With effect from the academic year 2024-2025

SCHEME OF INSTRUCTION AND EVALUATION
B.E. (BIOMEDICAL ENGINEERING)

SEMESTER - V

Syllabus with effect from AY 2024-25

Sl.No	Course Code	Course Name	Contact hours per week		Scheme of Examination		Credits
			L	P	CIE	SEE	
THEORY							
1.	PC 501 BM	Biomedical Equipment	3	-	40	60	3
2.	PC 502 BM	Cardio-Pulmonary Equipment	3	-	40	60	3
3.	PC 503 BM	MPMC in Medical Applications	3	-	40	60	3
4.	PC 504 BM	Biomedical Signal Processing	3	-	40	60	3
5.	PC 505 BM	Biomechanics	3	-	40	60	3
6.	***Professional Elective – II***		3	-	40	60	3
	PE 501 BM	Biotribology					
	PE 502 BM	Artificial Intelligence & Neural Networks In Medicine					
PRACTICALS							
7.	PC 551 BM	Biomedical Equipment Lab	-	2	25	50	1
8.	PC 552 BM	MPMC in Medical Applications Lab	-	2	25	50	1
9.	PC 553 BM	Biomedical Signal Processing Lab	-	2	25	50	1
10.	PC 554 BM	Python Programming in Medical Applications Lab	-	2	25	50	1
		TOTAL	**18**	**08**	**340**	**560**	**22**

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

Course Code	Course Title							Course Type
PC 501 BM	BIOMEDICAL EQUIPMENT							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	3

COURSE OBJECTIVES:

- 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.
- To understand the importance of electrical safety and metrology of medical equipment.

COURSE OUTCOMES:

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

1. Assess the need and operating principle of equipment used in surgery, physiotherapy and audiometry and ophthalmic instruments
2. Gain the knowledge and functionality of medical equipment used in neonatology and drug delivery.
3. Comprehend the principles of hemodialysis machine and lithotripter
4. Comprehend the principles of anesthesia machine and sterilization equipment.
5. Learn the electrical safety aspects and measurement errors in medical equipment.

UNIT-I

Classification of medical Equipment.

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, Hearing aids, Cochlear Implants. **Endoscope**, Block diagram, types of endoscopes, applications.

Ophthalmic Instruments - Intraocular Pressure Measurement, Contacting and Non-Contacting types, Refractometer, Ophthalmoscope, Retinoscope, Keratometer.

UNIT-II

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

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

UNIT-III

Dialyzer: Peritoneal and Haemodialyzer, Types of Dialyzers, Performance analysis of Dialyzer, 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.

UNIT-IV

Anesthesia Workstation: Gas supply systems, Vapor delivery systems, Humidification, Ventilator, patient breathing circuit, Liquid medical $–O_2$ systems, vaporizers, Gas Distribution System in Hospital and color coding.

UNIT-V

Types of sterilizers: Autoclave, Chemical, Dry-Heat, Thermal, CSSD equipment, Types of CSSD, CSSD layout, Cooling refrigerator for Blood bank.

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.

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.

Course Code	Course Title							Course Type
PC 502 BM	CARDIO PULMONARY EQUIPMENT							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	3

COURSE OBJECTIVES:

- To make the students understand the need for several Cardio pulmonary equipment.
- To make the students understand the operating principles of a wide range of Cardio pulmonary equipment.
- To understand the cardiac and pulmonary procedures.

COURSE OUTCOMES:

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

1. Learn about 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 and functions of respiratory equipment and ventilators.
5. Perceive the governing principles of oxygenators.

UNIT-I

Critical physiological parameters, Intensive coronary care unit layout, Bedside Monitor.

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, Types of tissue valves, Testing of prosthetic heart valves. Types of stents, Angioplasty, Ballistic angiography.

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

Pulmonary Equipment: Principles and techniques of impedance Pneumography and pneumotachograph. Spirometry, Ventilators: Artificial Ventilation, Types of ventilators- CPAP, BiPAP, Modes of ventilators, Modern Ventilators, High frequency Ventilators, Humidifiers, Nebulizers and Aspirators, calibration of a ventilator.

UNIT-V

Heart lung Machine: Governing principles, Qualitative requirements, Functional details of Bubble, Thin Film and membrane-type of blood oxygenators.

Working principle and operation of Laryngoscope, Tracheoscope, Bronchoscope.

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.

Course Code	Course Title							Course Type
PC 503 BM	MICROPROCESSORS AND MICROCONTROLLERS IN MEDICAL APPLICATIONS							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	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.

Course Code	Course Title							Course Type
PC 504 BM	BIOMEDICAL SIGNAL PROCESSING							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	3

COURSE OBJECTIVES:

- Understand the need for adaptive filters
- Appreciate the signal processing techniques used for ECG and EEG
- Comprehend the concepts of wavelet and their application in medicine
- Understand the signal processing steps involved in Brain-Computer Interface

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Identify different types of noises and filters used in biomedical signal processing
2. Process the ECG signal and analyze it
3. Implement signal processing on EEG signal
4. Select and manage appropriate choices of wavelet for signal processing`
5. Extract and realize the features involved in Brain computer interface

UNIT I

Filter design for Biosignal processing:

Butterworth and Chebyshev approximations. IIR digital filter design techniques. Impulse invariant techniques. Bilinear transform techniques. Digital Butterworth filters. Comparison of FIR and IIR filters. Frequency transformations.FIR Digital Design Techniques. Properties of FIR Digital filters. Design of FIR filters using windows.

UNIT II

Cardiological Signal Processing: preprocessing of ECG signal, QRS detection methods-Differentiation-based and template-based. Rhythm analysis and Arrhythmia detection algorithms. Automated ECG analysis. Heart Rate Variability analysis, Data compression techniques: Turning Point algorithm, AZTEC, CORTES, and the KL transform. Adaptive filters, Weiner filter principles, LMS & RLS, medical Applications of Adaptive Noise Cancellation.

UNIT III

Random variable and Probability Distribution: Conditional probability, mean, median, mode and standard deviation, random variables, discrete and continuous distribution: normal, poison's and binomial distributions. Tests of significance, statistical power analysis and sample size estimation. linear regression and correlation analysis.

UNIT IV

Neurological signal processing: Stochastic process. Linear prediction. Yule-Walker equations. Auto Regressive Modeling of EEG signal. Detection of EEG Rhythms, Template matching for EEG spike-and-wave detection, Detection of EEG spike-and-wave complexes, Coherence analysis of EEG channels, Adaptive segmentation of EEG signals. Sleep stage analysis using Markov model. Analysis of evoked potential using Prony's method.

UNIT V

Brain-Computer Interface: Brain signals for BCIs, SSVEP, P300 response, Generic setup for a BCI, Feature extraction and Feature translation involved in BCIs. Typical medical applications: Brain controlled wheelchair and robotic arm-components and signal processing.

Wavelets in Medicine: Need for wavelets, Types of wavelets, Selection of a wavelet for an application, Decomposition and reconstruction of signals using wavelets, Denoising of biosignals by using wavelets, Typical medical applications- segmentation of EEG, arrhythmia detection, medical image fusion.

