SCHEME OF INSTRUCTION
B.E. (BIOMEDICAL ENGINEERING)
VII – SEMESTER
Syllabus with effect from AY 2025-26

S. No	Course Code	Course Title	L	T	P	Scheme of Examination		Credits
						CIE	SEE	
1.	PC 701 BM	Basic Clinical Sciences-I (Nephrology, Neurology)	2	0	0	40	60	2
2.	PC 702 BM	Basic Clinical Sciences - II (Gastroenterology, General Surgery)	2	0	0	40	60	2
3.	PC 703 BM	Basic Clinical Sciences -III (Imaging Sciences & Radio therapy, Anesthesia)	2	0	0	40	60	2
4.	PC 704 BM	Basic Clinical Sciences-IV (Cardiology, Orthopedics)	2	0	0	40	60	2
5.	PC 705 BM	Biological Control Systems	3	0	0	40	60	3
6.	**Professional Elective IV**		3	0	0	40	60	3
	PE 701 BM	Rehabilitation Engineering						
	PE 702 BM	Drug Delivery Systems						
7.	**OE**	**Open Elective II**	3	0	0	40	60	3
PRACTICALS								
8	PC 751 BM	Basic Clinical Sciences -I Lab (Nephrology, Neurology)	0	0	2	25	50	1
9.	PC 752 BM	Basic Clinical Sciences-II (Gastroenterology, General Surgery)	0	0	2	25	50	1
10.	PC 753 BM	Basic Clinical Sciences-III (Imaging Sciences & Radio therapy, Anesthesia)	0	0	2	25	50	1
11	PC 754 BM	Basic Clinical Sciences-IV (Cardiology, Orthopedics)	0	0	2	25	50	1
13	PW 761BM	Project work-I	0	0	6	50	-	3
14	PW 762BM	Summer Internship	0	0	4	50	-	2
Total			**17**	**0**	**18**	**480**	**620**	**26**

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

Open Elective-II

S. No.	Course Code	Course Title
1.	OE 701 BM	Basic Medical Equipment
2.	OE 702 BM	Artificial Intelligence In HealthCare
3.	OE 701 CE	Green Building Technology
4.	OE 702 CE	Plumbing Technology
5.	OE 701 CS	Cloud Computing
6.	OE 702 CS	Data Base Management Systems
7.	OE 701 EC	Embedded Systems Design
8.	OE 702 EC	Basics of IOT
9.	OE 701 EE	Optimization Techniques
10.	OE 702 EE	Non-Conventional Energy Sources
11.	OE 701 ME	Nano Technology
12.	OE 702 ME	Startup Entrepreneurship

Course Code	Course Title							Course Type
PC 701 BM	BASIC CLINICAL SCIENCES THEORY - I							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	2	-	-	-	3	40	60	2

COURSE OBJECTIVES:

- To introduce the students to basic concepts of neurology and nephrology
- Understand various dialysis techniques, their principles, equipment, and clinical applications.

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

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

PART-I -NEPHROLOGY

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Reading

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

PART-II-NEUROLOGY

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Reading:

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

Course Code	Course Title						Course Type
PC 702 BM	BASIC CLINICAL SCIENCES THEORY - II						Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	2	-	-	-	3	40	60	2

COURSE OBJECTIVES

- To introduce the students to basic concepts of gastroenterology and general surgery.
- Understand the stages and biology of wound healing, surgical instruments and materials.
- Identify the common diseases of the GI tract and associated organs.
- Able to understand the procedures and indications for diagnostic techniques.

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

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

PART-I GASTROENTEROLOGY

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Suggested Reading:

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

PART-II-GENERAL SURGERY

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Reading:

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

Course Code	Course Title							Course Type
PC 703 BM	BASIC CLINICAL SCIENCES THEORY - III							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	2	-	-	-	3	40	60	2

COURSE OBJECTIVES:

- To introduce the students to basic concepts of imaging sciences, radiotherapy and anesthesia.
- Understand the biological effects of radiation on tissues and tumors, radio-sensitivity concepts, and therapeutic ratios relevant to radiotherapy.
- Identify anesthesia gas pipeline systems, flow meters, vaporizers, anesthesia circuits, and safety measures.

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

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

PART-I-IMAGING SCIENCES & RADIOTHERAPY

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Reading:

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

PART-II-ANAESTHESIA

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Reading:

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

Course Code	Course Title							Course Type
PC 704 BM	BASIC CLINICAL SCIENCES THEORY - IV							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	2	-	-	-	3	40	60	2

COURSE OBJECTIVES:

- To introduce the students to basic concepts of cardiology and orthopedics.
- Identify physiotherapy modalities such as diathermy, ultrasound therapy, cervical traction, and their application in musculoskeletal rehabilitation.
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COURSE OUTCOMES: Upon completion of the course, the students will be able to

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

PART-I-CARDIOLOGY

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Reading:

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

PART-II-ORTHOPAEDICS

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Reading:

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

Course Code	Course Title							Course Type
PC 705 BM	BIOLOGICAL CONTROL 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 study system concept and different mathematical techniques applied in analyzing any given system.
- To learn to do the analysis of given system in time domain and frequency domain.
- To develop an understanding of the fundamental principles behind control of various biological systems.
- To apply these analysis to study the biological systems.

