With effect from Academic year 2020-21

DEPARTMENT OF BIOMEDICAL ENGINEERING

Scheme of Instruction

and

Syllabi of

B.E. (Biomedical Engineering)

V & VI SEMESTER

AICTE Model Curriculum
2020-2021

UNIVERSITY COLLEGE OF ENGINEERING

(AUTONOMOUS)

OSMANIA UNIVERSITY

HYDERABAD – 500 007, TELANGANA

UNIVERSITY COLLEGE OF ENGINEERING

Vision

The Vision of the Institute is to generate and disseminate knowledge through a harmonious blending of Science, Engineering and Technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

Mission

- To achieve excellence in Teaching and Research
- To generate, disseminate and preserve knowledge
- To enable empowerment through knowledge and information
- Advancement of knowledge in Engineering, Science and Technology
- Promote learning in free thinking and innovative environment
- Cultivate skills, attitudes to promote knowledge creation
- Rendering socially relevant technical services for the community
- To impart new skills of technology development
- To inculcate entrepreneurial talents and technology appreciation programmes
- Technology transfer and incubation

DEPARTMENT OF BIOMEDICAL ENGINEERING

Vision

To coherently work with medical professionals in providing effective and affordable healthcare

Mission

1. To produce Biomedical Engineering graduates who can understand and apply basic engineering principles to solve the problems of the medical field.
2. To develop Biomedical Engineers to conceive innovative strategies for designing and developing Medical Equipment, implants, and other devices of immense use to the society.

Programme Educational Objectives (PEOs) for BE (BME) Programme

1. Exhibit strong skills in problem solving, leadership, teamwork and enterprise management.
2. Be able to effectively communicate with healthcare professionals to know their problems and provide effective solutions.
3. Use their skills to contribute to the scientific and engineering needs of the society in general and the Biomedical field in particular.
4. Pursue research degrees and practice technical competency as professionals in Biomedical Engineering or allied fields.
5. Sustain professional development in their fields and advance to positions of greater responsibility with life-long learning.

Programme Outcomes (POs) of BE (BME) Programme

Engineering Graduates will be able to:

PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**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.
PO3	**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.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**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.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7	**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.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**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.
PO11	**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.
PO12	**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 OUTCOMES (PSOs) of BE (BME) Programme

Engineering Graduates will be able to:

Program Specific Outcomes	
PSO1	To interact with health care professionals and medical R&D institutions in solving their problems
PSO2	To indigenize medical products through start-ups so as to provide affordable health care.

SCHEME OF INSTRUCTION
B.E. (Biomedical Engineering)
V - SEMESTER

S. No	Course Code	Course Title	Scheme of Examination		L	T	P	Hrs/ Wk	Credits
			CIE	SEE					
1.	PC501BM	Biomedical Equipment - I	30	70	3	0	0	3	3
2.	PC502BM	Biomedical Equipment - II	30	70	3	0	0	3	3
3.	PC503BM	Medical Imaging Systems	30	70	3	0	0	3	3
4.	PC504BM	MPMC in Medical Applications	30	70	3	0	0	3	3
5.	**Professional Elective I**		30	70	3	0	0	3	3
	PE511BM	Biomechanics							
	PE512BM	Bioinformatics							
6.	**Professional Elective II**		30	70	3	0	0	3	3
	PE521BM	Biological Control Systems							
	PE522BM	Biostatistics							
7.	MC901CE	Mandatory Course – I: Environmental Science	30	70	3	0	0	3	-
	Practicals								
8.	PC551BM	Biomedical Equipment Lab	25	50	0	0	2	2	1
9.	PC552BM	MPMC Lab	25	50	0	0	2	2	1
		Total	**260**	**590**	**21**	**0**	**04**	**25**	**20**

L-Lectures

T-Tutorials

P-Practicals

CIE-Continuous Internal Evaluation

SIE-Semester End Evaluation

PC501BM

BIOMEDICAL EQUIPMENT-I

Instruction: 3periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To understand the importance of electrical safety and metrology of medical Equipment.
- To familiarize the students with the operating principles of a wide range of biomedical equipment.
- To enable the students to gain knowledge on the applications of various medical equipment.

Course Outcomes: Upon completion of the course, the students will be able to:

1. Learn the electrical safety aspects and measurement errors in medical equipment.
2. Assess the need and operating principle of equipment used in surgery, physiotherapy and audiometry.
3. Gain the knowledge and functionality of medical equipment used in Neonatology and drug delivery.
4. Perceive the governing principles and functions of respiratory equipment and ventilators.
5. Comprehend the principles of anaesthesia machine and sterilization equipment.

UNIT-I

General Metrology: Global metrology scenario, Measurement units, Measurement standards, Measurement traceability. Measurement Units: Base SI units, Derived SI units, SI multipliers and conversions, Fundamental constants, Common measurements. **Electrical Safety:** physiological effects of electricity, macro-shock and micro-shock hazards, electrical safety codes and standards, electrical safety analyzers, testing the electrical systems, Electrical safety analyzer.

UNIT-II

Electrosurgical Equipment: ESU, principles of cutting and coagulation, spark gap, valve and solid state generators, safety features. **Physiotherapy Equipment**-Short Wave, Microwave and Ultrasound Diathermy, **Audiometry:** Common tests and procedures, audiometer.

UNIT-III

Neonatal instrumentation: Incubators, baby warmers, apnea monitor, calibration of warmers, and phototherapy devices.

Drug delivery systems: Infusion pumps, components of drug infusion system, syringe pump, peristaltic pump, Implantable infusion system, closed loop control in infusion systems, examples of typical infusion pumps, Insulin pumps, Calibration of infusion systems.

UNIT-IV

Respiratory measurements: Principles and techniques of impedance Pneumography and pneumotachograph. Ventilators: Artificial Ventilation, Types of ventilators, Modern Ventilators, High frequency Ventilators, Humidifiers, Nebulizers and Aspirators, calibration of a ventilator.

UNIT-V

General anesthesia: Medical gases and vacuum systems, Humidification, patient breathing circuit, ventilator & scavenging system, monitoring system, capnography, anesthesia equipment. Boyle's apparatus, Block diagram & principle of operation. Liquid medical $-O_2$ systems, vaporizers, Theatre sterility practices, CSSD equipment.

Suggested Reading:

1. Jay L. Bucher, "*The Metrology Handbook"*, ASQ Quality press, 2004
2. Christian Elbert, "*Calibration Technology",* (Basics, reference instruments for pressure and temperature, professional calibration) 2nd ed., 2013.
3. Khandpur R.S., *Handbook of Biomedical Instrumentation*, Tata McGraw Hill, 2016.
4. John G.Webster, *Medical Instrumentation: Application and Design,* John Wiley and Sons Inc., 3rd Ed., 2003.
5. Cotton H., *Electrical Technology*, AHW & Co., 1983.

PC502BM

BIOMEDICAL EQUIPMENT –II

Instruction: 3periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To make the students understand the need for several Biomedical Equipments.
- To make the students understand the operating principles of a wide range of Biomedical Equipment.

Course Outcomes: Upon completion of the course, the students will be able to:

1. Learnabout the cardiac assist devices and ICU layout.
2. Assess use of electrical stimulation principles to overcome cardiac rhythm disturbances
3. Gain the knowledge about various defibrillators along with their working principles
4. Perceive the governing principles of oxygenators and ophthalmic instruments.
5. Comprehend the principles of hemodialysis machine and lithotripter

UNIT-I

Critical physiological parameters to be monitored. Intensive coronary care unit layout.
Assist devices of the heart: Principles of external counter pulsation techniques. Intra-aortic Balloon pump.Prosthetic heart valves, Mechanical and tissue Valves. Types of mechanical valves: Ball and Cage, tilting disc and Bileaflet valves. Types of tissue valves: Homografts or Allografts (human cadaver) and Heterografts or Xenografts (Porcine or Bovine), Testing of prosthetic heart valves.

UNIT-II

Cardiac Pacemakers: Need for a Pacemaker, Types-Asynchronous, Synchronous, External and implantable. Asynchronous pacemakers: Working principle, block diagram.
Synchronous/Demand Pacemaker: Modes of triggering-ventricular triggered and atrio-ventricular synchronized pacemaker, Programmable pacemaker, Implantable Pacemaker: Technical and qualitative requirements of power supplies, lead wires and electrodes, packaging. Microprocessor based implantable pacemaker, Rate responsive pacemaker.

UNIT-III

Defibrillators: Need for Defibrillators, D.C. Defibrillator, Need for Synchronous Defibrillators, Types of electrodes and their features, Types of Waveforms, Automatic/Advisory External Defibrillators (AED), Implantable defibrillators.
Cardioverters: Working principle, Defibrillator analyzers.

UNIT-IV

Heart lung Machine: Governing principles, Qualitative requirements, Functional details of Bubble, Thin Film and membrane-type of blood oxygenators. Ophthalmic Instruments - Intraocular Pressure Measurement, Contacting and Non-Contacting types, Refractometer, Ophthalmoscope, Retinoscope, Keratometer.

UNIT-V

Haemodialyzer: Artificial Kidney, Dialyzers, Membranes for Haemodialysis, Haemodialysis Machine, Monitoring circuits for hemodialysis machine, Portable Kidney Machines.

Lithotriptors: Principles and Applications, Need for Lithotriptor, First Lithotriptor Machine, Modern Lithotriptor Systems, Extra-corporeal shock-wave Therapy.

Suggested Reading:

1. John G. Webster, "*Medical Instrumentation-Application and Design*", John Wiley and sons Inc., 3rd Ed., 2003.
2. Khandpur R.S., *Hand Book of Biomedical Instrumentation*, Tata Mc.Graw Hill Pub Co.Ltd., 2nd ed., New Delhi, 2016.
3. Joseph J. Carr ad John M. Brown, *Introduction to Biomedical Equipment Technology*, Pearson Education, 2001.