Suggested Reading:

1. Rangaraj M. Rangayyan, *"Biomedical Signal Analysis: A Case-Study Approach"*, John Wiley & Sons, 2005.
2. Willis J. Tompkins, "*Biomedical Digital Signal Processing"*, Prentice-Hall of India Pvt. Ltd.,2012.
3. Monson H. Hayes, "*Statistical Digital Signal Processing and Modeling"*, Wiley-India, 2009.
4. Jonathan Wolpaw and Elizabeth Winter Wolpaw, *"Brain-Computer Interfaces: Principles and Practice"*, Oxford University Press, 2012.
5. Stephane Mallat, "*Wavelet Tour of Signal Processing*: *The Sparse Way"*, 3rd ed. Academic Press, 2008.

Course Code	Course Title							Course Type
PC 505 BM	BIOMECHANICS							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	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

Biofluid 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, Bio-rheology.

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

Course Code	Course Title						Course Type
PE 501 BM	BIOTRIBOLOGY						Professional Elective- II
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	3

COURSE OBJECTIVES:

- To provide students with a comprehensive understanding of the fundamental principles of tribology, including friction, wear, and lubrication.
- To familiarize students with various tribological materials and surface engineering techniques used to enhance material performance.
- To introduce students to the field of biotribology and its applications in biomedical engineering.
- To equip students with practical skills in tribological and biotribological testing and characterization methods.
- To explore the industrial and biomedical applications of tribology and biotribology

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Explain the fundamental principles of tribology and apply them to solve practical engineering problems.
2. Identify and evaluate the properties of various tribological materials and surface treatments.
3. Describe the mechanisms of friction and wear in biological systems and understand the role of biomaterials.
4. Understand standard tribological tests, Understand test results, and characterization techniques and various microscopy and spectroscopy techniques.
5. Students will be able to assess the applications of tribology and biotribology in industry and biomedical fields.

Unit I

Fundamentals of Tribology: Definition and scope of tribology, Historical development and significance in engineering. Theories of contact: Hertzian contact theory, Surface roughness and texture, Contact pressure and stress distribution. Types of friction: static, kinetic, and rolling, Laws of friction and mechanisms of friction, Factors affecting friction: material properties, surface conditions, environment. Types of wear: abrasive, adhesive, erosive, and fatigue wear, Mechanisms of wear: micro and macro mechanisms, Factors influencing wear: material properties, load, speed, environment. Lubrication- Principles of lubrication: boundary, mixed, and hydrodynamic lubrication. Types of lubricants: solid, liquid, and gas lubricants, Properties and selection of lubricants: viscosity, additives, thermal stability.

Unit II

Tribological Materials- Metallic materials and their tribological properties, Polymers and composites in tribology, Ceramics and coatings for tribological applications. Surface treatment techniques: heat

treatment, shot peening, and case hardening. Coating technologies: PVD (Physical Vapor Deposition), CVD (Chemical Vapor Deposition), thermal spraying, and electroplating. Surface texturing and microstructuring: laser texturing, chemical etching. Advanced Materials and Coatings, Diamond-like carbon (DLC) coatings, Nanocomposites and their tribological applications, Self-lubricating materials.

Unit III

Biotribology: Definition and scope of biotribology, Importance in biomedical applications, Biological Interfaces, Structure and properties of biological tissues: skin, cartilage, bone, Biomechanics of joints and soft tissues. Friction in Biological Systems. Natural lubrication mechanisms: synovial fluid, mucus. Friction in joints and prosthetic interfaces. Factors affecting friction in biological systems. Wear in Biological Systems. Wear mechanisms in natural and artificial joints. Wear debris and its biological effects. Longevity and performance of joint replacements. Biomaterials for Tribological Applications. Materials used in joint replacements: metals, polymers, ceramics, Biocompatibility and bioactivity of tribological materials

Unit IV

Tribological Testing: Pin-on-disk test: principles, setup, and interpretation of results.Block-on-ring test, Ball-on-flat test. Scratch test, Wear Testing, Wear coefficient measurement, Abrasion testing, Erosion testing. Friction coefficient measurement techniques, Types of tribometers. Simulation of biological environments for testing, Joint simulator testing for prosthetic devices. Surface Characterization Techniques: Microscopy techniques: optical microscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Surface profilometry and roughness measurement: contact and non-contact methods, Spectroscopy techniques: X-ray Photoelectron Spectroscopy (XPS), Auger Electron Spectroscopy (AES), Atomic Force Microscopy (AFM) and its applications in tribology.

Unit V

Applications and Future Trends in Tribology and Biotribology

Industrial Applications of Tribology. Tribology in manufacturing processes. Tribological considerations in automotive industries. Tribology in aerospace industries. Biomedical Applications of Biotribology. Joint replacements and prosthetics. Dental tribology. Contact lenses and ocular tribology. Current Research and Innovations. Advances in lubricants and lubrication techniques. Smart materials and surfaces in tribology. Nanotribology: atomic and molecular scale tribology, applications in nanotechnology.

Suggested Reading and Resources:

[1] "Engineering Tribology" by Gwidon W. Stachowiak and Andrew W. Batchelor
[2] "Introduction to Tribology" by Bharat Bhushan
[3] "Biotribology" by J. Paulo Davim

Course Code	Course Title							Course Type
PE 502 BM	ARTIFICIAL INTELLIGENCE & NEURAL NETWORKS IN MEDICINE							Professional Elective- II
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	3

COURSE OBJECTIVES:

- Understand the role of artificial intelligence and neural networks in engineering
- Provide knowledge of control strategies and search techniques
- Develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents: Search, Knowledge representation, inference, logic, and learning.
- Provide knowledge of supervised and unsupervised learning using neural networks.
- Apply AI and ML algorithms in medical applications

COURSE OUTCOMES:

The student will be able to:

1. Apply the concepts and search techniques of artificial intelligence.
2. Represent the knowledge base using predicate calculus.
3. Perform knowledge representation using non-monotonic logic.
4. Familiarize with the concepts of Artificial Neural networks.
5. Apply the Artificial Intelligence algorithms in the field of medicine.

UNIT-I:

Introduction to Artificial Intelligence: Definition. AI Applications, AI representation. Properties of internal Representation, General problem solving, production system, control strategies: forward and backward chaining. Uninformed and informed search techniques. A* and AO* Algorithm

UNIT-II:

Knowledge representation using predicate logic: predicate calculus, Predicate and arguments, resolution and unification Semantic, Frame System, Scripts, conceptual Dependency

UNIT-III:

Knowledge representation using non-monotonic logic: TMS (Truth maintenance system), statistical and probabilistic reasoning, fuzzy logic, structure knowledge representation

UNIT-IV:

Introduction to Artificial Neural Network, network parameters, hebb rule, delta rule, supervised and unsupervised learning, pattern recognition problems, perception learning algorithm, Back propagation network-structure and algorithm

UNIT-V:

Applications of Artificial Intelligence & Neural Networks in Medicine – AI in Diagnosis-ELISA Model, automated drug delivery systems, Tumor Boundary Detection, cardiovascular applications

Suggested reading:

1. Eugene, Charniak, Drew Mcdermott: Introduction to artificial intelligence.
2. Elaine Rich and Kerin Knight, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill-2008.
3. Donna L. Hudson, Maunee E. Cohan, Neural Networks & Artificial Intelligence for Biomedical Engineering, Prentice Hall of India, New Delhi - 2001.
4. Kishen Mehrotra, Sanjay Rawika, K Mohan; Artificial Neural Network
5. Laurene Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms and Applications", PEI 3rd Edition, 2008.

