", Oxford, Clarendon Press, 1995.
6. Andrew Webb, "Statistical Pattern Recognition", Wiley International, Second Edition, 2002.

EC8791	EMBEDDED AND REAL TIME SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:
The student should be made to:
- Understand the concepts of embedded system design and analysis
- Learn the architecture and programming of ARM processor
- Be exposed to the basic concepts of embedded programming
- Learn the real time operating systems

UNIT I   INTRODUCTION TO EMBEDDEDSYSTEM DESIGN   9
Complex systems and micro processors– Embedded system design process –Design example: Model train controller- Design methodologies- Design flows - Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques - Designing with computing platforms – consumer electronics architecture – platform-level performance analysis.

UNIT II   ARM PROCESSOR AND PERIPHERALS   9
ARM Architecture Versions – ARM Architecture – Instruction Set – Stacks and Subroutines – Features of the LPC 214X Family – Peripherals – The Timer Unit – Pulse Width Modulation Unit – UART – Block Diagram of ARM9 and ARM Cortex M3 MCU.

UNIT III   EMBEDDED PROGRAMMING   9
Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.

UNIT IV   REAL TIME SYSTEMS   9
Structure of a Real Time System –– Estimating program run times – Task Assignment and Scheduling – Fault Tolerance Techniques – Reliability, Evaluation – Clock Synchronisation.

UNIT V   PROCESSES AND OPERATING SYSTEMS   9
Introduction – Multiple tasks and multiple processes – Multirate systems- Preemptive real-time operating systems- Priority based scheduling- Interprocess communication mechanisms – Evaluating operating system performance- power optimization strategies for processes – Example Real time operating systems-POSIX-Windows CE. - Distributed embedded systems – MPSoCs and shared memory multiprocessors. – Design Example - Audio player, Engine control unit – Video accelerator.

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Describe the architecture and programming of ARM processor
- Outline the concepts of embedded systems
- Explain the basic concepts of real time operating system design
- Model real-time applications using embedded-system concepts

TEXT BOOKS:

1. Marilyn Wolf, "Computers as Components - Principles of Embedded Computing System Design", Third Edition "Morgan Kaufmann Publisher (An imprint from Elsevier), 2012. (UNIT I, II, III, V)
2. Jane W.S.Liu," Real Time Systems", Pearson Education, Third Indian Reprint, 2003 UNIT IV).

REFERENCES:

1. Lyla B.Das, "Embedded Systems : An Integrated Approach" Pearson Education, 2013.
2. Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", Third Edition Cengage Learning, 2012.
3. David. E. Simon, "An Embedded Software Primer", 1st Edition, Fifth Impression, Addison-Wesley Professional, 2007.
4. Raymond J.A. Buhr, Donald L.Bailey, "An Introduction to Real-Time Systems- From Design to Networking with C/C++", Prentice Hall, 1999.
5. C.M. Krishna, Kang G. Shin, "Real-Time Systems", International Editions, Mc Graw Hill 1997
6. K.V.K.K.Prasad, "Embedded Real-Time Systems: Concepts, Design & Programming", Dream Tech Press, 2005.
7. Sriram V Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", Tata Mc Graw Hill, 2004.

GE8073	FUNDAMENTALS OF NANOSCIENCE	L T P C
		3 0 0 3

OBJECTIVE:

To learn about basis of nanomaterial science, preparation method, types and application

UNIT I   INTRODUCTION   8

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II   GENERAL METHODS OF PREPARATION   9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III   NANOMATERIALS   12

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications-Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays-functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

UNIT IV   CHARACTERIZATION TECHNIQUES   9

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

UNIT V   APPLICATIONS   7

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery.

TOTAL: 45 PERIODS

OUTCOMES:
- Will familiarize about the science of nanomaterials
- Will demonstrate the preparation of nanomaterials
- Will develop knowledge in characteristic nanomaterial

TEXT BOOKS :
1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
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