PC503BM

MEDICAL IMAGING SYSTEMS

Instruction: 3periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To familiarize the students with various medical imaging modalities.
- To make learners understand the principles, detectors and operating procedures of X-ray, CT, MRI, ultrasound, PET and SPECT.
- To make the students learn the advantages, disadvantages and hazards of various medical imaging equipment.

Course Outcomes: Upon completion of the course, the students will be able to:

1. Interpret the working principle and operating procedure and applications of X-ray equipment.
2. Understand the image reconstruction techniques and applications of CT.
3. Summarize the image acquisition and reconstruction techniques in MRI.
4. Comprehend the working principle, modes and medical applications of ultrasound imaging.
5. Examine the operation and applications of PET, SPECT and radio nuclide instrumentation.

UNIT-I

X Ray Imaging: Electromagnetic spectrum, Production of X-rays, X-ray tubes- Stationary and Rotating Anode types, Block diagram of an X-Ray Machine, Collimators and Grids, Timing and Exposure controls. X-Ray Image visualization-Films, Fluorescent screens, Image Intensifiers.
Dental X-Ray machines, Portable and mobile X-Ray units, Mammographic X-Ray equipment,
Digital Radiography and flat panel detectors.
Radiation safety, ALARA principle, Dose units and dose limits, Radiation dosimeters and detectors.

UNIT-II

Computed Tomography: Basic principles, CT number scale, CT Generations. Major sub systems- Scanning system, processing unit, viewing unit, storage unit. Need and Principle of sectional imaging, 2D image reconstruction techniques - Iteration and Fourier methods. Applications of CT - Angio, Osteo, Dental, Perfusion (Body & Neuro), Virtual Endoscopy, Coronary Angiography.

UNIT-III

Magnetic Resonance Imaging: Principles of NMR imaging systems, Image reconstruction techniques- Relaxation processes, imaging/ pulse sequences. Sub systems of an NMR imaging system, NMR detection system, types of coils, biological effects and advantages of NMR imaging.
Functional MRI - The BOLD effect, intra and extra vascular field offsets, source of T2* effects, Creating BOLD contrast sequence optimization sources and dependences of physiological noise in fMRI.

UNIT- IV

Ultrasound Imaging: - Principles of image formation -Imaging principles and instrumentation of A-mode, B-Mode, Gating Mode, Transmission mode and M-mode. Basics of multi-element linear array scanners, Digital scan conversion.
Doppler Ultrasound and Colour Doppler imaging, Image artifacts, Biological effects, Ultrasound applications in diagnosis, therapy and surgery.

UNIT-V

Nuclear Medicine–Radioisotopes in medical diagnosis, Basic instrumentation- Radiation detectors, Pulse height analyzer, Rectilinear scanner, Gamma camera.

Emission Computed Tomography (ECT), Principle and instrumentation of Single Photon Emission Computed Tomography(SPECT) and Positron Emission Tomography (PET).

Comparison of SPECT, PET and combined PET/ X-ray CT.

Suggested Reading:

1. Khandpur R.S., *Handbook of Biomedical Instrumentation*, Tata McGraw Hill, 2016.
2. S Webb, "*The Physics of Medical Imaging*", Adam Highler, Bristol Published by CRC Press, 1988.
3. A C Kak, "*Principle of Computed Tomography*", IEEE Press New York, 1988.
4. Hykes, Heorick, Starchman, *Ultrasound physics and Instrumentation* MOSBY year book, 2nd Ed. 1992.
5. Stewart C.Bushong, *Magnetic Resonance Imaging- physical and biological principles*, MOSBY, 2nd Ed., 1995.

PC504BM

MICROPROCESSORS AND MICROCONTROLLERS IN MEDICAL APPLICATIONS

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- Understand the architecture of 8085 microprocessor and 8051 microcontroller.
- Program the 8085 microprocessor and 8051 microcontroller using suitable techniques
- Interface sensors to 8085 and 8051

Course Outcomes: Upon completion of the course, the students will be able to

1. Understand microprocessors and Microcontroller concepts.
2. Develop a microprocessor based system with various peripheral devices.
3. Develop simple programs in assembly language and Embedded C environment.
4. Design and construct serial communication between two systems.
5. Extend these principles to Interface various sensors for biomedical applications.

UNIT-I

8085 Microprocessor: Architecture, Instruction cycle, basic timing diagrams, Addressing Modes, Instruction Set, Memory and I/O interfacing, interrupts, I/O ports and data transfer concepts**.** Introduction to 8086, Architecture, Memory segmentation.

UNIT-II

Peripheral Interfacing: Programmable peripheral interface chip (8255), Programmable communicator chip (8251), Programmable Internal timer chip (8253), Programmable interrupt controller (8259), DMA (8257) controller.

UNIT-III

Programming of 8085 Microprocessor: General Programs, debugging of Programs, interfacing with 8085- ADC, DAC, seven Segment display, stepper motor, traffic control, digital multiplexer, digital demultiplexer, square wave generation using microprocessor

UNIT-IV

8051 Microcontroller**:** Architecture, Internal and External Memories, Counters and Timers, Register Set, Synchronous and Asynchronous Serial Communication, Interrupts, Instruction Set, Basic C Programming in 8051 Microcontroller.

UNIT-V

Interfacing with 8051 - Biomedical sensors, ADC, DAC, Seven Segment display, stepper motor, LCD and Keypad Controllers for biomedical applications,
Biomedical Applications of Bluetooth Protocol using Radio Technology, Ethernet-Use of Internet Protocols.

Suggested Reading:

1. Kenneth J. Ayala, *the 8051 Microcontroller-Architecture, Programming and Applications, 2nd Ed*., Penram International Publishing, 2005.
2. Goankar R.J**,** *Microprocessor architecture, programmable and applications with the 8085*, 6th edition, 2013.
3. Mazidi, Mazidi and Rolin D Mckinley, *the 8051 Microcontroller and Embedded Systems: Using Assembly and C*, 2nd Edition, 2011.

PE 511BM

BIOMECHANICS
(PROFESSIONAL ELECTIVE I)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- To make the student learn the mechanical properties of biological tissues and compare them with those of Engineering Materials.
- To make the student determine and analyze the forces at skeletal joints for various static postures.
- To make the students understand the concepts of blood flow and cardiovascular mechanics

Course Outcomes: Upon the completion of the course, the student will be able to:

1. Outline the mechanical properties of bone and understand the concepts of viscoelasticity.
2. Summarize the mechanical properties of soft tissues.
3. Apply the principles of statics to estimate joint forces.
4. Recognize the mechanical features of blood and cardiac tissue.
5. Develop the pressure flow relationship in blood vessels for some idealized cases.

UNIT-I

Mechanical properties of Hard Tissues: Structure, Composition, Functions and Mechanical Properties of bone-Cortical and Cancellous bones. Structural integrity of bone, Fractures. Features of Viscoelasticity, Constitutive equations of Viscoelastic models- Maxwell, Voigt and 3 element models. Uses of Viscoelastic models.

UNIT-II

Mechanical properties of Soft Tissues: Structure, Functions, Mechanical Properties and modeling of collagen, elastin, cartilage, tendons, ligaments and muscles. Force-length curve of a skeletal muscle, Muscle models.

UNIT-III

Biomechanical Analysis of joints: Analysis of rigid bodies in equilibrium, conditions for equilibrium, free body diagrams, General procedure to analyze systems in equilibrium, Basic assumptions and limitations. Types of skeletal joints, Forces and stresses in human joints. Biomechanical analysis of elbow, shoulder, spinal column, hip, knee and ankle. Parameters of gait and their analysis in various neuromuscular disorders.

UNIT-IV

Bio-fluid Mechanics: Forces involved in blood flow, Generalized Bernoulli's equation and its applicability to flow in blood vessels, Wind Kessel model, Stresses in the ventricular wall, Pressure-Volume loop and Functional curves of Left Ventricle. Flow properties of blood.

UNIT-V

Cardiovascular Mechanics: Dynamics of fluid flow in the intact human cardiovascular system - modeling and experimental approaches, Hagen-Poiseuille Law-derivation and applications, steady laminar flow in elastic tube. Wave propagation in blood vessels, Pulse wave velocities in arteries, Reflection and transmission of waves at arterial junctions. Measurement/Estimation of In-vivo elasticity of blood vessels. Blood flow in veins, microcirculation.

Suggested Reading:

1. Y.C.Fung., *Biomechanics-Mechanical Properties of Living Tissues*, Springer-Verlag, 1981.
2. Nihat Ozkaya and Margareta Nordin, "*Fundamentals of Biomechanics-Equilibrium, Motion and Deformation*", Springer-Verlag, 1984.
3. Y.C.Fung., *Biodynamics-Circulation,* Springer-Verlag,1984.
4. D. Dowson and V. Wright, "*An Introduction to Biomechanics of Joints and Joint Replacements*", Mechanical Engineering Publications, 1980

PE 512BM

BIOINFORMATICS
(PROFESSIONAL ELECTIVE I)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- To give students an introduction to the basic techniques of bioinformatics.
- Emphasis will be given to the application of bioinformatics and biological databases to problem solving in real research problems.

Course Outcomes: Upon completion of the course, the students will be able to:

1. Describe the contents and properties of the most important bioinformatics databases, perform text- and sequence-based searches, and analyze and discuss the results in light of molecular biological knowledge
2. Explain the major steps in pair-wise and multiple sequence alignment, explain the principle for, and execute pair-wise sequence alignment by dynamic programming.
3. Predict the secondary and tertiary structures of protein sequences.