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

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

Muscle stretch reflex, skeletal muscle Servo-mechanism.

Cardiovascular Control Systems-Regulation of heart rate, blood pressure and cardiac output. Respiratory Control system-Chemical regulation of ventilation, Cheyne Stokes breathing.

Suggested Reading:

1.NagrathI.J and Gopal M., *Control Systems Engineering*, 3rd Ed, New Age Publishers, 2002

2. Michael C. Khoo, *Physiological Control Systems-Analysis, Simulation and Estimation*, IEEE Press, 2000

3. Suresh R. Devasahayam, *Signals and Systems in Biomedical Engg*, Springer Science& Business Media, 2012.

Course Code	Course Title							Course Type
PE 701 BM	REHABILITATION ENGINEERING (PROFESSIONAL ELECTIVE IV)							PE
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 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: Successfully the student will be able to:

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, Measurement and analysis of human movement, Disability associated with aging in the workplace and their solutions, clinical practice of rehabilitation engineering.

UNIT-II

Assistive Technology, Seating Biomechanics and systems. Wheeled Mobility: Categories of Wheelchairs. Wheelchair Structure and Component Design. Ergonomics of Wheel chair propulsion. Power Wheelchair Electrical Systems. Control. Personal Transportation. Auxiliary devices and systems.

UNIT – III

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. Measurement tools and processes: fundamental principles, structure, function; performance and behavior. Subjective and objective measurement methods.

UNIT–IV

Rehabilitation Robotics, Major Limb Prosthetic Devices, Orthotic Devices, Types of orthotics and prosthetics, Intelligent prosthetic Knee, Prosthetic Hand, Controlled orthotics and prosthetics 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*, 3rd Ed., CRC Press, Taylor & Francis Group, London, 2006.

Course Code	Course Title							Course Type
PE 702 BM	DRUG DELIVERY SYSTEMS (PROFESSIONAL ELECTIVE IV)							PE
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:

1. Understand various approaches for development of novel drug delivery systems
2. Formulate and evaluate novel drug delivery systems
3. Understand criteria for selection of drugs and polymers for the development of delivering system.
4. Develop skills in formulation and evaluation of novel drug delivery systems

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

1. Explain the fundamental principles of drug delivery systems.
2. Students understand the various approaches for development of drug delivery system.
3. Students understand the criteria for selection of drugs and polymers for the development of delivering system.
4. Students shall be able to develop skills in formulation and evaluation of novel drug delivery system.
5. Students shall be able to formulate and evaluate novel drug delivery systems.

UNIT-I

Controlled and Sustained Drug Delivery Systems: fundamental concepts of controlled drug delivery, mechanism of drug release – diffusion, dissolution, osmotic, floating, ion-exchange and bioadhesive. Physicochemical & biological approaches for SR/CR formulation. Formulation approaches to design controlled release. Polymers: Classifications, properties, drug in polymer matrices polymers in the formulation of controlled release drug delivery systems.

Unit 2

Rate Controlled Drug Delivery Systems: Principles and fundamentals, Types of release kinetics, formulation, modulated drug delivery systems, mechanically activated, pH activated, enzyme- triggered, and osmotic controlled release, feedback regulated drug delivery systems. Advantages, disadvantages and applications.
Microencapsulation: Introduction, types of microencapsulated particles- microspheres, microcapsules, microparticles. Methods and applications of microencapsulation in drug delivery systems.

Unit 3:

Occular Drug Delivery Systems: Barriers to drug permeation in ocular tissues, strategies to overcome the barriers. **Gastroretentive Drug Delivery Systems**: Principles, concepts advantages and disadvantages, approaches for GRDDS- floating, high density systems, inflatable and gastro adhesive systems. **Buccal drug delivery systems:** Principle of muco adhesion, advantages and disadvantages, mechanism of drug permeation, Methods of formulation and its evaluations.

Unit 4

Transdermal Drug Delivery Systems (TDDS): Structure of skin and barriers, Penetration through skin, factors affecting penetration, penetration enhancers, transdermal drug delivery systems, formulation and evaluation.
Mucosal Drug Delivery Systems: Introduction, principles of bioadhesion /mucoadhesion, penetration of transmucosal and advantages and disadvantages.
Protein and Peptide Delivery: Barriers for protein delivery. Formulation and evaluation of delivery systems of proteins and other macromolecules.