Course Code	Course Title							Course Type
PC 551 BM	BIOMEDICAL EQUIPMENT LAB							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	25	50	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

i. Study, Operation & Maintenance of the following equipment

1. Bedside Monitor
2. Syringe pump
3. Infusion Pump
4. Audiometer
5. Ultrasound Diathermy
6. Shortwave Diathermy
7. Baby Warmer
8. Phototherapy Unit
9. ESU
10. Anesthesia Machine
11. Ventilator
12. Ultrasound Machine
13. Multi Channel Data Acquisition System (Polygraph)
14. X-Ray unit for demonstration.

ii. Calibration of Medical equipment using following Analyzers

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

5. Hematology Analyzer
6. Biochemical Analyzer

iii. Mini project:

1. Design of a Biopotential amplifiers for medical instruments
2. Design of Pulse oximeter.

Note: Minimum of 10 experiments to be performed.

Course Code	Course Title							Course Type
PC 552 BM	MICROPROCESSORS AND MICROCONTROLLERS IN MEDICAL APPLICATIONS LAB							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	25	50	1

COURE 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 8051 microcontroller and simulation using Proteus software
   a) 7-segment display
   b) Analog to Digital Converter
   c) Matrix keyboard
   d) LCD display
   e) Digital to Analog Converter
   f) Stepper motor
   g) DC- motor

Note: Minimum of 10 experiments to be performed.

Course Code	Course Title							Course Type
PC 553 BM	BIOMEDICAL SIGNAL PROCESSING LAB							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	25	50	1

Course Objectives:

- Understand the need for adaptive filters
- Understand the signal processing techniques used for biosignals
- Comprehend the concepts of design and their application in medicine

Course Outcomes:

Upon completion of the course, the student will be able to

1. Design and implement digital filters for noise reduction of biological signals
2. Implement various feature extraction algorithms on biosignals
3. Identify different types of noises and filters used in biomedical signal processing
4. Perform data compression techniques.
5. Process the EEG signal and analyze it

List of Experiments

1. Sine wave generation and FFT calculation
2. Calculation of FFT of an ECG signal
3. Butterworth filter design for ECG signal
4. Chebyshev filter design for ECG signal
5. Comparison between the frequency spectrums of raw and filtered ECG signals
6. FIR filter design for ECG signal
7. Calculation of FFT of an EEG signal
8. Segmentation of EEG signal
9. Calculation of maximum power frequency of an EEG Signal
10. Factorial program using for and while loops
11. Maximum and minimum values of a vector
12. Generation of chirp signals and FFT calculation
13. Short-term Fourier transform (STFT)
14. Wavelet-based denoising of ECG signal
15. QRS detection using Simple Differentiation method
16. QRS detection using PAN-TOMPKINS algorithm

17. QRS detection using Template Matching With Cross Correlation algorithm
18. QRS detection using Template Matching With Simple Subtraction algorithm
19. ECG data compression using TURNING POINT algorithm
20. ECG data compression using AZTEC algorithm

Note: Minimum of 10 experiments to be performed.

Course Code	Course Title							Course Type
PC 554 BM	PYTHON PROGRAMMING IN MEDICAL APPLICATIONS LAB							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	25	50	1

Course Objectives:

1. To be able to introduce core programming basics and different operators of Python programming language
2. To demonstrate about Python data structures.
3. To understand the high-performance programs designed to strengthen the practical expertise.

Course Outcomes:

1. Student should be able to understand the basic concepts scripting and the contributions of the language
2. Ability to explore python especially the object oriented concepts, and the built in objects of Python.
3. Ability to create practical and contemporary applications.

List of Programs : Write a program script to

1. Demonstrate different number data types in Python.
2. Perform different Arithmetic Operations in Python.
3. Create, concatenate and print a string and accessing sub-string from a given string.
4. Print the current date in the following format “Tues June 25 09:30:23 IST 2024”
5. Create, append, and remove lists in python.
6. Demonstrate working with tuples in python.
7. Demonstrate working with dictionaries in python.
8. Find largest of n numbers.
9. Convert temperatures to and from Celsius, Fahrenheit. [Formula : c/5 = f-32/9].
10. Define a module to find Fibonacci Numbers and import the module to another program.
11. Solve Quadratic Equation
12. Perform String Operations
13. Perform Matrix Multiplication
14. Demonstrate Class and Objects
15. Perform Single and Multiple Inheritance

16. Define a module and import a specific function in that module to another program.
17. Write a Python class to implement pow(x, n)
18. Generate prime numbers within an interval using for and while statements.
19. Find factorial of a number using Recursion.
20. Perform Operator Overloading
21. Construct the following pattern, using a nested for loop

```
*
* *
* * *
* * * *
* * *
* *
*
```

22. Perform File Handling
23. Perform Exception Handling
24. Perform Send and Receive Messages using UDP
25. Perform File Transfer using File Transfer Protocol
26. Image Segmentation
27. Image Classification
28. Signal Classification

Note: Minimum of 10 experiments to be performed.

TEXT BOOKS

1. Learning Python, Mark Lutz, Orielly, 3 Edition 2007.
2. Python Programming: A Modern Approach, Vamsi Kurama, Pearson, 2017.

REFERENCE BOOKS

1) Think Python, 2 Edition, 2017 Allen Downey, Green Tea Press
2) Core Python Programming, 2016 W. Chun, Pearson.
3) Introduction to Python, 2015 Kenneth A. Lambert, Cengages
4) https://www.w3schools.com/python/python_reference.asp.

With effect from the academic year 2024-2025

SCHEME OF INSTRUCTION AND EVALUATION
B.E. (BIOMEDICAL ENGINEERING)

SEMESTER - VI

Syllabus with effect from AY 2024-25

Sl.No	Course Code	Course Name	Contact hours per week		Scheme of Examination		Credits
			L	P	CIE	SEE	
THEORY							
1.	PC 601 BM	Medical Imaging Systems	3	-	40	60	3
2.	PC 602 BM	Medical Image Processing	3	-	40	60	3
3.	PC 603 BM	Medical Embedded Systems & RTOS	3	-	40	60	3
4.	PC 604 BM	Medical Device Regulations	3	-	40	60	3
5.	***Professional Elective – III***		3	-	40	60	3
	PE 601 BM	Cell and Tissue Engineering					
	PE 602 BM	Nanotechnology for Medical Applications					
	PE 604 CS	Deep Learning					
6.	OE	***Open Elective –I***	3	-	40	60	3
PRACTICALS							
7.	PC 651 BM	Medical Image Processing & Modeling Lab	-	2	25	50	1
8.	PC 652 BM	Medical Embedded Systems Lab	-	2	25	50	1
9.	PW 601 BM	***Mini-Project***	-	6	50	-	3
		TOTAL	**18**	**10**	**340**	**460**	**23**

Note: Summer internship to be carried out during summer vacation for Six weeks and evaluation will be done in the VII Semester.

Open Elective-I

S. No.	Course Code	Course Title
1.	OE 601 BM	Engineering Applications in Medicine
2.	OE 602 BM	Human Assistive Technologies
3.	OE 601 CE	Disaster Management
4.	OE 602 CE	Road Safety Engineering
5.	OE 601 EC	Verilog HDL
6.	OE 602 EC	Principles of Electronic Communication Systems
7.	OE 601 ME	3D Printing Technology
8.	OE 602 ME	Finite Element Method
9.	OE 601 EE	Applications of Electrical Energy
10.	OE 602 EE	Electrical Safety Management
11.	OE 601 CS	Python Programming
12.	OE 602 CS	Cyber security

Course Code	Course Title							Course Type
PC 601 BM	MEDICAL IMAGING SYSTEMS							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	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, LINAC, Cyclotron. 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.