UNIT I

Prediction of protein molecular function and structure: Primary sequence of a protein and its analysis, Secondary, Tertiary and quaternary structures and their prediction methods, Fold recognition methods, Homology/comparative modeling of proteins, Energy calculations, local and global minimization, Energy Minimizations: Conjugate, steepest and Powell , Molecular dynamics and simulation studies.

UNIT II

Algorithms: Algorithms and complexity, Biological algorithms, computer algorithms, The change problem, Correct, incorrect algorithms, Recursive algorithms, Iterative, recursive algorithms, Fast and slow algorithms, Big-O notation, Algorithm designing techniques- Exhaustive search, Branch-and-bound algorithms, Dynamic programming, Divide-and-conquer algorithms, Randomized algorithms, Gibbs sampling.

UNIT III

Computer algorithms for prediction of protein structures. DNA Sequence Comparison, Algorithms for alignment of sequences and structures of proteins and protein families, PAM, BLOSUM, Bayesian modeling and networks, Probabilistic models or Hidden Markov models, Needleman Wunch and Smith Waterman algorithms, Global sequence alignment, Scoring alignments, Local sequence alignment, Alignment with gap penalties. Multiple alignment, Gene prediction-Statistical and Similarity-based approaches. Spliced alignment.

UNIT IV

Genetic algorithms: Genetic algorithms for the prediction of multiple sequence alignment, Gene expression analysis, Hierarchical clustering, K-Means clustering, clustering and corrupted cliques. Evolutionary trees- Distance-based tree reconstruction, Reconstructing trees from additive matrices, Evolutionary trees and hierarchical clustering. Character-based tree reconstruction- Small parsimony problem, large parsimony problem.

UNIT V

Neural Networks: Biological neurons and neural networks. Networks of artificial neurons. Learning in single layer and multi-layer perceptrons. Back-propagation. Radial basis function networks: Algorithms and applications. Committee machines. Self-organizing maps: algorithms and applications. Learning vector Quantization. Machine Learning, Statistical learning, Decision trees. Inductive logic programming, Computation learning, Unsupervised learning, temporal difference learning, Delayed reinforcement learning, Explanation based learning.

Suggested Reading:

1.Bioinformatics – Sequence and Genome Analysis. David W. Mount.

2.Beale and T.J. Jackson, Introduction to Neural Networks, IOP Publishing Company, 1990.

3.Baeck, D.B. Fogel and Z. Michalewicz, Genetic Algorithms, IOS Press, 1997.

PE521BM

BIOLOGICAL CONTROL SYSTEMS
(PROFESSIONAL ELECTIVE II)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- To study system concept and different mathematical techniques applied in analyzing any given system.
- To learn to do the analysis of given system in time domain and frequency domain.
- To develop an understanding of the fundamental principles behind control of various biological systems.
- To apply these analysis to study the biological systems.

Course Outcomes: Upon completion of the course, the students will be able to:

1. analyze the concepts used in open and closed loop control systems
2. analyze of second order systems with different controllers
3. comprehend the stability concepts in a control system
4. appreciate the special features of physiological control systems through examples
5. understand complex physiological models

UNIT-I

Open and closed loop systems. Mathematical models of physical systems. Transfer functions. Block diagram algebra. Signal flow graphs. Feedback characteristics of control systems. Control systems and components. DC and AC servomotors.

UNIT-II

Standard test signals. Time response of first order and second order systems. Design specifications of second order systems. Proportional controller. Proportional derivative controller. Proportional-Integral controller, Proportional-Integral-Derivative controller, steady state response of the system.

UNIT-III

Performance indices of control systems. Necessary conditions for stability. Hurwitz and Routh stability criteria. Relative stability. Frequency response analysis, Correlation between time and frequency response, Bode plots. Stability in frequency domain. Nyquist stability criteria.

UNIT-IV

Difference between general control systems and physiological control systems, examples of positive and negative feedback physiological control systems. Body temperature Regulation. Blood glucose regulation. Pupil Control System. Visual Fixation System. Oculo-Motor System.

UNIT-V

Muscle stretch reflex, skeletal muscle Servo-mechanism.
Cardiovascular Control Systems-Regulation of heart rate, blood pressure and cardiac output. Respiratory Control system-Chemical regulation of ventilation, Cheyne Stokes breathing.

Suggested Reading:

1.NagrathI.J and Gopal M., *Control Systems Engineering*, 3rd Ed, New Age Publishers, 2002
2. Michael C. Khoo, *Physiological Control Systems-Analysis, Simulation and Estimation*, IEEE Press, 2000
3. Suresh R. Devasahayam, *Signals and Systems in Biomedical Engineering,* SpringerScience& Business Media, 2012.

PE 522BM

BIOSTATISTICS
(PROFESSIONAL ELECTIVE II)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

COURSE OBJECTIVES:

- To introduce basic statistical methods like curve fitting, correlation and regression.
- To provide the knowledge of probability distributions like normal, Poisson and tests of significance.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:

1. Apply various probability distributions to solve practical problems, to estimate unknown parameters of populations and apply the tests of hypotheses.
2. Perform regression analysis and to compute and interpret the coefficient of correlation

UNIT- I

Concepts of Biostatistics. Basic statistical measures, measures of central tendency, measures of dispersion, variance, standard deviation, properties of probability, probability distribution, sampling distribution.

UNIT- II

Estimation and hypothesis testing. Confidence intervals for data, t distribution, determination of sample size for estimating means and proportions. Hypothesis testing for a single population mean/proportion difference between two population means/proportions, sample size to control type I and type II errors.

UNIT- III

Analysis of variance. The completely randomized design, random sized complete block design, repeated measures design.

UNIT- IV

Regression and correlation. Simple linear regression model, regression equation, the correlation model, multiple linear regression model, multiple regression equation, multiple correlation model, additional techniques of regression analysis.

UNIT- V

Chi-square distribution, tests of good fit, independence, homogeneity, non-parametric statistical procedures, regression analysis.

Suggested Reading:

1. Stanton A. Glantz, *Primer of biostatistics*, Mc Graw Hill, 2nd Ed.
2. Wayne S. Daniel, *Biostatistics: A foundation for analysis in the health sciences*, John Wiley & Sons, 6th Ed. 2012.

MC901CE

ENVIRONMENTAL SCIENCE
(MANDATORY COURSE-I)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 0

Course Objectives:

- Comprehend the need of environmental science, ethics and issues
- Illustrate the characteristics and functions of ecosystem
- Understand the concepts of Biodiversity and its conservation needs
- Study various environmental pollution effects, prevention and control acts

Course Outcomes:

1. Application of awareness on environmental Issues for sustainable society
2. Acquaintance with utilization of various natural resources and ecosystems
3. Ability in conserving and protecting the biodiversity
4. Knowledge of social and environment related issues and their preventive measures

UNIT – I

Multidisciplinary nature of Environmental Studies: Definition, scope and importance, Need for public awareness. Environmental ethics: issues and possible solutions. Population growth. Sustainable development and SDGs.

Current Environmental Issues: global warming and Climate change, acid rain, ozone layer depletion. Environment protection Acts. Environment and human health

UNIT – II

Natural Resources: Renewable and nonrenewable resources: Natural resources and associated problems Forest resources, Water resources, Mineral Resources, Water conservation, Food Resources Energy Resources.

Land Resources: Land as a resource, land degradation, soil erosion, and desertification Role of individual in conservation of natural resources, Equitable use of resources for sustainable life styles.

UNIT – III

Ecosystems: Concept of an ecosystem Structure and function of an ecosystem, Producers, consumers, decomposers. Energy flow in the eco systems. Ecological succession, Food chains, food webs and ecological pyramids,

Introduction, types, characteristic features, structure and functions: Terrestrial ecosystem, Forest ecosystem, Grass land ecosystem, Desert ecosystem. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

UNIT – IV

Biodiversity and its Conservation: Introduction-Definition: genetics, species and ecosystem diversity. Biogeographically classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, national and local level. India as a mega diversity nation.

Hot-spots of biodiversity, Threats to biodiversity: habitats loss, poaching of wild life, man wildlife conflicts. Endangered and endemic spaces of India, Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity, Wildlife conservation and protection act, Forest conservation and protection act

UNIT – V

Environmental Pollution: Definition, Causes, effects and control measures - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards,
Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act Solid waste Management: Causes, effects and control measures of urban and industrial wastes Role of an individual's, communities and NGOs in prevention of pollution

Suggested Reading:

1. Gilbert, M. Masters, "Introduction to Environmental Engineering and Science", Prentice- Hall of India Pvt. Ltd., New Delhi, 1995.
2. Textbook of Environmental studies, Erach Bharucha, UGC.
3. Hammer. M J. and Hammer. MJ. Jr., Water and Wastewater Technology.
4. Prentice-Hall of India Pvt. Ltd., New Delhi. 1998.
5. Fundamental concepts in Environmental Studies, D D Mishra, S Chand & Co Ltd.
6. Sasi Kumar, K. and Sanoop Gopi Krishna., Solid waste Management, Prentice-Hall of India Pvt. Ltd., New Delhi, 2009.

PC551BM

BIOMEDICAL EQUIPMENT LAB

Instruction: 2 Periods per week *Duration of SEE: 2 hours*
CIE: 25 Marks *SEE: 50 Marks*
Credits: 1

Course Objectives:

- To introduce the students to the basic concepts of biomedical equipment.
- To familiarize the students with the instruments used to record biopotentials
- To introduce the students to different medical instruments calibration.