Unit 5

Vaccine Drug Delivery Systems: Vaccines, uptake of antigens, single shot vaccines, mucosal and transdermal

delivery of vaccines. **Implantable Drug Delivery System:** Concept of implants and osmotic pump. **Targeted Drug Delivery:** Concepts of liposomes, niosomes, nanoparticles, monocolonal antibodies and their applications. Approaches of TDD with advantages and disadvantages.

Suggested Reading and Resources:

[1] "Controlled Drug Delivery: Fundamentals and Applications" by Joseph R. Robinson and Vincent H.L. Lee
[2] "Biomedical Engineering Principles in Drug Delivery" by K. Park
[3] "Drug Delivery Systems" by Vladimir P. Torchilin
[4] "Polymeric Drug Delivery Systems" by Glen S. Kwon
[5] "Drug Delivery Systems: Methods and Protocols" by Kewal K. Jain

Course Code	Course Title						Course Type
OE 701 BM	BASIC MEDICAL EQUIPMENT						Open elective
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:	
The course is taught with the objectives of enabling the student to:	
1	To make the students understand the need for several Biomedical equipment.
2	To make the students understand the operating principles of a wide range of Biomedical Equipment
3	Tofamiliarizestudentswiththedesignandfunctionalaspectsofmedicalimagingsystemsand Therapeutic devices.
4	Todeveloptheabilitytoassesstheappropriatebiomedicalequipmentneededforspecific Clinical and therapeutic applications.
5	Toenablestudentstounderstandtheoperatingprinciplesandclinicaluseoftherapeutic Devices like pacemakers, dialysis machines, and lithotripters.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Learn about various physiological parameters, monitoring and recording.
CO-2	Assess the need and operating principle of equipment used in physiotherapy
CO-3	Interpret the working principle and operating procedure and applications of Medical Imaging equipments.
CO-4	Perceive the governing principles and functions of critical care equipments.
CO-5	Learn about the various Therapeutic Equipment used for different applications

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

Correlation rating: Low/Medium/High: 1/2/ 3respectively.

UNIT–I

Medical Monitoring and recording: Patient monitoring: System concepts, bedside monitoring systems, central monitors, heart rate and pulse rate measurement. Temperature measurement Blood pressure measurement: Direct and indirect methods. Respiration rate measurement: Impedance pneumograph, Apnoea detectors. Ambulatory monitoring: Arrhythmia monitor

UNIT–II

Physiotherapy and Electrotherapy Equipment: Diathermy machines: Short wave diathermy, Microwave diathermy and ultrasonic diathermy Electro diagnostic/Therapeutic apparatus: Nerve muscle stimulator, Functional electrical stimulator etc.

UNIT–III

Medical Imaging Equipment:

X-Ray machines: Properties and production of X-Rays, X-ray machine, Image Intensifier. X-ray computed tomography: basic principle and construction of the components. Ultrasonic Imaging: Physics of ultrasonic waves, medical ultrasound, basic pulse echo apparatus. Magnetic Resonance Imaging: Principle, Image reconstruction techniques, Basic NMR components, Biological effects, Merits.

UNIT-IV

Critical care Equipment:

Ventilators: Mechanics of respiration, artificial ventilators, Positive pressure ventilator, Types and classification of ventilators. Drug delivery system: Infusion pumps, basic components, implantable infusion system, closed loop control in infusion pump. Cardiac Defibrillators: Need for defibrillators, DC defibrillator, Implantable defibrillators, Defibrillator analyzer.

UNIT– V

Therapeutic Equipment:

Cardiac pacemakers: Need for cardiac pacemakers, External and implantable pacemakers, types. Dialysis Machine: Function of the kidney, artificial kidney, Dialyzers, Membranes, Hemodialysis machine. Lithotripters: The stone disease problem, Modern Lithotripter systems, extra corporeal shockwave therapy.

SUGGESTEDREADING:

1	R.S.Khandpur,HandbookofBiomedicalInstrumentation,TataMcGraw-Hill,Second Edition, 2014.
2	John G. Webster, Medical Instrumentation Application and design, Wiley India Edition,2009.
3	LeslieCromwell,*BiomedicalInstrumentationandMeasurements,2ndEdition,Prentice Hall of India,*

Course Code	Course Title						Course Type
OE 702 BM	ARTIFICITAL INTELLIGENCE IN HEALTH CARE						Open elective
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:	
The course is taught with the objectives of enabling the student to:	
1	To introduce students to the fundamentals of Artificial Intelligence (AI) with a focus on healthcare applications.
2	To explore AI techniques in clinical diagnostics and decision-making.
3	To understand the role of AI in medical imaging, disease prediction, patient monitoring, and personalized medicine.
4	To examine ethical, legal, and regulatory considerations in the deployment of AI in healthcare.
5	To enable students to design and evaluate AI-based healthcare solutions for improving patient outcomes and operational efficiency

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Understand and explain the fundamental AI concepts and techniques relevant to Healthcare.
CO-2	Apply machine learning and deep learning methods to analyze medical data and assist in clinical decision-making.
CO-3	Analyze AI-based diagnostic tools used in medical imaging and disease prediction.
CO-4	Evaluate the implementation challenges and ethical implications of AI in healthcare systems.
CO-5	Design AI-driven healthcare applications and propose data-driven solutions to real-world health problems.