Course Code	Course Title							Course Type
PC 602 BM	MEDICAL IMAGE PROCESSING							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	3

COURSE OBJECTIVES:

- To understand various image processing methodologies and enhancement techniques on images
- To know about the noise models and filtering methods.
- To analyze the images by applying segmentation methods.
- Gaining fundamental idea on representation, description and recognition of medical images.

COURSE OUTCOMES:

The student will be able to:

1. Have the basic knowledge of image fundamentals necessary for medical image processing
2. Familiarize with the image enhancement techniques
3. Demonstrate restoration procedures on images.
4. Illustrate image segmentation techniques on the images and analyze them.
5. Exemplify image representation and recognition methods.

UNIT-I: Fundamentals

Digital image, Elements of digital geometry, Components of DIP, Visual detail, Image file formats.

Image Characteristics: Brightness adaptation and Contrast, Acuity and contour, Texture and pattern discrimination, Shape detection and recognition, Perception of color. Image formation-Geometric Model and Photometric Model.

UNIT-II: Image Enhancement

Spatial Domain Methods –Binary Image, Negative of an Image, Log Transformations, Power law Transformation, contrast enhancement, Histogram equalization, Spatial Domain Filters-Smoothing filters, Sharpening filters.

Frequency Domain Methods- Steps for filtering in the frequency domain, Convolution theorem, Smoothing filters, Sharpening filters, Homomorphic filtering.

UNIT-III: Image Restoration

A model of the image degradation, noise models, restoration in the presence of noise-spatial filtering, periodic noise reduction by frequency domain filtering, linear & position-invariant degradations, estimating the degradation function, inverse filtering, wiener filtering, constrained least squares filtering, geometric mean filter.

UNIT-IV: Image Segmentation

Point detection, line detection, edge detection methods, Histogram based image segmentation, segmentation using split and merge method, region growing method, watershed method, k-means clustering method, self-similar fractal method, comparison of all the methods.

UNIT-V: Representation, Description and Recognition

Representation, boundary descriptors, regional descriptors, principal component analysis, relational descriptors. Recognition based on decision-theoretic and structural methods. Case studies: detection and classification of lung cancer and brain tumor.

Suggested Reading :

1. R.C Gonzalez and R.E. Woods, Digital Image Processing, 2nd Ed, Prentice Hall. 2002.
2. Anil K. Jain, Fundamentals of Image Processing, Prentice Hall, Englewood clifs, New Jersey, 1989
3. G.R. Sinha and Bhagavathi Charan Patel, Medical Image Processing concepts and applications,PHI,2014
4. Chanda & Majumdar, Digital image processing and analysis, Second edition PHI, 2013.

Course Code	Course Title							Course Type
PC 603 BM	MEDICAL EMBEDDED SYSTEMS AND RTOS							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	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.

Course Code	Course Title							Course Type
PC 604 BM	MEDICAL DEVICE REGULATIONS							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	3

COURSE OBJECTIVES:

- To understand the medical device classes and regulatory efforts
- To understand the of national and international medical device regulations and standards
- To know about the patents and intellectual property rights.

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

1. Differentiate the medical devices under their respective classes.
2. Design medical products using different methodologies
3. Deliver the rules of Indian Medical Device Regulations-2017
4. Understand the product safety and legal issues
5. Apply the concepts in design of medical equipment.

UNIT I

Definition of Testing, Parsing Test Requirements, Test Protocol, Test Methodology, Purpose Of The Test, Failure Definition, Determining Sample Size And Test Length, Types Of Testing.

Analysis of Test Data- Failure Rate, Mean Time between Failure, Reliability, Confidence Level, Confidence Limits, Minimum Life, Graphical Analysis.

Reliability And Liability- Negligence, Strict Liability, Breach Of Warranty, Defects, Failure To Warn Of Dangers, Plaintiff's Conduct, Defendants' Conduct, Defendant Related Issues, Manufacturers And Physicians Responsibilities, Accident reconstruction and forensics.

UNIT II

Food And Drug Administration- History of Device Regulation, Device Classification, Registration And Listing, 510(K) Process, Declaration Of Conformance To A Recognized Standard, PMA Application , Investigational Device Exemptions, Good Laboratory Practices, Good Manufacturing Practices, Human Factors, Design Control, FDA And Software, Software Classification, FDA Inspection, Advice On Dealing With The FDA

Regulations And Standards- Definition OFA Medical Device, MDD, United States Domestic Standards, Rest Of The World Standards

UNIT III

Indian Medical Device Rules and Regulations-2017

Licensing Patents Copyrights And Trade Secrets Patents, Copyrights, Trademarks, Trade Secrets.

Manufacturing and quality control- GMP regulations, design for manufacturability, design for assembly, manufacturing process.

UNIT IV

Miscellaneous Issues- Learning From Failure, Design For Failure, Design For Convenience, Universal Design, Design For Assembly, Prevention Through Design, Design For The Environment, Poka-Yoke, Product Life Issues, Product Testing Issues.

Product Issues- Product Safety And Legal Issues, Accident Reconstruction And Forensics, Biomechanics And Traffic Accident Investigations.

Professional Issues- BME – Related Professional Societies, Standards Setting Groups, Professional Engineering Licensure, Rules Of Professional Conduct, Codes Of Ethics, Forensics And Consulting, Continuing Education.

UNIT V

Design of Case studies: Multidetector brain scanning system development, testing of anesthetists, apnea detection system, cancer clinic charting, EKG analysis techniques & module.

Suggested Reading:

1. Paul H. King & Richard C. Fries, Design of Biomedical Devices and systems.
2. Richard C.Fries, *Handbook of medical device design*, Marcel Dekker Inc., 2001.

Course Code	Course Title							Course Type
PE 601 BM	CELL AND TISSUE ENGINEERING							Professional Elective-III
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	3

COURSE OBJECTIVES:

- This course helps to gain deeper knowledge of cell and tissues for variety of approaches used to regenerate the damaged tissue.
- The students will learn about the key concepts of cell biology and tissue organization and the technologies used in tissue engineering.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

1. Understand the basic concepts of tissue engineering in cells, scaffold and growth factors.
2. Understand the concepts of cell interactions and properties of various biomaterials used in biomedical applications.
3. Acquire knowledge on process of tissue culturing and significance of stem cells in tissue regeneration.
4. Learn about various tools and techniques to analyze the surface characterization and cell structure.
5. Understand the clinical challenges of tissue engineering applications.

UNIT-I

Cell structure and organization: Cell structure and basic functions of cell organelles. Signal transduction, Checkpoints of cell cycle, cell growth, cell death and differentiation. Stem cells- Embryonic stem cells, Adult stem cells. Growth factors and Morphogenesis: Bone Morphogenetic proteins (BMPs), Cartilage- derived Morphogenetic proteins (CDMPs), BMP receptors.

UNIT-II

Dynamics of Cell-extracellular matrix interactions: Mechanical forces on cells: Mechanical stimulation of cells in vitro- Shear stress, stretch, pressure/compression. Mechanosensing of Cultured cells to Externally Applied Mechanical Forces: Direct and Indirect mechanosensing and its applications. Cell-cell and cell-matrix interactions, cell adhesion molecules, components of the extracellular matrix, cellular junctions.