Course Outcomes: Upon completion of the course, the students will be able to:

1. Learn the operation and characteristics of medical equipment through experiments.
2. See and identify the components of medical instruments
3. Understand the calibration of various medical instruments

List of Experiments

1. ECG Recorder
2. EEG monitoring system (Polygraph).
3. Pulse Oximeter
4. Bedside Monitor
5. Syringe pump
6. Infusion Pump
7. Audiometry to find the Hearing ability of the subjects
8. Ultrasound Diathermy
9. Shortwave Diathermy
10. Recording of Evoked potentials
11. Conductivity meter.
12. Colorimeter
13. pH meter
14. Treadmill Test

Calibration of Medical equipment using following Analyzers

1. Infusion Pump Analyzer
2. Vital Sign Monitor
3. Electrical Safety Analyzer
4. Gas Flow Analyzer

Note: Minimum of 10 experiments to be performed

PC552BM

MICROPROCESSORS AND MICROCONTROLLERS IN MEDICAL APPLICATIONS LAB

Instruction: 2 Periods per week *Duration of SEE: 2 hours*
CIE: 25 Marks *SEE: 50 Marks*
Credits: 1

Course Objectives:

- To expose students to the operation of typical microprocessor (8085) trainer kit.
- To prepare the students to solve problems by developing different programs in 8085 and 8051.

Course Outcomes: Upon completion of the course, the students will be able to

1. Handle various arithmetic and logical operations in assembly language on 8085 kits.
2. Interface various peripheral devices to 8085 microprocessor.
3. Implement various programming concepts of 8051 microcontroller.
4. Work with standard microprocessor and microcontroller real time interfaces including serial ports, digital-to-analog converters and analog-to-digital converters.
5. Simulate all programs using Proteus software.

1. Basic Assembly Programs in 8085 microprocessor and 8051 microcontroller

   a) 8-bit Arithmetic operations (Addition, Subtraction, Multiplication, Division)
   b) 16-bit Arithmetic operations (Addition, Subtraction, Multiplication, Division)
   c) Moving an array from one memory location to another
   d) Arranging an array in ascending and descending order
   e) Maximum and Minimum values from an array
   f) Program to generate delays

2. Interfacing with 8085 microprocessor and 8051 microcontroller and simulation using Proteus software

   a) Serial Communication with PC interface
   b) 7-segment display
   c) Analog to Digital Converter
   d) Matrix keyboard
   e) LCD display
   f) Digital to Analog Converter
   g) Stepper motor
   h) DC- motor
   i) Interrupt based application

Note: Minimum of 10 experiments to be performed.

SCHEME OF INSTRUCTION
B.E. (BIOMEDICAL ENGINEERING)
VI - SEMESTER

S. No.	Course Code	Course Title	Scheme of Examination		L	T	P	Hrs/ Wk	Credits
			CIE	SEE					
1.	PC601BM	Basic Clinical Sciences -I (Nephrology, Neurology)	30	70	2	0	0	2	2
2.	PC602BM	Basic Clinical Sciences -II (Gastroenterology, General Surgery)	30	70	2	0	0	2	2
3.	PC603BM	Basic Clinical Sciences -III (Imaging Sciences & Radio therapy, Anesthesia)	30	70	2	0	0	2	2
4.	PC604BM	Basic Clinical Sciences -IV (Cardiology, Orthopedics)	30	70	2	0	0	2	2
5.	**Professional Elective III**		30	70	3	0	0	3	3
	PE631BM	Medi Embedded Systems and RTOS							
	PE632BM	Product Design and Development							
6.	**Open Elective I**		30	70	3	0	0	3	3
7.	MC902AS	Mandatory Course - II: Essence of Indian Traditional Knowledge	30	70	3	0	0	3	-
Practicals									
8	PC651BM	Basic Clinical Sciences -I Lab(Nephrology, Neurology)	10	20	0	0	2	2	1
9.	PC652BM	Basic Clinical Sciences -II (Gastroenterology, General Surgery)	10	20	0	0	2	2	1
10.	PC653BM	Basic Clinical Sciences -III (Imaging Sciences & Radio therapy, Anesthesia)	10	20	0	0	2	2	1
11	PC654BM	Basic Clinical Sciences -IV (Cardiology, Orthopedics)	10	20	0	0	2	2	1
12	PC655BM	Medi Embedded Systems Lab	25	50	0	0	2	2	1
13	PC656BM	Mini Project	50	-	0	0	4	4	2
14	PW961BM	Summer Internship	Six weeks during summer vacation and evaluation will be done in the VII Semester						
Total			**325**	**620**	**17**	**0**	**14**	**31**	**21**

L-Lectures; T-Tutorials; P-Practicals; CIE-Continuous Internal Evaluation; SIE-Semester End Evaluation

Open Elective-I

S. No.	Course Code	Course Title
1.	OE601BM	Engineering Applications in Medicine
2.	OE602CE	Disaster Management
3.	OE603EC	Electronic Instrumentation
4.	OE604EC	Principles of Electronic Communication Systems
5.	OE605ME	3D Printing Technology
6.	OE606ME	Finite Element Method

PC601BM

BASIC CLINICAL SCIENCES THEORY-I

Instruction: 2 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 2

COURSE OBJECTIVES:

- To introduce the students to basic concepts of neurology and nephrology

COURSE OUTCOMES: Upon completion of the course, the students will be able to

1. Understand physiological functioning of kidney and nervous system
2. Identify renal failure rectification process
3. Determine principles of dialysis and various dialyzers
4. Understand the various disorders of neuromuscular system
5. Evaluate neuromuscular system using electrophysiology and imaging

PART-I -NEPHROLOGY

UNIT-I

Laboratory evaluation of the kidney. Diagnostic application of Radio Nuclides in Renal Medicine. Acute Renal failure. Chronic Renal Failure.

UNIT-II

Haemodialysis, Acetate dialysis. Bicarbonate dialysis. Peritoneal dialysis. Chronic Ambulatory peritoneal dialysis. Haemoperfusion, sequential ultra-filtration. Haemofiltration, Adequacy of dialysis. Clearance, Dialysance.

UNIT-III

Components of dialysing system. Dialysate, composition of dialysate. Types of dialysers. Controls and monitoring devices of dialysers. Clinical significance.

UNIT-IV

Treatment of city water for Haemodialysis usage. Types of water purification systems. Water softeners. De-ionisers. Reverse osmosis.

UNIT-V

Renal transplantation. Basic Principles, Cadaver and donor types of transplantation, Tissue typing tests.

Suggested Reading

1. Strauss, Maurice B. (Ed.); Welt, Louis G. (Ed.), Diseases of the Kidney: Second Edition, Little Brown Co.; Second Edition (1971)
2. Salmon and Paper, Clinical Nephrology-The Kidney Diseases.

PART-II-NEUROLOGY

UNIT-I

Parts of the brain. Brain structure. The motor system. Sensation. Cranial nerves. Functional topography of the brain.

UNIT-II

Electrophysiology of eye, EOG, ERG, Spinal cord, Consciousness, Higher Functions, Speech.

UNIT-III

Diseases of nervous system. Diagnostic investigations. Spinal Cord Lesions. Motor neuron disease. Prolapsed intravertebral disc. Neuropathis. Myasthenia gravis. Disease of muscle.

UNIT-IV

Diagnostic investigations. Electro Encephalography. Computerized Axial Tomography. Radio- active Brain Scanning. Angiography. Pneumoencephalography. Recording.

UNIT-V

The motor unit. The methods of Electro-diagnosis. Neuromuscular stimulation. Electromyography, Clinical applications. Diseases of muscle. Motor neuron disorders. The electrical study of reflexes. Disorders of neuromuscular transmission.

Suggested Reading:

1. Adams and Victor's Principles of Neurology 11th Edition, Allan H. Ropper, Martin A. Samuels, Joshua Klein, McGraw Hill Professional.
2. Brodal.A, Neurological anatomy, Oxford University Press, 2nd Edition.
3. By James W. Lance, James G. McLeod, A Physiological Approach to Clinical Neurology, Butterworth-Heinemann, 3rd Edition, 2013

PC602BM

BASIC CLINICAL SCIENCES THEORY-II

Instruction: 2 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 2

Course Objectives

- To introduce the students to basic concepts of gastroenterology and general surgery.

Course Outcomes: Upon completion of the course, the students will be able to

1. Understand the symptoms and features of GIT disorders
2. Evaluate the digestion process of Carbohydrates proteins and fats
3. Demonstrate various equipment used in gastroenterology
4. Outline the various surgical procedures and their complications
5. Study operation of various surgical equipment used in general surgery

PART-I GASTROENTEROLOGY

UNIT I

Diseases of the GI tract: Stomach (ulcers), Liver(jaundice), Gall Bladder(gall stone). Disease diagnosis and treatment. Juices-Gastric, Bile, Pancreatic, Intestinal, including their functions and clinically significant symptoms-signs and diseases.

UNIT II

Digestion of Carbohydrates, Proteins and Fats. Nutritional support and parenteral nutrition. Height and weight estimations according to age.

UNIT III

Colonoscopy, Ryles's tube, Laparoscopy, C.T scan & ultrasound of Abdomen, Liver Biopsy.

UNIT IV

Endoscopy: Video endoscopy, fiber optic endoscopy, various endoscopic procedures, indications for E.R.C.P, therapeutic uses of endoscope in gastroenterology.

UNIT V

Intravenous cannulae. I.V. sets. Infusion pumps, stomach wash tubes, Nebulizers-types of humidifiers, sterilization of the equipment.

Suggested Reading:

1. T. L. Dent, W. E. Strodel, and J. G. Turcotte, Surgical Endoscopy, Year book Medical Publishers, 1985
2. Ian A.D. Bouchier; Robert N. Allan; Humphrey J.F. Hodgson; Michael R.B. Keighley Bouchire, Allan-Text Book of Gastroenterology, Bailliere Tindall, London, 1984

PART-II-GENERAL SURGERY

UNIT-I

Surgical Patient, Clinically significant Investigations. Preoperative care, Post operative care and complications. Preoperative investigations for Hernia surgery. Nutritional support before and after operation. Consent by patient. Distribution of water in the body

UNIT-II

Shock and wound healing: Account of shock. Various kinds of shock. Neuro endocrine response of trauma. Types of hemorrhage. Causes of shock. Hypokalaemia. Dehydration. Metabolic acidosis. Acidosis and alkalosis. Cardiacarrest.