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

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
Machine Learning and Deep Learning for Healthcare: Supervised, unsupervised, and reinforcement learning. Classification and regression techniques in clinical datasets. Neural networks, CNNs, RNNs and their applications. Case studies: Diabetes prediction, cancer classification, readmission prediction. Model evaluation: accuracy, precision, recall, ROC curves

UNIT–III
AI in Medical Imaging and Diagnostics: Image processing fundamentals and feature extraction. AI in radiology: X-rays, CT, MRI, Ultrasound. Computer-aided diagnosis systems. Deep learning for medical image segmentation and classification. Real-world tools: Google DeepMind, IBM Watson Health.

UNIT-IV
Natural Language Processing in Healthcare: Basics of NLP and its significance in healthcare**.** Clinical text mining and named entity recognition (NER).Chatbots and virtual health assistants. AI in Electronic Health Record (EHR) processing. Case study: Predictive analysis from clinical notes.

UNIT – V
Ethical, Legal, and Future Perspectives. Ethical concerns: bias, transparency, and ability. Data privacy and security in AI systems. Regulatory aspects: FDA, HIPAA, CDSCO. Human-AI collaboration in clinical settings. Future directions: AI in genomics, telemedicine, and wearable technologies.

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	Mathias Goyen, *Artificial Intelligence in Healthcare: Past, Present and Future*, Elsevier, 2021.
4	Eric Topol, *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*, Basic Books, 2019
5	Parashar Shah, *AI in Healthcare: A Practical Guide*, BPB Publications, 2021.

Course Code	Course Title						Course Type
OE 702 CE	GREEN BUILDING TECHNOLOGY						Open elective
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:	
The course is taught with the objectives of enabling the student to:	
1	Exposure to the green building technologies and their significance.
2	Understand the judicial use of energy and its management.
3	Educate about the Sun-earth relationship and its effect on climate.
4	Enhance awareness of end-use energy requirements in the society.
5	Develop suitable technologies for energy management.

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Understand concept of Energy in Buildings, factors on energy usage and Management.
CO-2	Environmental, Air conditioning and Auditory requirement indoors
CO-3	Climate, radiation, wind in connection with Energy
CO-4	End use energy requirements in buildings, concepts of heat gain and thermal performance
CO-5	Energy audit, energy management.

Articulation matrix of Course outcomes with PO's:

	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	1	3	3	3	2	1	2	1	3	1	1
CO2	3	2	3		1		3	2	2	2		3	1	2
CO3	2	1	3	1	1	2	3	2	3	1	1	2	1	1
CO4	2	2	3	1	1	3	2	2	2	2			2	2
CO5	3	3	3	2	1	3	3	2	2	2	2	1	2	2

Correlation rating: Low/Medium/High:1/2/3 respectively

UNIT-I

Overview of the significance of energy use and energy processes in building: Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors

- Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

UNIT-II

Indoor environmental requirement and management: Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement – Auditory requirement.

UNIT-III

Climate, solar radiation and their influences: Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

UNIT-IV

End-use, energy utilization and requirements: Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building - Heat gain and thermal performance of building envelope - Steady and non-steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope-Evaluation of the overall thermal transfer

UNIT-V

Energy management options: Energy audit and energy targeting - Technological options for energy management.

Suggested Readings:

1. Michael Bauer, Peter Mösle and Michael Schwarz, *"Green Building–Guide book for Sustainable Architecture"*, Springer, Heidelberg, Germany, 2010.
2. Norbert Lechner, *"Heating, Cooling, Lighting-Sustainable Design Methods for Architects",* Wiley, New York, 2015.
3. Mike Montoya, *"Green Building Fundamentals* ‖,Pearson, USA, 2010.
4. Charles J. Kibert, *"Sustainable Construction-Green Building Design and Delivery*‖, John Wiley & Sons, New York, 2008.
5. Regina Leffers, *"Sustainable Construction and Design*‖, Pearson / Prentice Hall, USA 2009
6. James Kachadorian, *"The Passive Solar House: Using Solar Design to Heat and Cool Your Home",* Chelsea Green Publishing Co., USA, 1997.