UNIT-III

Principles of Cell and tissue culture: Types of tissue culture, media, Cell Culture Techniques: 2D and 3D cell culture techniques, Primary culture, subculture, cryopreservation, cell revival. Culture environment and maintenance of cells in vitro, cell counting. Cell fractionation and isolation: Centrifugation, Magnetic-Activated Cell Sorting (MACS), Fluorescence-Activated Cell Sorting (FACS).

UNIT-IV

Tools and Techniques of Cell Biology: Histology, staining, fluorescence microscopy, Confocal microscopy, SEM and TEM, Two-photon Microscopy**,** Differential Interference Contrast (DIC) Microscopy, Fluorescent dyes: GFP, RFP tagged proteins, Western Blotting**,** Enzyme-Linked Immunosorbent Assay (ELISA).

UNIT-V

Tissue engineering applications and challenges: Types of biomaterials used in hard and soft tissue engineering, Invitro culture environments: Spinner flasks, Rotating bioreactors, Effects of Mechanical Conditioning, Convective mixing, Flow, and Mass Transfer. Applications of tissue engineering and challenges: Bone, Skin, Cornea, and Liver.

Suggested reading:

1. Cell and Molecular Biology, Gerald Karp, John Wiley & Sons, Inc.6th Edition ISBN-13 978-0-470-48337-4.
2. The Principles of Tissue engineering (4th edition), by Robert Lanza, Robert Langer, and Joseph P. Vacanti. ISBN: 978-0-12-398358-9.
3. Tissue Engineering. Clemens van Blitterswijk. ISBN: 978-0-12-370869-4.
4. The molecular and cellular biology of wound repair. Clark, Plenum Press.ISBN: 978-1-4615-1795-5.
5. Biomaterials for tissue engineering applications, Burdick, Jason A., Mauck, Robert L. ISBN 978-3-7091-0385-2.
6. Tissue Engineering and Artificial Organs, Joseph D. Bronzino, Third Edition, ISBN 10:0-8493-2123-8.

Course Code	Course Title							Course Type
PE 602 BM	NANOTECHNOLOGY FOR MEDICAL APPLICATIONS							Professional Elective-III
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	3

COURSE OBJECTIVES:

- To introduce the students to the application of Nanotechnology to medicine
- To familiarize different Nanomaterials and their fabrication
- To introduce the diagnostic and therapeutic applications of Nanomaterials

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand characteristics, properties and classification of Nanomaterials.
2. Compare the different types of Nanomaterials.
3. Explain the fabrication techniques of Nanomaterials
4. Recognize the applications of Nanomaterials to diagnostics
5. Apply Nanomaterials to therapeutics.

UNIT-I

Introduction to Nanotechnology: Nano materials- Definition, Structure and bonding, Characteristics and Properties of Nano materials, Classification of Nanodevices based on the characteristics, Nanotechnology in science.

UNIT-II

Nanomaterials: Types of Nanomaterials, Nanoparticles, Quantum dots and their properties, Fullerenes and carbon forms, Carbon Nanoparticles, Carbon Nanotubes, types of carbon Nanotubes, single-walled, multi- walled, torus, Nano bud, properties of carbon Nanotubes.

UNIT-III

Fabrication of Nanomaterials: Fabrication of Nanomaterials by Bottom-up and Top- down approaches, Synthesis of Nanoparticles, Synthesis of carbon Nanotubes by Arc discharge, laser ablation, chemical vapor deposition techniques, Characterization methods of Nanomaterials.

UNIT-IV

Nanomaterials in diagnostics: Molecular imaging, Medical use of Nanomaterials, Quantum Dots and Nanoparticles for cancer imaging, Applications of Nanomaterials in Medical imaging, Neuro-electronic interfaces.

UNIT-V

Nanomaterials in therapeutics: Drug delivery systems, Targeted drug delivery systems, Drug tracking systems, Nanomaterials for drug delivery, Quantum Dots and Nanoparticles for cancer treatment, Nanoparticle mediated gene therapy, Growth of neurons on Nanomaterials, Nanomaterials for brain protection and repair, Nanorobotics for surgery.

Suggested Readings:

1. Alain Nouailhat, *An introduction to Nanoscience and Nanotechnology*, ISBN: 978-0-470-39353-6, Wiley-VCH

2.. Gunter Schmid, *Nanotechnology: Volume 1: Principles and Fundamentals* ,ISBN: 978-3-527-31732-5 Wiley-VCH

3. Dieter Vollath, *Nanoparticles - Nanocomposites – Nanomaterials, An Introduction for Beginners*, ISBN: 978-3-527-33460-5, Wiley-VCH

4. CSSR Kumar, J.Hormes, C. Leuschner, *Nanofabrication towards Biomedical, Techniques, Tools, Applications, and Impact* by WILEY-VCH

5. Gabor L. Hornyak, John J. Moore, H.F. Tibbals, Joydeep Dutta, *Fundamentals of Nanotechnology*, ISBN 9781138627413, CRC Press

Course Code	Course Title							Course Type
PE 604 CS	DEEP LEARNING							Professional Elective-III
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	40	60	3

Course Objectives:

- To understand complexity of Deep Learning algorithms and their limitations
- To understand modern notions in data analysis oriented computing;
- To apply Deep Learning algorithms in practical applications
- To perform experiments in Deep Learning using real-world data.

Course Outcomes:

The student will be able to

1. Understand the concepts of Neural Networks, its main functions, operations and the execution pipeline
2. Implement deep learning algorithms, understand neural networks and traverse the layers of data abstraction.
3. Learn topics such as Convolutional neural networks, recurrent neural networks, training deep networks and modifications
4. Build deep learning models in PyTorch and interpret the results

UNIT-I

Artificial Neural Networks: Introduction, Perceptron, XOR Gate ,Perceptron Training Rule, Activation Functions.

Linear Neural Networks: Linear Regression, Implementation of Linear Regression, Softmax Regression, The Image Classification Dataset , Implementation of Softmax Regression

UNIT-II

Multilayer Perceptrons:

Multilayer Perceptrons, Implementation of Multilayer Perceptrons, Model Selection, Underfitting and Overfitting, Weight Decay, Dropout, Forward Propagation, Backward

Propagation, and Computational Graphs, Numerical Stability and Initialization, Considering the Environment, Predicting House Prices on Kaggle.

Optimization Algorithms: Optimization and Deep Learning, Convexity, Gradient Descent, Stochastic Gradient Descent, Mini batch Stochastic Gradient Descent, Momentum, Adagrad, RMS Prop, Ada delta, Adam, Learning Rate Scheduling.

UNIT-III

Introduction to Convolutional Neural Networks: Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple Filters

Modern Convolutional Neural Networks: Deep Convolutional Neural Networks (AlexNet), Networks Using Blocks (VGG), Network in Network (NiN), Networks with Parallel Concatenations (GoogLeNet), Batch Normalization, Residual Networks (ResNet), Densely Connected Networks (DenseNet).

UNIT-IV

Recurrent Neural Networks:

Sequence Models, Text Preprocessing, Language Models and the Dataset, Recurrent Neural Networks, Implementation of Recurrent Neural Networks from Scratch, Concise Implementation of Recurrent Neural Networks, Back propagation Through Time**.**

Modern Recurrent Neural Networks: Gated Recurrent Units (GRU), Long Short Term Memory (LST), Deep Recurrent Neural Networks, Bidirectional Recurrent Neural Networks, Machine Translation and the Dataset, Encoder-Decoder Architecture, Sequence to Sequence, Beam Search.