UNIT-III

Process of wound healing: Collagen. Ground substance. Epithelial covering. Scar formation factors, modifying wound healing. Nosocomial infection.

UNIT-IV

Study and operation of surgical equipment. Method of sterilization. Types of endoscopes. Laparoscopy and its use in various surgeries, Micro surgical equipment. Role of cautery. Diathermy. Suction apparatus.

UNIT-V

Surgical equipment: Tissue forceps. Atraumatic needle. Oat gut. Stethoscope. Self-retaining retractors. Staples. Prolene mesh, cold light sources. Fiber optic Instruments.

Suggested Reading:

1. Farquharson's Textbook of Operative General Surgery 9Ed CRC Press, 2005
2. Tean W. Salesh, Laparoscopy
3. Schwartz's Principles of Surgery, 10th edition, F. Charles Brunicardi, Dana K. Andersen, Timothy R. Billiar, David L. Dunn, John G. Hunter, Jeffrey B. Matthews, Raphael E. Pollock, McGraw Hill Professional

PC603BM

BASIC CLINICAL SCIENCES III

Instruction: 2 Periods per week *Duration of SEE:3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 2

Course Objectives:

- To introduce the students to basic concepts of imaging sciences, radiotherapy and anesthesia.

Course Outcomes: Upon completion of the course, the students will be able to

1. Study various imaging procedures and equipments.
2. Summarize various cancer therapy techniques
3. Understand Nuclear medicine and precautionary measures to be taken
4. Discuss different anesthesia techniques along with monitoring devices
5. Illustrate various machines used in anesthesia

PART-I-IMAGING SCIENCES & RADIOTHERAPY

UNIT-I

Physical principles of X-Ray diagnosis. Photographic effect of X-Ray films. Density, definition, contrast and distortion. Controlling factors. Speed of X-Ray films. Digital subtraction Angiography. High KV technique. Tomography, image intensification and cine radiography.

UNIT-II

Organ imaging procedures. Respiratory System. The thyroid. The liver, the spleen. The pancreas. The skeletal system. The kidney.

UNIT-III

Radio-sensitivity and Radio-resistance of tumors and tissues. Classification of tumors. Cell survival theory. Cell repair, radio-curability of tumors. Therapeutic ratio. Normal tissue tolerance dose. Modification of radiation response. Physical, chemical and biomedical modifiers.

UNIT-IV

Tele-therapy Equipment. Selection of treatment method. Indications. X-Ray therapy machines- Kilo-Voltage, super-voltage, Mega-Voltage. Telecobalt and Caesium machines. Linear accelerator. Electron therapy. Rotational therapy. Beam definition and beam direction devices. Wedge filters. Compensators. Beam flattening devices. Brachy therapy. Sealed radioactive sources. Radium dosage system. Interstitial implantation. Planner implants. Volume implants.

UNIT-V

Nuclear Medicine. Determination of distribution of radioactive material within the body. Mass spectrometer, rectilinear scanner, renograph, Gamma Camera. Use of radioactive detectors- for health protection. Therapeutic uses of radio Isotopes (Unsealed).

Suggested Reading:

1. Fundamental physics of radiology, 2nd Edition, W. J. Meredith, John Barlow Massey, J. Wright books,
2. Johns and Cunningham's the Physics of Radiology, 5th Edition, Charles C. Thomas, Publisher, Limited, 2019
3. Introductory Physics of Nuclear Medicine, 4th Edition, Ramesh Chandra, Lea & Febiger, 1992

PART-II-ANAESTHESIA

UNIT-I

General anesthesia. The uptake of anesthetic gases and vapours. Pre-anesthetic care and preparation. Clinical signs of anesthesia. Post-operative care. Laws of gases. Fires and Explosions. Recommendations for prevention.

UNIT-II

Anesthetic gases. Equipment. Components. Gas delivery systems. Testing Choice of anesthetic hypnosis. Electrical anesthesia. Regional Spinal. Care and sterilization of equipment. Patient monitoring during surgery- Invasive and non invasive. Organization of theaters.

UNIT-III

Hypoxia, Artificial respiration. Diagnostic and therapeutic indications. Study of ventilators. Humidifiers. Constant pressure and constant volume types. Selection Criteria. Premature baby incubators.

UNIT-IV

Gas pipe lines. Gas flow meters of various types. Boyles machine. Warning devices. Anesthesia circuits. Vaporizers. Principles of operation. Calibration. Repairs. Recalibration. Scavenging systems. Oxygen therapy and blood gas analysis.

UNIT-V

Measurement of Intra-vascular pressures. Blood flows. Plethysmography. Humidity and temperature measurements. Clinical significance.

Suggested Reading:

1. Sykes M. K and Vickers M. D., Measurement in Anesthesia, Blackwell, 1981
2. Mushin. Automatic Ventilation of Lung, Blackwell,1976
3. Miller's Anesthesia, 9th Edition, Elsevier, 2019

PC604BM

BASIC CLINICAL SCIENCES THEORY-IV

Instruction: 2 Periods per week *Duration of SEE:3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 2

Course Objectives:

- To introduce the students to basic concepts of cardiology and orthopedics

Course Outcomes: Upon completion of the course, the students will be able to

1. Understand various Diagnostic tools used in cardiology
2. Summarize various cardiac therapeutic equipment
3. Demonstrate different cardiac invasive procedures
4. Compare various Physiotherapy equipment
5. Examine various Orthopedic rehabilitative devices

PART-I-CARDIOLOGY

UNIT-I

Cardiac cycle. Various valves and their functions. IABP. Cardio vascular measurements. Prosthetic devices. Monitors. Heart lung machine. Clinical significance. CVP and SWAN Catheters.

UNIT-II

Electrocardiography: Sources of ECG potentials. Dipole theory. Conduction system. Normal and abnormal ECGs. Diagnostic applications. Interpretation of ECG.

UNIT-III

Cardiac pacing. Diagnostic indications. Criteria for selection. Therapeutic indications. Complications. Nursing management of the patient with pacemaker. Temporary pacing. Permanent pacing. Fibrillation: Atrial and ventricular, Application of cardiac Assist Devices. Cardiac Catheterization.

UNIT-IV

Diagnostic usage of ultrasound scanners. Doppler ultrasound measurements. Echo Cardiography. Cine Angiography. Treadmill, Applications, Clinical significance.

UNIT-V

Open heart surgery grafts. Bypass surgery. Instrumentation used for open-heart surgery. Organization of ICCU. Clinical aspects.

Suggested Reading:

1. Physiology and Biophysics: The brain and neural function, Volumes of Physiology and Biophysics, Theodore Cedric Ruch, Text-book of physiology for medical students and physicians Theodore Cedric Ruch, Harry D. Patton, 20th Edition, Saunders publishing.
2. Medical Physics, Volume 2, Otto Glasser Year Book Publishers,1994
3. Cardiovascular dynamics, Robert Frazer Rushmer, John R. Blackmon, 3, illustrated Saunders, 1970 University of Michigan
4. Physiology and biophysics of the circulation : an introductory text, Physiology Textbook Series Alan C. Burton Year Book Medical Publ., 1968

PART-II-ORTHOPAEDICS

UNIT-I

Bone: Structure. Type of material. Remodelling and growth, Stress and Strain at fracture site, joint dislocations. Fractures: Normal Healing. Materials Stress and strain at fracture site.

UNIT-II

Supports and Prosthesis. Hospital Review. Materials and their use. Engineering considerations in the design of Orthopedic appliances. Tools and Machinery used. Supports and Braces for spine and trunk. Upper extremity appliances. Lower extremity appliances.

UNIT-III

Measurements. Range of joint motion. Marking of joint areas. Measurements of upper extremity, lower extremity, body girths. Shoe measurements.

UNIT-IV

Physiotherapy. Applications of Short wave diathermy. Microwave diathermy. Ultrasonic diathermy. Cervical traction. Dynamic and Static exercises. Arthroscopy.

UNIT-V

Electro Induction for bone growth. Ultrasound and other methods. Role of external fixtures in the orthopedic Surgery.

Suggested Reading:

1. Wilton H. Bunch, Robert D. Keagy, C. V. Mosby Co., *Principles of orthotic treatment*, 1976
2. John Crawford Adams, David L. Hamblen, *Outline of Fractures: Including Joint Injuries*, 11th Edition, Churchill Livingstone, 1999, University of Michigan
3. Victor Hirsch Frankel, Margareta Nordin, Lea & Febiger, *Basic biomechanics of the skeletal system*, 1980, University of Michigan
4. Edward Bellis Clayton, Pauline M. Scott, *Clayton's Electrotherapy and Actinotherapy: Including the Physics of Movement and Hydrotherapy*, 7th Edition, Baillière Tindall, 1975, University of Michigan

PE631BM

MEDI EMBEDDED SYSTEMS AND RTOS
(PROFESSIONAL ELECTIVE III)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:
- To know the basic concepts of embedded systems.
- Able to write programs to interface with Arduino and Raspberry Pi
- Know the concept of designing of medical embedded devices.

Course Outcomes: Upon completion of the course, the students will be able to
1. Understand and develop and embedded system
2. Design concepts related to hardware and software of embedded system
3. Illustrate the concept of kernel and its objects
4. Develop the programming skills using Arduino board.
5. Design medical devices using embedded systems

UNIT-I
Embedded Systems: Basic concepts, requirements, categories, design challenges Embedded operating system –Types, Hardware architecture, Software architecture, application software, communication software, process of generating executable image, development/testing tools

UNIT-II
Embedded System Development -The development process, requirements engineering, design, implementation, integration and testing, packaging, configuration management, management of development projects. The execution environment-memory organization, system space, code space, data space, unpopulated memory space, i/o space, system start up, interrupt response cycle, Functions Calls & Stack Frames, run time environment.