Course Code	Course Title						Course Type
OE 702 CE	**PLUMBING TECHNOLOGY**						Open elective
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:	
The course is taught with the objectives of enabling the student to:	
1.	Understand plumbing components for various systems such as water supply, waste water, high rise buildings
2.	Study various plumbing fixtures materials, tools and equipment
3.	Study the codes and standards in the building industry for plumbing

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Understand and identify the various plumbing related systems, component and types,
CO-2	Ability to understand various plumbing terminology for water supply
CO-3	Ability to understand various plumbing fixtures materials, tools and equipment.
CO-4	Understand about different pumping systems available.
CO-5	Comprehend the importance of codes, the key responsibilities of a plumbing sector and plumber

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1		1	3	-	2	2	3	-	1	1	2
CO2	2	2	1		1	3	-	2	2	3	-	1	1	2
CO3	2	1		1	1		1	1	2	2	1	2	1	2
CO4	2	1		1	1		1	1	2	2	1	2	1	2
CO5	1	1		1		2	2		1	1		2		

Correlation rating: Low/Medium/High:1/2/3 respectively.

UNIT – I

Building Plumbing - Introduction to Plumbing Systems, components of plumbing systems, and basic physics as related to plumbing. Various types of home plumbing systems for water supply and waste water disposal, high rise building plumbing, Pressure reducing valves, Break pressure tanks, Storage tanks, Building drainage for high rise buildings, various kinds of fixtures and fittings used.

UNIT – II

Plumbing Terminology: Definitions, use/purpose of Plumbing Fixtures - accessible, readily accessible, aerated fittings, AHJ, bathroom group, carrier, flood level rim, floor sink, flushometer valve, flush tanks, lavatories, macerating toilet, plumbing appliances, plumber.
Traps: indirect waste, vent, blow off, developed length, dirty arm, FOG, indirect waste, receptors, slip joints, trap, and vent.
Water supply: angle valve, anti-scald valve, backflow, bypass, check valve, cross connection, ferrule, gate valve, gray water, joints

UNIT– III

Plumbing Fixtures and Fittings: Definitions of plumbing fixtures, fittings, appliances and appurtenances; maximum flow rates, water closets, bidets, urinals, flushing devices, washbasins, bath/shower, toilets for differently abled, kitchen sinks, water coolers, drinking fountain,clotheswasher,dishwasher,mopsink,overflows,strainers,prohibitedfixtures,floor drains, floor slopes, location of valves, hot water temperature controls, installation standard dimensions in plan and elevation.

UNIT – IV

Pumping Systems : Terminology, pump heads, types of Pumps, applications, pump selection, pump characteristics, pumps and motors, pump efficiency, motor efficiency, Hydro Pneumatic Systems (HPS), Zoning, Storm Water and Drainage Pumps, introduction to starters and control panels.

UNIT – V

Codes and Standards: Scope, purpose; codes and standards in the building industry, UIPC-I, NBC and other codes, Local Municipal Laws, approvals, general regulations, standards, water supply, protection of pipes and structures, waterproofing.

Introduction to the Sector and the Job Role:

Overview of the Plumbing Sector- Importance and scope of plumbing in construction and maintenance, career opportunities in plumbing.
Understanding the Job Role of a Plumber – Duties and responsibilities of a plumber,
Skills and attributes required for a plumber.
Safety Measures and Regulations –Importance of safety in plumbing, Basic safety regulations and practices.
Tools and Equipment – Introduction to basic plumbing tools and equipment, Proper use and handling of plumbing tools.

Reference books and codes:

- Uniform Illustrated Plumbing Code-India (UIPC- I) published by IPA and IAPMO (India)
- National Building Code (NBC) of India
- IS17650 Part1 and Part2 for Water Efficient Plumbing Products
- Water Efficient Products-India (WEP-I) published by IPA and IAPMO (India)
- Water Efficiency and Sanitation Standard (WE. Stand) published by IPA and IAPMO (India)
- Water Pollution, Berry, CBS Publishers.
- 'A Guide to Good Plumbing Practices', a book published by IPA.
- Elements of Water Pollution Control Engineering, O.P.Gupta, Khanna Book Publishing, New Delhi
- Plumbing Engineering.Theory,DesignandPractice,S.M.Patil,1999
- Water supply and sewerage system– G. Birdie

Learning Website:

1. www.nptel.co.in
2. https://ndrfandcd.gov.in/Cms/NATIONA0LBUILDINGCODE.aspx

Course Code	Course Title						Course Type
OE701CS	**CLOUD COMPUTING**						Open elective
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 :	
1	To introduce basic concepts cloud computing and enabling technologies
2	To learn about Auto-Scaling, capacity planning and load balancing in cloud
3	To introduce security, privacy and compliance issues in clouds
4	To introduce cloud management standards and programming models

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the basic approaches and Core ideas of Cloud Computing.
CO-2	Understand the Challenges and approaches in the management of the Cloud environments.
CO-3	Familiarize with advanced paradigms and solutions necessary for building and managing modern Cloud environments.
CO-4	Envision use of Cloud environment in Enterprise.