UNIT-V

Auto Encoders : Types of Auto Encoders and its applications

Generative Adversarial Networks: Generative Adversarial Network, Deep Convolutional Generative Adversarial Networks

Suggested Readings:

1 Good fellow, I., Bengio,Y., and Courville, A., "*Deep Learning"*, MIT Press, 2016.

2 Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, "*Dive into Deep Learning",* 2020.

Course Code	Course Title						Course Type
PC 651 BM	MEDICAL IMAGE PROCESSING & MODELING LAB						Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	25	50	1

COURSE OBJECTIVES:

- To perform enhancement techniques on images.
- To execute the noise models and filtering methods.
- To analyze the images by applying segmentation methods.

COURSE OUTCOMES:

The student will be able to:

1. Execute and familiarize with the image enhancement techniques
2. Demonstrate filtering procedures on images.
3. Perform Image histogram and Histogram Equalization
4. Illustrate image segmentation techniques on the images and analyze them.
5. Exemplify modeling of 3D models.

Experiments on Image Processing

1. Reading and displaying JPEG and BMP images.
2. Negative of an image.
3. Contrast Stretching
4. Logarithmic Transform.
5. Power-law Transform.
6. Transpose of an image.
7. Filtering in spatial domain
   a) High pass filter.
   b) Low pass filter
   c) Laplacian filter.
8. Filtering in frequency domain
   a) Low pass filter
   b) High pass filter
   c) Butterworth low-pass & high-pass filters.
   d) Gaussian low pass& high pass filter
9. Determine the image after applying the threshold
10. Highlight a specific range of gray levels in a given image.
11. Enhance the given image by Histogram processing & Histogram Equalization.
12. Edge detection operators
13. Importing images and .stl file.
14. Segmentation of liver/hip
15. Creating the 3D object of the liver/hip.

Course Code	Course Title							Course Type
PC 652 BM	MEDICAL EMBEDDED SYSTEMS LAB							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	3	-	-	-	3	25	50	1

COURSE OBJECTIVES:

- To know the basic concepts of embedded systems.
- Able to write programs to interface with RasberryPi/ NodeMCU

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 RasberryPi/ NodeMCU
3. Interface matrix sensors to RasberryPi/ 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.

Course Code	Course Title							Course Type
PW 601 BM	MINI PROJECT							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	-	-	-	6	-	50	-	3

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:

- Conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis.
- Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to solve the conceived problem.
- 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.

Course Code	Course Title						Course Type
OE 601 BM	ENGINEERING APPLICATIONS IN MEDICINE						OE-I
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	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:

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.

Course Code	Course Title						Course Type
OE 602 BM	**HUMAN ASSISTIVE TECHNOLOGIES**						OE-I
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To extend knowledge of the amputee, of lost and remaining functions affecting locomotion, and to collect information on the best possible medical treatment.
- To improve fitting techniques and practices, including training, so that existing devices might be used with greater comfort and function.
- To develop improved lower-extremity devices.

Course Outcomes:

1. Apply fundamental knowledge of engineering in rehabilitation
2. Apply analytical skills to assess and evaluate the need of the end-user
3. Develop self-learning initiatives and integrate learned knowledge for problem solving
4. Understand the basics of robotics and apply their principles in developing prosthetics
5. Apply the knowledge of computers in solving rehabilitation problems

UNIT- I

Introduction to Rehabilitation Engineering, Definition of Rehabilitation Engineering, Scope and importance of the field, Historical perspective. Interdisciplinary nature and collaboration with healthcare professionals. Physical disabilities: mobility impairments, spinal cord injuries. Cognitive disabilities: learning disabilities, traumatic brain injuries. Psychosocial aspects of disability.

UNIT-II

Assistive Technology, Human Factors and Ergonomics in Assistive Technology Design. Mobility Aids, Types of Wheelchairs and design aspects: Manual wheelchairs, Powered wheelchairs, Customizable features and design considerations, Auxiliary devices and systems. Human-Centered Designing.

UNIT- III

Sensory disabilities: visual and hearing impairments. Sensory augmentation and substitution: Visual system: Visual augmentation. Tactual vision substitution, Auditory vision substitution; Auditory system: Auditory augmentation. Cochlear implantation, Visual auditory substitution, Tactual auditory substitution, Tactual system: Tactual augmentation. Tactual substitution. Assessment and Outcome Measurement

UNIT-IV

Rehabilitation Robotics, Exoskeletons, Major Limb Prosthetic Devices, Orthotic Devices, Types of orthotics and prosthetics, Intelligent prosthetic Knee, Prosthetic Hand, Controlled orthotics and prosthetics Materials and fabrication techniques, Functional and cosmetic considerations. FES system, Restoration of Hand function, Restoration of standing and walking, Myo-electric Hand.

UNIT-V

Case Studies and Real-World Applications. Augmentative and Alternative communications, Software tools for simulation and testing. Virtual reality applications in rehabilitation. Machine learning applications in assistive technology. Predictive analytics for personalized rehabilitation

Suggested Reading:

1. Robinson C.J., *Rehabilitation Engineering*, CRC Press, 1995.
2. Ballabio E., et al., *Rehabilitation Technology*, IOS Press, 1993.
3. Rory A Cooper, Hisaichi Ohnabe, Douglas A. Hobson, *Series in medical physis and biomedical engineering: An introduction to rehabilitation engineering*, Taylor and Francis Group, London, 2007.
4. Joseph D. Bronzino *The biomedical engineering handbook -biomedical engineering fundamentals*, 3rdEd., CRC Press, Taylor & Francis Group, London, 2006.

With effect from the academic year 2024-2025

Course Code	Course Title						Course Type
OE 601 CE	DISASTER MANAGEMENT						OE-I
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

UNIT- I

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 Emerging Trends: Classification, Causes, Consequences and Controls of: Geophysical hazards-Earthquakes, Landslides, Tsunami; Weather related hazards- Meteorological (Cyclones, and Storm- surge), Hydrological (Floods, Droughts, Avalanches), Climatological (Wildfire, Cold & Heat Waves); Biological hazards-Epidemic & Pandemics; Technological hazards-Chemical, Industrial, Nuclear; 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 Micro-zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Building; 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); Technological in Disaster Communication System (Early Warning and Its Dissemination), rescue and restoration of services; Disaster Safe Designs and Constructions; Application of technology and innovations for Structural and non structural Mitigation; Science & Technology Institutions for Disaster Management in India

Suggested Reading:

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, Anu Kapur & others, 2005, 283 pages, Rawat Publishers, Jaipur
6. National Disaster Management Policy, 2009, GoI.
7. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management

With effect from the academic year 2024-2025

Course Code	Course Title						Course Type
OE 602 CE	ROAD SAFETY ENGINEERING						OE-I
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To introduce the fundamentals of road safety and road safety audit.
- To get familiarized with various road safety techniques, measures and their applications.
- To be able to understand and evaluate various traffic control devices.
- Familiarize with traffic management techniques.
- To examine and analyze the incident management process.

Course Outcomes:

1. Analyze Accident data.
2. Plan and design of road safety improvement programs
3. Apply the principles of road safety in urban transport
4. Apply traffic management techniques
5. Able to plan effective incident management program

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	2	3	1	2	2	2	-	-	2	-	-	-	2	2
CO 2	2	2	2	2	2	2	-	2	-	1	1	-	1	1
CO 3	2	2	1	1	1	1	-	-	-	-	-	1	2	-
CO 4	3	2	2	2	2	2	-	1	2	-	-	2	3	2
CO 5	1	3	3	3	2	3	2	1	2	1	2	1	1	2

UNIT- I

Road accidents: Causes, scientific investigations and data collection, analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, Basic concepts of road accident statistics, safety performance function: The empirical Bayes method identification of hazards road location. Application of computer analysis of accident data.