UNIT-III
Architecture of Kernel, Tasks and Task Scheduler - Task States, Content Switching, Scheduling Algorithms, Rate Monotonic Analysis, Task Management Function Calls. Interrupt Service Routines, Semaphores, mutex, mailboxes, message queues, event registers, pipes, signals, timers, memory management, Priority Inversion Problem.

UNIT-IV
Arduino- Board details, IDE programming- Raspberry Pi- Interfaces and Raspberry Pi with Python Programming.
Biomedical Applications of Bluetooth Protocol using Radio Technology, Ethernet- Use of Internet Protocols.

UNIT-V
Design methodologies and design flows, case studies- fetal heart rate monitor, versatile drop foot stimulator, myoelectric arm, telemonitoring system.

Suggested Reading:
1. Arnold S. Berger, *An introduction to Processes, Tools and Techniques*, CMP books, 2005.
2. Dr.K.V.K.K.Prasad, *Embedded Real time Systems*, Dreamtech Press, 2003.
3. Wayne wolf, *Computers as Components: Principles of Embedded Computer systems design*, Morgan Kaufmann Publishers, 2000
4. Vijay Madisetti, Arshdeep Bahga, "*Internet of Things: A Hands-On Approach*", 2014.

With effect from the academic year 2020-2021

PE632BM

PRODUCT DESIGN AND DEVELOPMENT
(PROFESSIONAL ELECTIVE III)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- This course is designed to focus on theory, technologies and practical applications in the product design, development and management over whole product life cycle.

Course Outcomes: Upon completion of the course, the students will be able to

1. Identify and analyze the product design and development processes in manufacturing industry
2. Define the components and their functions of product design and development processes
3. Analyze, evaluate and apply the methodologies for product design, development and Management
4. Develop the concept of human factor engineering
5. Familiar with different test methods for biocompatibility

UNIT-I

Biomedical engineering design: Design, essential of design, biomedical engineering design in an industrial context, generic steps in the design and development of products and processes. Fundamental design tools - brainstorming and idea generation techniques, conventional solution searches, function analysis, elementary decision making techniques, objective trees, introduction quality function deployment diagrams, introduction to TRIZ.

UNIT-II

Product Definition -– Definition of Medical Device, Product definition process, Overview of QFD, QFD Process, Product Development – Product Requirements, Design & Development planning, system Requirements specification, design input & output, design Verification & Validation, Design Transfer.

UNIT-III

Hardware Development Methods And Tools – Six Sigma, Redundancy, Component Selection, Component Derating, Safety Margin, Load Protection, Product Misuse, Extended TRIZ Design techniques.

Software Development Methods and Tools - Software Development Planning,- Choice of the Software Development Process Model, Software Design Levels, Design Alternatives and Trade-Offs, Software Architecture, Choice of Methodology and Language, Software Risk Analysis, Requirements Traceability Matrix, Software Review, Design Technique, Performance Predictability and Design Simulation, Module Specifications, Coding Design Support Tools, Design as the Basis for Verification and Validation Activity.

UNIT-IV

Human Factors- Definition, Hardware and Software Element in Human Factors, Human Factors Process, Planning, Analysis, Conduct User Studies, Set Usability Goals, Design User Interface Concepts, Model the User Interface, Test the User Interface, Specify the User Interface, Additional Human Factors Design Considerations, Fitt's Law. Industrial Design – Design user interface concepts, specify the user interface, additional industrial design considerations.

UNIT-V

Biomaterials and Material Testing- FDA and biocompatibility, IRE, device category and choice of test program, preparation of extracts, biological control tests, tests for biological evaluation, alternative test methods.

Suggested Reading:

1. Paul H. King & Richard C. Fries, *Design of Biomedical Devices and system*, 2013.

2. Richard C. Fries, *Handbook of Medical Device Design*, Marcel Dekker Inc., 2001.

With effect from the academic year 2020-2021

OE601BM

ENGINEERING APPLICATIONS IN MEDICINE
(Open Elective-I)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- To make the students gain basic knowledge of Human Physiology.
- To make the students learn the applications of various branches of engineering in Medicine.

Course Outcomes: Upon the completion of the course, the students will be able to:

1. Describe the major organ systems of the human body
2. Understand the concepts of bioelectricity and medical instruments
3. Apply solid and fluid mechanics principles to joints and blood flow respectively
4. Learn the need and applications of BCI
5. Analyze and choose proper biomaterial for various applications

UNIT-I

Evolution of Modern healthcare, Major organ systems- Cardiovascular, Respiratory, Nervous, Skeletal, Muscular. Homeostasis. Physiological signals and their diagnostic importance.

UNIT-II

Bioelectricity-Excitable cells, Resting potential, Action potential, Accommodation, Strength-Duration Curve, Propagation of impulses in myelinated and unmyelinated nerves.
Medical Instrumentation System-Functions, Characteristics, Design Challenges.
Signal Processing-QRS detection.

UNIT-III

Solid mechanics-Analysis of muscle force and joint reaction force for the limb joints.
Fluid mechanics-Factors governing and opposing blood flow, Wind-Kessel model, Application of Hagen-Poiseuille flow to blood flow.

UNIT-IV

Brain-Computer Interface: Brain signals for BCIs, Generic setup for a BCI, Feature extraction and Feature translation involved in BCIs. Typical applications-Word forming, Device control.

UNIT-V

Materials and Tissue Replacements-Types of Biomaterials- Metals, Polymers, Ceramics and Composites and their applications in Soft and Hard tissue replacements. Implants- Manufacturing process, Design, fixation.

Suggested Reading:

1. John Enderle, Susan M. Blanchard and Joseph Bronzino, *Introduction to Biomedical Engineering*, Second Edition, Elsevier, 2005.
2. Ozkaya, Nordin. M, *Fundamentals of Biomechanics*, Springer International Publishing, 4th Edition, 2017.
3. Khandpur R.S., *Handbook of Biomedical Instrumentation*, Tata McGraw Hill, 2016.
4. John G.Webster, *Medical Instrumentation: Application and Design*, John Wiley and Sons Inc., 3rd Ed., 2003.

With effect from the academic year 2020-2021

OE 602CE

DISASTER MANAGEMENT
(Open Elective-I)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- To introduce basic conceptual understanding of natural & man-made hazards and different contextual aspects.
- To develop the knowledge and understanding of the International and nationalstrategy for disaster reduction (UN-ISDR)
- To ensure skills and abilities to analyze potential effects of disasters and of the strategies and methods to deliver public health response to avert these effects.
- To promote the use of science and technology for implementing the disaster risk reduction (DRR) plans and policies.

Course Outcomes:

1. Aptitude to link hazards, risk, vulnerability, differential impacts and capacity building to the life and property loss during disasters and its impacts on the society and sustainability.
2. Ability to understand various aspects of natural and man-made hazards and emerging trends
3. Acquaintance with different steps involved in disaster risk reduction (DRR) and international initiatives for prevention, mitigation and preparedness.
4. Knack to appreciate the national policy and role of individuals, communities, and government organizations in disaster management.
5. Capacity to identifying current technological constraints and hazard specific solutions, particularly construction codes etc.

UNITI: INTRODUCTION TO DISASTER

- Understanding the Concepts, Definitions and Terminologies used in the field of Disaster Management (i.e. Hazard, Risk, Vulnerability, Resilience, and Capacity Building).
- Differential impacts of Disasters in terms of Gender, Age, Social Status, Location, Prosperity, Disabilities.
- Disaster- Development Nexus.

UNIT II: TYPES of HAZARDS AND EMRGING TRENDS

- Classification, Causes, Consequences and Controls of
  - I) Geophysical hazards-Earthquakes, Landslides, Tsunami
  - II) Weather related hazards- Meteorological (Cyclones, Storm-surge and Lighting)
    Hydrological (Floods, Droughts, Avalanches)
    Climatological (Wildfire, Cold & Heat Waves)
  - III) Biological hazards-Epidemic & Pandemics,
  - IV) Technological hazards-Chemical, Industrial, Nuclear
  - V) Man-made hazards-Structural Failure, Fire, Transportation accidents, Terrorism and Wars
- Emerging Disasters- Urban Areas, Climate Change.
- Regional and Global Trends-loss of life & Property in various hazards

UNIT III: DISASTER MANAGEMENT CYCLE AND INTERNATIONAL FRAMEWORK

- Disaster Management Cycle
  Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness
  During Disaster – Evacuation – Disaster Communication – Search and Rescue– Emergency Operation Centre – Incident Command System – Relief and Rehabilitation –
  Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment
- Paradigm Shift in Disaster Management: International Decade for Natural Disaster Reduction; Yokohama Strategy; Hyogo Framework of Action

UNIT IV: DISASTER RISK MANAGEMENT IN INDIA

- Disaster Profile of India – Mega Disasters of India and Lessons Learnt
- Disaster Management Act 2005 – Institutional and Financial Mechanism
- National Policy on Disaster Management,
- National Guidelines and Plans on Disaster Management;
- Role of Government (local, state and national),Non-Government and Inter-governmental Agencies

UNIT V: TECHNOLOGICAL APPROACHES TO DISASTER RISK REDUCTION

- Geo-informatics in Disaster Management (RS, GIS, GPS and RS)
- Disaster Communication System (Early Warning and Its Dissemination)
- Land Use Planning and Development Regulations
- Disaster Safe Designs and Constructions
- Structural and Non Structural Mitigation of Disasters
- Science &Technology Institutions for Disaster Management in India

Suggested Books/ Material/ References

1. Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.
2. Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi
3. An overview on natural & man-made disasters and their reduction, R K Bhandani, CSIR, New Delhi
4. World Disasters Report, 2009. International Federation of Red Cross and Red Crescent, Switzerland
5. Disasters in India Studies of grim reality, AnuKapur& others, 2005, 283 pages, RawatPublishers, Jaipur
6. 10 Disaster Management Act 2005, Publisher by Govt. of India
7. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management
8. National Disaster Management Policy, 2009, GoI

With effect from the academic year 2020-2021

OE 603EC

ELECTRONIC INSTRUMENTATION

(Open Elective-I)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- To familiarize with various measurement parameters and Standards of measurement.
- To learn the working principles of various types of Microphones and Hygrometers.
- To understand the operation and applications of CRO.
- To understand about the operation of various transducers.
- To understand the importance of biomedical instrumentation and Virtual instrumentation.