UNIT– I
Introduction, Benefits and challenges, Cloud computing services, Resource Virtualization, Resource pooling sharing and provisioning.

UNIT – II
Scaling in the Cloud, Capacity Planning, Load Balancing, File System and Storage,

UNIT – III
Multi-tenant Software, Data in Cloud, Database Technology, Content Delivery Network, Security Reference Model, Security Issues, Privacy and Compliance Issues

UNIT – IV
Portability and Interoperability Issues, Cloud Management and a Programming Model Case Study, Popular Cloud Services

UNIT –V
Enterprise architecture and SOA, Enterprise Software , Enterprise Custom Applications, Workflow and Business Processes, Enterprise Analytics and Search, Enterprise Cloud Computing Ecosystem.

Suggested Reading:

1	Cloud Computing - Sandeep Bhowmik, Cambridge University Press, 2017.
2	Enterprise Cloud Computing - Technology, Architecture, Applications by Gautam Shroff, Cambridge University Press, 2016.
3	Kai Hwang, Geoffrey C.Fox, Jack J.Dongarra, ―Distributed and Cloud Computing From Parallel Processing to the Internet of Things‖, Elsevier, 2012.
4.	https://aws.amazon.com/about-aws/
5.	https://cloud.google.com/why-google-cloud?hl=en
6.	https://azure.microsoft.com/en-gb/

Course Code	Course Title						Course Type
OE702CS	DATA BASE MANAGEMENT SYSTEMS						Open elective
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 three schema architecture and DBMS functional components.
- To understand the principles of ER modeling and design.
- To learn query languages of RDBMS.
- Tofamiliarizetheoryofserializablityandimplementationofconcurrencycontrol, and recovery.
- To study different file organization and indexing techniques.

Course Outcomes:

Student will be able to:

1. Understand the mathematical foundations on which RDBMS are built.
2. Model a set of requirements using the Entity Relationship Model (ER), transform into a relational model, and refine the relational model using theory of Normalization.
3. Develop Database application using SQL and Advanced SQL.
4. Understand the working of concurrency control and recovery mechanisms in RDBMS.
5. Use the knowledge of indexing and hashing to improve database application performance.

Unit 1: Introduction to DBMS:

- **Introduction:** Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Database Design, Database Engine, Database and Application Architecture, Data Base Users and Administrators.

- **Introduction to the Relational Model:** Structure of Relational Databases, Database Schema, Keys, Schema Diagram, Relational Query Languages, The Relational Algebra

Unit 2: Data Models and Database Design:

- **Entity-Relationship (ER) Model**: The Entity-Relational Model, Complex Attributes, Mapping Cardinalities, Primary key, Removing Redundant Attribute in Entity Set, Reducing E-R diagrams to Relational Schemas, Extended E-R features, Entity-Relationship Design Issues, Alternative Notations for Modelling Data.

- **Relational Model**: Features of Good Relational Designs, Decomposition Using Functional Dependencies, Normal Forms, Functional-Dependency Theory, algorithms for Decomposition using Functional Dependencies, Decomposition Using multivalued Dependencies, Atomic Domains and First Normal Form, Database-Design process, Modelling Temporal Data

Unit 3: SQL and Querying:

- **SQL Basics**: Data definition, data manipulation, and data control languages. functions in sql (single row and multirow & conversion functions), Creating Tables, keys, integrity constraints (column level and table level)
- **Advanced SQL**: Joins, subqueries, aggregate functions, and views. Synonyms
- **Stored Procedures and Triggers**: Concepts and usage.

Unit 4: Transaction Management and Concurrency Control:

- **Transaction Concepts**: Transaction Concept, transaction states, A simple transaction Model, Implementation of Atomicity and Durability, Implementation of Isolation, Serializability (view Serializability, conflict serializability)
- **Concurrency Control**: Locking mechanisms, Lock-based protocol, Timestamp-Based Protocol, Validation Based Protocol, Multiple Granularity, deadlock handling.
- **Recovery Techniques**: Failure Classification, Storage Structure, Recovery and Atomicity, Recovery Algorithm, Buffer Management, Failure with Loss of Non-Volatile Storage, High Availability Using Remote Backup Systems, ARIES, Early Lock Release and Logical Undo Operations, Recovery in Main-memory Databases.