UNIT-II

Safety in Road Design: Operating the road network for safety, highway operation and counter measures, road safety audit, principles-procedures and practice, code of good practice and checklists, vehicle design factors & driver characteristics influencing road safety

UNIT- III

Road Signs and Traffic Signals: Classification, Location of signs, measures of sign effectiveness, Types of visual perception, sign regulations, sign visibility, sign variables, Text versus symbols, Road marking: Role of road marking, classification, visibility. Traffic signals: Need, Signal face illumination and location of signals, factors affecting signal design, pedestrian's safety, fixed and vehicle actuated signals. Design of signals, area traffic control, Delineators, traffic impact attenuators, road side rest areas, safety barriers, traffic aid posts

UNIT-IV

Traffic Management Techniques: Integrated safety improvement and traffic calming schemes, speed and load limit, traffic lights, safety cameras, tests on driver and vehicles, pedestrian safety issues, parking, parking enforcement and its influence on accidents, travel demand management, methods of traffic management measures: restriction of turning movements, One way streets, tidal flow operation methods, exclusive bus lanes and closing side-streets; latest tools and techniques used for road safety; legislation, enforcement, education and propaganda.

UNIT-V

Incident Management: Introduction, characteristics of traffic incidents types of incidents, impacts, incident management process, incident traffic management; application of ITS: Motorist information, equipment used; planning effective incident management program, best practice in incident management programs. National importance of survival of transpiration systems during and after all natural disasters especially cyclones, earthquakes, floods etc and manmade disasters like sabotage, terrorism etc.

Suggested Reading:

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017.
2. KadiyaliL.R,.Traffic Engineering and Transport planning, 9th Edition, Khanna Tech Publishers, 2013.
3. Donald Drew, Traffic Flow Theory Chapter 14 in Differential Equation Models, Springer, 1983
4. C. Jotinkhisty and B. Kent Lall, Transportation Engineering – An Introduction, 3rd Edition, Pearson publications, 2017
5. Rune Elvik, Alena Hoye, TrulsVaa, Michael Sorenson, Handbook of Road Safety measures, second Edition, Emerald Publishing, 2009

Course Code	Course Title					Course Type
OE 601 EC	VERILOG HDL					OE-I
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE / SEE	
	3	-	-	3	40 / 60	3

Course Objectives:

- To familiarize with various modeling styles: structural, dataflow and behavioral of Verilog HDL
- To develop combinational and sequential circuits using various modeling styles of Verilog HDL
- To design and develop Verilog HDL models of combinational and sequential circuits
- To learn Synthesis and FPGA design flow
- To design and develop real time applications: Booth's multiplier, Divider, hardwired control for basic CPU, FIR filter

Course Outcomes:

1. Implement and distinguish different Verilog HDL modeling styles.
2. Construct and analyze Verilog HDL models of combinational and sequential circuits.
3. Design and develop Verilog HDL modeling and test bench for digital systems for the given specifications.
4. Outline FPGA design flow and timing analysis.
5. Understand implementation of real time applications.

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	1	2	2	-	-	-	-	-	2	-	-	-	2	-
CO 2	2	2	2	2	2	-	-	-	2	2	-	-	2	-
CO 3	2	3	3	2	2	-	-	-	2	2	-	-	2	-
CO 4	2	3	3	2	2	1	-	-	2	2	-	2	2	-
CO 5	2	2	2	-	-	1	-	-	2	1	-	2	2	-

UNIT- I

Introduction to HDL: Overview and Importance of HDLs, Differences between HLL, HDL and ALP. Design methodologies, Modules, Lexical Conventions, Number Specifications, Strings, Identifiers and Keywords Data types, System task and compiler Directives, Port declaration and port connection rules

UNIT-II

Structural and Dataflow Modeling: gate-level modeling, delays, hazards, dataflow modeling: Continuous Assignments, Delays, Expressions, Operators and Operands, Operator Types and Design Examples.

UNIT- III

Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, multi-way branching, Loops, Sequential and Parallel blocks, Generate blocks. Combinational, sequential logic modules Simulation: Types of Simulation, Event driven Simulation and Cycle Based Simulation; design examples.

UNIT-IV

Synthesis and Verification: Tasks and Functions: Differences between Tasks and Functions, Tasks and Functions. Verilog HDL synthesis, synthesis, Application Specific IC (ASIC) and Field Programmable Gate Array (FPGA) design flow. Verification: Timing analysis and Test bench design. Design examples.

UNIT-V

Real time implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), DSP modules: FIR and IIR filters, CPU design: Data path and control units.

Suggested Reading:

1. Samir Palnitkar, ―*Verilog HDL A Guide to Digital Design and Synthesis,*‖ 2nd Edition, Pearson Education, 2006..
2. Ming-Bo Lin, ―*Digital System Designs and Practices: Using Verilog HDL and FPGA,*‖ Wiley India Edition, 2008
3. J. Bhasker, ―*A Verilog HDL Primer*,‖ 2nd Edition, BS Publications, 2001

Course Code	Course Title						Course Type
OE 602 EC	**PRINCIPLES OF ELECTRONIC COMMUNICATION SYSTEMS**						OE-I
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- Provide an introduction to fundamental concepts in the understanding of Electronic 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
- Provide an introduction to fundamental concepts in the understanding of Telecommunication and optical communications systems
- Provide an introduction to fundamental concepts in Analog and Digital Communications

Course Outcomes:

1. Understand the working of analog and digital communication systems.
2. Understand the Data Communication and Networking
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

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	1	-	-	-	1	1	1	1
CO2	2	1	2	1	-	-	-	-	1	1	1	1
CO3	2	1	1	1	-	-	-	-	1	1	1	1
CO4	3	2	2	2	-	1	1	1	1	1	1	1
CO5	1	1	2	2	1	-	1	-	1	1	1	1

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 Reading:

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.
4. Keiser Gerd "Optical Fiber Communication (SIE)",5th Edition, McGraw Hill Education India,2017.
5. Simon Haykin, "Communication Systems", 5th Edition, Wiley publications, 2006

Course Code	Course Title						Course Type
OE 601 ME	**3D PRINTING TECHNOLOGY**						OE-I
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	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:

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 Reading:

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. Rafiq Noorani, 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

Course Code	Course Title						Course Type
OE 602 ME	**FINITE ELEMENT METHOD**						OE-I
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	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:

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.

With effect from the academic year 2024-2025

Course Code	Course Title					Course Type
OE 601 EE	APPLICATIONS OF ELECTRICAL ENERGY					OE-I
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating.
- To understand various techniques of electric welding and types of batteries.
- To understand the concept of illumination and study about the laws of illumination.
- To know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electric traction including speed – time curves of different traction services.

Course Outcomes:

1. Identify a suitable heating scheme for a given application.
2. Identify proper welding technique and various characteristics of batteries.
3. Study the nature and production of light and laws related to illumination.
4. Classify types of electric light sources based on nature and operation and their objectives, performance and reliability.
5. Determine the speed-time characteristics of various traction services and also estimate the energy consumption levels at various modes of operation.