Course Outcomes:

1. Analyze the various characteristics of measurement parameters and Standards of measurement.
2. Evaluate the operation and application of microphones
3. Use the CROs for various applications and explore its features.
4. Explore various types of Transducers and their characteristics.
5. Analyze the operation of various biomedical instruments and the features of Virtual Instrumentation.

UNIT – I

Measurement parameters: History of instrumentation. Error in Measurement, Types of Errors, Statistical analysis of errors, Limiting errors, Standards of measurement, IEEE and ISO standards.

UNIT – II

Microphones and Hygrometers: Microphones: Microphones and their types, Humidity measurement, resistive, capacitive, aluminium-oxide and crystal Hygrometer types – Operation and applications.

UNIT – III

CRO: Basic Principle of CRT, its features, Block diagram and operation of CRO, Oscilloscope Controls, Waveform display, Measurement of frequency and Phase using Lissajous method, Applications and Advantages of CRO.

UNIT –IV

Transducers: Introduction, Electrical Transducer, Factors for Selecting a Transducer, Active and Passive Transducers, Operation and applications of Resistive transducers, Strain gauges and Thermistors.

UNIT –V

Biomedical and Virtual Instrumentation: Biomedical instrumentation, Bio-potential electrodes, Principles of operation and applications of ECG, EEG, EMG, X-ray machines, CT scanners and Introduction to virtual instrumentation.

Suggested Reading:

1. Albert D.Helfrick and William D.Cooper, *"Modern Electronic Instrumentation and Measurement Techniques",* Prentice-Hall of India Private Limited, New Delhi, 1996.
2. H S Klasi, *"Electronic Instrumentation", Tata* McGraw-Hill Company Limited, New Delhi, 2004.
3. David A.Bell, *"Electronic Instrumentation and Measurements",* 2nd Edition, Prentice-Hall of India Private Limited, New Delhi, 1994.
4. R.S.Khandpur, *"Handbook of biomedical Instrumentation",* Tata McGraw- Hill publishing company Limited, New Delhi, 2000.

With effect from the academic year 2020-2021

OE604EC

PRINCIPLES OF ELECTRONIC COMMUNICATION SYSTEMS
(Open Elective-I)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- Provide an introduction to fundamental concepts in the understanding of communications systems.
- Provide an introduction to network model and some of the network layers including physical layer, data link layer, network layer and transport layer.
- Provide an introduction to the evolution of wireless systems and current wireless technologies.

Course Outcomes: Student will be able to

1. Understand the working of analog and digital communication systems
2. Understand the OSI network model and the working of data transmission
3. Understand the concepts of modulation and demodulations
4. Understand the evolution of communication technologies from traditional telephony systems to modern wireless communication systems.
5. Understand the principles of optical communications systems

UNIT- I

Introduction to communication systems: Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels, Signal Transmission Concepts-Baseband transmission and Broadband transmission, Communication parameters-Transmitted power, Channel bandwidth and Noise, Need for modulation Signal Radiation and Propagation-Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation.

UNIT- II

Analog and Digital Communications: Amplitude modulation and demodulation, FM modulation and demodulation, Digital converters, Digital modulation schemes – ASK, FSK, PSK, QPSK, Digital demodulation.

UNIT- III

Data Communication and Networking: Network Models, OSI Model, Data Link Layer – Media Access control, Ethernet, Network Layer – Internet Protocol (IPv4/IPv6), Transport Layer – TCP, UDP.

UNIT- IV

Telecommunication Systems: Telephones, Telephone system, Paging systems, Internet Telephony. Optical Communications: Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.

UNIT- V

Wireless Communications: Evolution of Wireless Systems: AMPS, GSM, CDMA, WCDMA, And OFDM. Current Wireless Technologies: Wireless LAN, Bluetooth, PAN and ZigBee, Infrared wireless, RFID communication, UWB, Wireless mesh networks, Vehicular adhoc networks.

Suggested Readings:

1. Louis E. Frenzel, "*Principles of Electronic Communication Systems*", 3e, McGraw Hill publications, 2008.
2. Behrouz A. Forouzan,*"Data Communications and Networking",* 5e TMH, 2012.
3. Kennady, Davis, "*Electronic Communications systems*", 4e, TMH, 1999.

OE605ME

3D PRINTING TECHNOLOGY
(Open Elective-I)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- To understand the fundamental concepts of 3D Printing, its advantages and limitations.
- To know the working principle, advantages, disadvantages and applications of liquid, solid and Powder based 3D Printing Technologies.
- To know the various types of STL file errors and other data formats used in 3D Printing Technology.
- To know the features of various 3D Printing software's.
- To know diversified applications of 3D Printing Technologies.

Course Outcomes: At the end of the course the student will be able to:

1 Interpret the features of 3D Printing and compare it with conventional methods.
2 Illustrate the working principle of liquid, solid and powder based 3D Printing Technologies.
3 Identify various types of errors in STL file and other data formats used in 3D Printing Technology.
4 Select suitable software used in 3D Printing Technology.
5 Apply the knowledge of various 3D Printing technologies for developing innovative applications.

UNIT-I

Introduction: Prototyping fundamentals: Need for time compression in product development, Historical development, Fundamentals of 3D Printing, 3D Printing Process Chain, Advantages and Limitations of 3D Printing, 3D Printing wheel, Commonly used Terms, Classification of 3D printing processes, Fundamental Automated Processes: Distinction between 3D Printing and Conventional Machining Processes.

UNIT-II

Liquid-based 3D Printing Systems: Stereo Lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Polyjet: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies

Solid-based 3D Printing System: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT-III

Powder Based 3D Printing Systems: Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following 3D Printing Technologies like Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM),

UNIT-IV

3D Printing Data Formats & Software: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. 3D Printing Software's Features: Magics, Mimics, Solid View, View Expert, 3 D Rhino, 3 D doctor, Flash Print, Object Studio, Cura, ITK Snap, 3-matic, Simplant, 3-matic, Simplant, MeshLab, Ansys for Additive Manufacturing.

UNIT-V

Applications of 3D Printing : Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Electronic Industry, Jewellery Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Biopolymers, Packaging, Disaster Management, Entertainment and Sports industry.

Suggested Readings:

1. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific
2. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing- Ian Gibson, David W Rosen, Brent Stucker, Springer, Second Edition, 2010.
3. Rapid Prototyping & Engineering Applications – Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.
4. RafiqNoorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.
5. NPTEL Course on Rapid Manufacturing. https://nptel.ac.in/courses/112/104/112104265/

OE606ME

FINITE ELEMENT METHOD
(Open Elective-I)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- To understand the theory and application of the finite element method for analyzing structural systems.
- To learn Approximation theory for structural problems as the basis for finite element methods.
- To learn formulations for a variety of elements in one, two, and three dimensions. Implementations of element formulations will be examined using Matlab.
- To understand modeling and analysis of structures using planar, solid, and plate elements

Course Outcomes: Upon successful completion of this course, the student will be able to:

1	Demonstrate a basic understanding of the concepts, mathematical formulation and numerical implementation.
2	Demonstrate the ability to invoke appropriate assumptions, select proper elements and develop FEA models that adequately and efficiently represent physical systems.
3	Underlying the FEA as applied to solid mechanics.
4	Solve 2D vector variable problems and analyze higher order elements and its applications.
5	Create his/her own FEA computer programs using Matlab to solve simple engineering problems.

UNIT I: Introduction

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II: One-Dimensional Problems

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices – Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes.

UNIT III: Two Dimensional Scalar Variable Problems

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems – Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

UNIT IV: Two Dimensional Vector Variable Problems

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations – Plate and shell elements.

UNIT V: Isoparametric Formulation

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems – Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Suggested Reading:

1. Tirupathi R. Chandraputla and Ashok, D. Belgundu" Introduction to Finite Elements in Engineering", Pearson Education, 2002, 3rd Edition.
2. Rao S.S., "The Finite Element Methods in Engineering", pergamon Press, 1989.
3. Segerlind, L.J. "Applied Finite Element Analysis", Wiley Publication, 1984.
4. Reddy J.N., "An Introduction to Finite Element Method", McGraw-Hill Company, 1984.

MC902AS

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE
(Mandatory Course-II)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 0

Course Objectives:

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

Course Outcomes: Student will be able to

1. Ability to understand, connect up and explain basics of Indian Traditional knowledge modern scientific perspective.
2. To explain holistic life style of yoga science
3. Understand basic structure of Indian knowledge system

Course Content

Basic Structure of Indian Knowledge System (i) वेद, (ii) उपवेद (आयुर्वेद, धनुर्वेद, गन्धर्वेद, स्थापत्य आदि) (iii) वेदांग (शिक्षा, कल्प, निरुत, व्याकरण, ज्योतिष छंद), (iv) उपाइग (धर्म शास्त्र, मीमांसा, पुराण, तर्कशास्त्र)

- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case Studies.