Unit 5: Indexing and Hashing:

Database-System Architectures: Centralized Database Systems, Server System Architectures, Parallel Systems, Distributed Systems, Transaction Processing in Parallel and Distributed Systems, Cloud-Based Services.

Introduction to Big Data: Big Data Storage Systems, The Map Reduce Paradigm, Beyond Map Reduce, Algebraic Operations, Streaming Data, Graph Databases

Reference Books:

1) Database System Concepts Seventh Edition Abraham Sliberschantz, Henry f. Korth ,S. Sudarshan, 7th Edition, 2024.
2) Rama krishnan, Gehrke, "*Database Management Systems"*, McGraw-Hill International Edition, 3rd Edition, 2003.
3) Elma sri, Nava the, Somayajulu, "*Fundamentals of Database Systems "*Pearson Education, 4th Edition, 2004.

Course Code	Course Title						Course Type
OE 701 EC	**Embedded Systems Design**						Open elective
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:	
1	Learn basics of Computer architecture, its working and types.
2	Learn basics of Embedded Systems and their applications.
3	Learn interfacing various components with Embedded Systems

Course Outcomes:	
On completion of this course, the student will be able to :	
1	Learn about the general principles of computer architecture
2	Understand the working of a simple embedded system and embedded system applications
3	Understand the hardware aspects of embedded systems
4	Understand the sensors, ADCs and actuators used in embedded systems
5	Understand the real world examples of embedded systems

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Basics of computer architecture and the binary number system:
Basics of computer architecture, computer languages, RISC and CISC architectures, number systems, number format conversions, computer arithmetic, units of memory capacity.

UNIT–II

Introduction to embedded systems:
Application domain of embedded systems, desirable features and general characteristics of embedded systems, model of an embedded system, microprocessor Vs microcontroller, example of a simple embedded system, figure of merit for an embedded system, classification of MCUs: 4/8/16/32 bits, history of embedded systems, current trends.

UNIT–III
Embedded systems-The hardware point of view: Microcontroller unit(MCU), a popular 8-bit MCU, memory for embedded systems, low power design, pull up and pull down resistors

UNIT-IV
Sensors, ADCs and Actuators: Sensors: Temperature Sensor, Light Sensor, Proximity/range Sensor; Analog to digital converters: ADC Interfacing; Actuators Displays, Motors, Opto couplers/Opto isolators, relays.

UNIT – V
Examples of embedded systems: Mobile phone, automotive electronics, radio frequency identification (RFID), wireless sensor networks (WISENET), robotics, biomedical applications, brain machine interface.

Suggested Reading:

1	Lyla B Das, Embedded systems: An Integrated Approach, 1st Ed., Pearson, 2013
2	Raj Kamal, Embedded Systems – Architecture, Programming and Design, 2nd Edition, TMH, 2008
3	Shibu, K.V., Introduction to Embedded Systems, 1st Ed., TMH, 2009
4	Kanta Rao B, Embedded Systems, 1st Ed., PHI
5	Frank Vahid & Tony Givargis, Embedded System Design, 2nd Edition, John Wiley.

Course Code	Course Title						Course Type
OE 702 EC	BASICS OF IOT						Open elective
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 :	
The course is taught with the objectives of enabling the student to:	
1	To understand the concepts of the Internet of Things and be able to build IoT applications
2	To learn the programming and use of Arduino and Raspberry Pi boards Design And detail the deep beams.
3	To study about various IoT case studies and industrial applications.

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Known basic protocols in sensor networks.
CO-2	To Know the Architecture and Protocols of IoT.
CO-3	Python programming and interfacing for Raspberry Pi.
CO-4	Interfacing sensors and actuators with different IoT architectures.
CO-5	Compare IOT Applications in Industrial &real world

Course outcome	PO-1	PO-2	PO-3	PO-4	PO-5
CO-1	2	1	2	2	2
CO-2	2	3	3	2	1
CO-3	3	2	3	3	2
CO-4	3	2	2	2	1
CO-5	3	2	3	3	3

UNIT–I

Introduction to the Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols.

UNIT– II

IoT Architecture: Physical and Logical design of IoT, IoT frameworks, IoT Protocols – MQTT, COAP, 6LOWPAN.

UNIT - III
Introduction to Python programming, Introduction to Raspberry Pi, Interfacing Raspberry Pi with basic peripherals, Implementation of IoT with Raspberry Pi.

UNIT– IV
IoT applications in home, Infrastructures, Buildings, Security, Industries, Home appliances, other IoT electronic equipments.