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	1	2	-	-	2	-	-	1	-	-	1	2	1
CO 2	3	1	2	-	-	2	-	-	1	-	-	1	2	1
CO 3	3	2	2	-	-	2	-	-	1	-	-	1	2	1
CO 4	3	1	2	-	-	2	-	-	1	-	-	1	2	1
CO 5	3	1	2	-	-	2	-	-	1	-	-	1	2	1

UNIT- I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens, Design of heating element. High frequency heating, Induction Heating, Induction furnaces, Core type, Coreless furnaces, Dielectric heating. Electric Arc furnaces, Direct Arc furnace, Indirect Arc furnaces.

UNIT-II

Electric welding: Classification of electric welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

UNIT- III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, Lighting calculations, Determination of M.S.C.P, Rousseau‟s construction.

UNIT-IV

Types of lamps - Discharge lamps, Sodium vapour lamps, Mercury vapour lamps, Fluorescent lamp and LED lamps. Starting and power factor corrections, stroboscopic effects, Application to factory lighting, Street lighting and Flood lighting.

UNIT-V

Electric Traction: System of Electric Traction, Transmission of drive, Systems of track electrification, Traction mechanics, Speed time curves, Tractive effort, Power of Traction motor, Specific energy consumption, Mechanics of train movement, Coefficient of adhesion..

Suggested Reading:

1. Partab H, Art and Science of Utilization of Electric Power, Dhanpat Rai & Sons, 1997.
2. K.B. Raina & S.K. Bhattacharya, Electrical Design, Estimating 1. and Costing, Wiley Eastern Ltd., 1991.
3. Partab H, Modern Electric Traction, Dhanpat Rai & Sons, 2000.
4. B.L.Theraja, A Text Book of Electrical Technology, S.Chand & Company Ltd, Vol-I.

Course Code	Course Title					Course Type
OE 602 EE	ELECTRICAL SAFETY MANAGEMENT					OE-I
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- Understand electrical safety measures, the hazards associated with electric current, and voltage identify different types of electrical shocks.
- Understand installation work of electrical plant and equipment. Safety during installation of outdoor switchyard equipment, safety during installation of electrical rotating machines.
- Understand procedure of domestic wirings to handle different domestic electrical appliances, Procedure of Agricultural pump installation.
- Identifies different hazardous zones, classification of equipment enclosure for various hazardous gases, importance of earthing system. Understand Management Safety Policy.
- Understand standards on electrical safety, different IE Rules and Acts.

Course Outcomes:

1. Explain the objectives and precautions of Electrical safety, effects of shocks and their prevention.
2. Summarize the safety aspects during installation of plant and equipment.
3. Describe the electrical safety in residential, commercial and agricultural installations.
4. Describe the various Electrical safety in hazardous areas, Equipment earthing and system neutral earthing.
5. State the electrical systems safety management and IE rules.

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	3	3	1	2	2	2	-	2	2	-	2	2	2
CO 2	3	3	3	1	2	2	2	-	2	2	-	2	2	2
CO 3	3	3	3	1	2	2	2	-	2	2	-	2	2	2
CO 4	3	3	3	2	2	2	2	-	2	2	-	2	2	2
CO 5	3	3	3	1	2	2	2	-	2	2	-	2	2	2

UNIT- I

Introduction to electrical safety, shocks and their prevention: Terms and definitions, objectives of safety and security measures, Hazards associated with electric current, and voltage, who is exposed, principles of electrical safety, Approaches to prevent Accidents, scope of subject electrical safety. Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity,

medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shops.

UNIT-II

Safety during installation of plant and equipment: Introduction, preliminary preparations, preconditions for start of installation work, during, risks during installation of electrical plant and equipment, safety aspects during installation, field quality and safety during erection, personal protective equipment for erection personnel, installation of a large oil immersed power transformer, installation of outdoor switchyard equipment, safety during installation of electrical rotating machines, drying out and insulation resistance measurement of rotating machines.

UNIT- III

Electrical safety in residential, commercial and agricultural installations: Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances.

UNIT-IV

Electrical safety in hazardous areas: Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipment for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations.

Equipment earthing and system neutral earthing: Introduction, Distinction between system grounding and Equipment Grounding, Equipment Earthing, Functional Requirement of earthing system, description of a earthing system, neutral grounding (System Grounding), Types of Grounding, Methods of Earthing Generators Neutrals.

UNIT-V

Safety management of electrical systems: Principles of Safety Management, Management Safety Policy, Safety organization, safety auditing, Motivation to managers, supervisors, employees.

Review of ie rules and acts and their significance: Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage –Rules regarding first aid and fire fighting facility. The Electricity Act, 2003, (Part1, 2, 3, 4 & 5).

Suggested Reading:

1. S.Rao, Prof. H.L.Saluja, "Electrical safety, fire safety Engineering and safety management", 1st edition Khanna Publishers. New Delhi, 2016 Reprint.
2. Pradeep Chaturvedi, "Energy management policy, planning and utilization", Concept Publishing company, New Delhi, 1997.

With effect from the academic year 2024-2025

Course Code	Course Title					Course Type
OE 601 CS	PYTHON PROGRAMMING					OE-I
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	T	P		CIE	SEE
	3	-	-	3	40	60	3

Course Objectives:

- To know the basics of Programming
- To convert an algorithm into a Python program
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions
- To use Python data structures-lists, tuples, dictionaries.
- To do input/output with files in Python.
- To construct Python programs as a set of objects.

Course Outcomes:

1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Develop simple Python programs for solving problems.
4. Structure a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries.
6. Read and write data from/to files in Python Programs

UNIT-I

Introduction to Computing and Problem Solving: Fundamentals of Computing – Computing Devices – Identification of Computational Problems – Pseudo Code and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms.

Introduction to Python Programming: Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements, Reading Input, Print Output, Type Conversions, The type() Function and Is Operator, Dynamic and Strongly Typed Language.

Control Flow Statements: The if, The if…else,The if…elif…else Decision Control Statements, Nested if Statement, The while Loop, The for Loop, The continue and break Statements.

UNIT-II

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, Command Line Arguments.

Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.

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

UNIT-III

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.
Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings
Dictionaries and Sets: Dictionaries, Sets, Serializing Objects.

UNIT-IV
Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance The Polymorphism.
Functional Programming: Lambda. Iterators, Generators, List Comprehensions.

UNIT-V
GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.

Suggested Readings:

1. Richard L. Halterman, "*Learning To Program With Python*", Copyright © 2011.
2. Dr. Charles R, "*Python for Everybody, Exploring Data Using Python 3*", Severance. 2016.
3. Gowrishankar S., Veena A, "*Introduction to Python Programming*", CRC Press, Taylor & Francis Group, 2019.
4. Allen B. Downey, "*Think Python: How to Think Like a Computer Scientist*", 2nd Edition, Shroff O"Reilly Publishers, 2016

Course Code	Course Title						Course Type
OE 602 CS	**CYBER SECURITY**						OE-I
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- Learn the various threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and IT laws and policies.

Course Outcomes:

1. Understand the various network threats
2. Analyze the forensic tools for evidence collection
3. Apply the firewalls for threat analysis

UNIT-I

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

UNIT-II

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

UNIT-III

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, search and seizure of computer systems, password cracking.

UNIT-IV

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrieval, Email analysis from mobile phones.

UNIT-V

Ethics, Policies and IT Act

Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal

Code , Computer Security Act 1987, National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

Suggested Readings:

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.
2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.
5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.