Suggested Text/Reference Books

1. V. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014
2. Swami Jitatmanand, Modern Physics and Vedant, BharatiyaVidya Bhavan
3. Fritzof Capra, Tao of Physics
4. Fritzof Capra, The wave of Life
5. V N Jha (Eng. Trans,), Tarkasangraha of Annam Bhatta, Inernational Chinmay Foundation, Velliarnad, Amaku,am
6. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta
7. GN Jha(Eng. Trans.) Ed. R N Jha, Yoga-darshanam with VyasaBhashya, Vidyanidhi Prakasham, Delhi, 2016
8. RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakasham, Delhi, 2016
9. P R Sharma (English translation), Shodashang Hridayam

PC651BM

BASIC CLINICAL SCIENCES-I LAB

Instruction: 2 Periods per week *Duration of SEE: 3 hours*
CIE: 10 Marks *SEE: 20 Marks*
Credits: 1

Course Objectives:

- To familiarize the students with the mechanisms of basic equipments used in neurology and nephrology.

Course Outcomes: Upon completion of the course, the students will be able to

1. Learn the principles and mechanism of dialysis and various dialyzers.
2. Learn the principles and mechanism of basic neurology equipments

PART I-NEPHROLOGY

Demonstration /Practicals

1. Dialysers
2. Dialysate preparation
3. Haemodialysis machine.
4. Peritoneal dialysis
5. Water treatment Plant.

PART II-NEUROLOGY

Demonstration /Practicals

1. EMG recorder
2. EMG stimulators
3. EEG recorder
4. Special techniques in EEG
5. Cerebral angiography
6. Myelograph

PC652BM

BASIC CLINICAL SCIENCES -II LAB

Instruction: 2 Periods per week *Duration of SEE: 3 hours*
CIE: 10 Marks *SEE: 20 Marks*
Credits: 1

Course Objectives:

- To familiarize the students with the mechanism of basic equipments used in gastroenterology and general surgery.

Course Outcomes: Upon completion of the course, the students will be able to

1. Learn the principles and mechanism of various equipment used in gastroenterology.
2. Learn the principles and mechanism of surgical equipment used in general surgery.

PART I-GASTROENTEROLOGY

Demonstration/Practicals

1. Infusion pumps
2. IV sets
3. Endoscopic Instruments
4. Stomach wash tubes

PART II- GENERAL SURGERY

Demonstration/Practicals

1. Surgical equipment-Adult and Paediatric
2. Suction apparatus
3. Cautery
4. Light Sources
5. Laparoscopic Instruments
6. Micro Surgical Equipments.

PC653BM

BASIC CLINICAL SCIENCES -III LAB

Instruction: 2 Periods per week *Duration of SEE: 3 hours*
CIE: 10 Marks *SEE: 20 Marks*
Credits: 1

Course Objectives:

- To familiarize the students with the mechanism of basic equipments used for imaging and anesthesia

Course Outcomes: Upon completion of the course, the students will be able to

1. Learn the principles and mechanism of various equipment used for imaging.
2. Learn the principles and mechanism of various equipment used for anesthesia.

PART I-IMAGING SCIENCE & RADIO THERAPY

Demonstration/Practicals

1. X-Ray plant
2. X-Ray film developing technique
3. Spiral CT
4. MRI
5. Co-60 Teletherapy unit
6. Linear accelerator
7. Gamma camera
8. Scintillation counters
9. Ionization chambers

PART II-ANAESTHESIA

Demonstration/Practicals

1. Endotracheal tubes
2. Electro-surgical generators
3. Cold light sources
4. Servo Ventilators
5. Boyles apparatus
6. Spinal and epidural needles
7. Pulse oximeter
8. Ventilators
9. CSSD equipment
10. Cylinders for anesthetic gases

PC654BM

BASIC CLINICAL SCIENCES -IV LAB

Instruction: 2 Periods per week *Duration of SEE: 3 hours*
CIE: 10 Marks *SEE: 20 Marks*
Credits: 1

Course Objectives:

- To familiarize the students with the mechanism of different equipments used for cardiology and orthopedics

Course Outcomes: Upon completion of the course, the students will be able to

1. Learn the principles and mechanism of various orthopedic rehabilitative devices
3. Learn the principles and mechanism of various equipment used for cardiology and orthopedics.

PART I-CARDIOLOGY

Demonstration/Practicals

1. ECG recorder and monitor
2. Holter monitor
3. Stress test
4. Pacemakers
5. Defibrillators
6. Heart lung machine
7. Hypothermia Unit
8. Oxygenators
9. Blood gas analyzers
10. Electrolyte analyzer etc.

PART II-ORTHOPAEDICS

Demonstration/Practicals

1. Orthotics
2. Splints
3. Prosthetic devices
4. Fracture fixation devices
5. Short wave diathermy
6. Microwave diathermy
7. Ultrasound diathermy

PC655BM

MEDI EMBEDDED SYSTEMS LAB

Instruction: 2 Periods per week *Duration of SEE: 3 hours*
CIE: 25 Marks *SEE: 50 Marks*
Credits: 1

Course Objectives:

- To know the basic concepts of embedded systems.
- Able to write programs to interface with Rasberry Pi/Node MCU

Course Outcomes: Upon completion of the course, the students will be able to

1. Interface various devices with ARM-7 and MSP430F54xx
2. Understand functionality of Rasberry Pi/NodeMCU
3. Interface matrix sensors to Rasberry Pi/NodeMCU

1. Interfacing the following with ARM-7 and MSP430F54xx
   a) LED.
   b) Switches.
   c) 12 bit internal Alphanumeric LCD.
   d) 4x4 matrix keypad.
   e) I2C based EEPROM
   f) SPI based EEPROM
   g) Stepper Motor
   h) Stepper Motor with Direction and Angle Control
   i) DC Motor and its Direction Control
   j) Servo Motor and its Angle Control
   k) PWM

2. Interfacing of matrix sensors to RasberryPi/Node MCU
   a) RasberryPi/Node MCU GPI OP in out and functionality study.
   b) Using RasberryPi/Node MCU as a Breath analyzer-Interfacing MQ2 alcohol sensor.
   c) Fetal Heart Rate Monitoring using RasberryPi/Node MCU- Interfacing MAX30100.
   d) Interfacing 6DOF Accelerometer/ Gyroscope with RasberryPi/Node MCU-MPU6050
   e) Continuous Body Temperature monitoring and reporting using RasberryPi/Node MCU-LM35 sensor.

PC656BM

MINI PROJECT

Instruction: 4 Periods per week *CIE: 50 Marks*
Credits: 2

Course Objectives:

- To enhance practical and professional skills.
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes: At the end of the course, students will be able to:

1. Conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis.
2. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to solve the conceived problem.
3. Write comprehensive report on mini project work and demonstrate effective written and oral communication skills

1. The aim of mini project is to develop solutions to real time problems by applying the knowledge and skills obtained in different courses, new technologies and current industry practices.
2. The mini-project is a team activity having 3-4 students in a team.
3. The mini project may be a complete hardware or a combination of hardware and software. The software part in mini project should be less than 50% of the total work.
4. Based on special lectures by faculty members or industry personnel/ comprehensive literature survey/ need analysis, the student shall identify the title, and define the aim and objectives of mini-project.
5. The students are expected to identify specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first 2 weeks of the semester to the mini project coordinator.
6. The students are expected to design, develop and test the proposed work as per the schedule.
7. Seminar schedule will be prepared by the coordinator for all the students from the 5^{th} week to the last week of the semester which should be strictly adhered to.
8. Each group will be required to:
   i. Submit a one-page synopsis before the seminar to the coordinator.
   ii. Give a 30-minute presentation followed by 10 minutes discussion.
   iii. Submit a technical write-up on the mini project work.
9. At least two teachers will be associated with the mini project to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.
10. The seminar presentation and technical write-up (mini project report) should include: Problem definition and specification, Literature survey, Broad knowledge of available techniques to solve a particular problem, Planning of the work, preparation of bar (activity) charts, Presentation- oral and written.

PW 961EC

SUMMER INTERNSHIP*

Instruction: 6 weeks *CIE: 50 marks*
Credits: 2

COURSE OBJECTIVES:

- To train and provide hands-on experience in the design and troubleshooting of medical equipment and thus enhance the students' practical and professional skills.
- To expose the students to industry practices, ethics and team work.
- To train the students in soft skills, presentation skills and technical report writing.

COURSE OUTCOMES: At the end of the course, students will be able to:

1. Gain practical experience of medical equipment design and development within Industrial/R&D/hospital environments following standard procedures and norms.
2. Troubleshoot equipment problems confidently.
3. Prepare technical reports and others relevant documentation.

1. The aim of summer internship is to encourage students to work on need based problems in industries/hospitals.
2. It develops the students' thought process and reasoning abilities.
3. A batch of three students will be attached to a person from the Industry/R&D Organization.
4. This will be during the summer vacation following the completion of VI semester.
5. One faculty coordinator will also be attached to the group of 3 students to monitor the progress and to interact with the industry coordinator.
6. The students are expected to identify specifications, methodology, resources required, critical issues involved in design and implementation during the internship.
7. After the completion of the internship, students will submit a brief technical report on the project executed and present their work through a seminar organized at the department.
8. Seminar schedule will be prepared by the coordinator for all the students in the VII Semester which should be strictly adhered to.
9. Each group will be required to:
    i. Submit a technical report before the seminar to the coordinator.
    ii. Give a 30-minute presentation followed by 10 minutes discussion.
    iii. Submit a technical write-up on the Internship.
10. At least two teachers will be associated with the Summer Internship to evaluate students for the award of sessional marks which will be on the basis of performance based on originality, purposeful write-up, quality of content presented, depth of knowledge and skills.