UNIT–V
Prototyping and Programming for IoT: Sensors, Actuators, Micro Controllers, SoC, Choosing a platform, prototyping hardware platforms- Arduino, Raspberry Pi, Prototype in Physical design- Laser Cutting, 3D-Printing, CNC milling, techniques for writing Embedded

Suggested Reading:

1	Raj Kamal, "Internet of Things – Architecture and Design Principles", McGraw Hill Education Pvt. Ltd., 2017
2	"Makesensors":Terokarvinen,kemo,karvinenandvilleyvaltokari,1stedition,maker media, 2014.
3	IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017
4	Internet of Things – A hands-on approach, Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015
5	Rao, M. (2018). Internet of Things with Raspbery Pi 3: Leverage the power of Raspberry Pi 3 and JavaScript to build exciting IoT projects. Packt Publishing Ltd
6	Internet of Things and Data Analytics, Hwaiyu Geng, P.E, Wiley Publications, 2017

Course Code	Course Title						Course Type
OE 702 EE	NON-CONVENTIONAL ENERGY SOURCES						Open elective
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:	
The course is taught with the objectives of enabling the student to:	
1	To understand the different types of energy sources.
2	To understand the need of non-conventional energy sources and their principles.
3	To understand the limitations of non-conventional energy sources.
4	To outline division aspects and utilization of renewable energy sources for diriment application.
5	To analyze the environmental aspects of renewable energy resources.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Know the different energy resources and need of renewable energy resources.
CO-2	Understand the concepts of working of fuel cell systems along with their applications.
CO-3	Describe the use of solar energy and the various components and measuring devices used in the energy production and their applications.
CO-4	Appreciate the need of Wind Energy and their classification and various components used in energy generation and working of different electrical wind energy system.
CO-5	Understand the concept of OTEC technology, Biomass energy resources and different types of biogas Plants used in India.

Course Articulation Matrix:

CO	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	-	2	-	-	-	-	1	3	2
CO2	3	3	-	-	2	-	2	-	-	-	-	1	2	2
CO3	3	3	-	2	3	-	2	-	-	-	-	2	3	3
CO4	3	2	-	2	2	-	3	-	-	-	-	2	3	3
CO5	2	2	-	-	2	-	3	-	-	-	-	2	2	3

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I
Review of Conventional and Non-Conventional energy sources, Need for non-conventional energy sources Types of Non-conventional energy sources, Fuel Cells, Principle of operation with special reference to H2O2 Cell, Classification and Block diagram of fuel cell systems, Ion exchange

membrane cell, Molten carbonate cells, Solid oxide electrolyte cells, Regenerative system, Regenerative Fuel Cell, Advantages and disadvantages of Fuel Cells, Polarization, Conversion efficiency and Applications of Fuel Cells.

UNIT–II

Solar energy, Solar radiation and its measurements, Solar Energy collectors, Solar Energy storage systems, Solar Pond, Application of Solar Pond, Applications of solar energy.

UNIT–III

Wind energy, Principles of wind energy conversion systems, Nature of wind, Power in the Wind, Basic components of WECS, Classification of WECS, Site selection considerations, Advantages and disadvantages of WECS, Wind energy collectors, Wind electric generating and control systems, Applications of Wind energy, Environmental aspects.

UNIT–IV

Energy from the Oceans, Ocean Thermal Electric Conversion (OTEC) methods, Principles of tidal power generation, Advantages and limitations of tidal power generation, Ocean waves, Wave energy conversion devices, Advantages and disadvantages of wave energy, Geo- thermal Energy, Types of Geo-thermal Energy Systems, Applications of Geo-thermal Energy.

UNIT–V

Energy from Biomass, Biomass conversion technologies / processes, Photosynthesis, Photosynthetic efficiency, Biogas generation, Selection of site for Biogas plant, Classification of Biogas plants, Details of commonly used Biogas plants in India, Advantages and disadvantages of Biogas generation, Thermal gasification of biomass, Biomass gasifies.

Suggested Reading:

1	Rai G.D, Non-Conventional Sources of Energy, Khandala Publishers, New Delhi, 1999.
2	M.M.El-Wakil, Power Plant Technology. McGraw Hill, 1984.

Course Code	Course Title						Course Type
OE701ME	NANO TECHNOLOGY						Open elective
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 Nano materials and technology.
- To understand Nano structures, fabrication and special Nano materials.

Course Outcomes:

UNIT-I

Introduction: Nanoscale, Properties at Nanoscale, advantages and disadvantages, importance of Nano Technology, Bottom-up and Top-down approaches, challenges in Nano Technology.

UNIT-II

Materials of Nano Technology: Introduction-Si-based materials, Ge-based materials, Smart materials, metals, Ferroelectric materials, Polymer materials, GaAs & InP (III-V) group materials, Nano tribology and Materials, Principles and analytical techniques of XRD, SEM, TEM and STM/AFM.

UNIT-III

Nano Structures: Zero dimensional Nano structure (Nano Particles)- Synthesis procedure, characterization techniques, properties and applications of Nano Particles One dimensional Nano structures (Nano Wires, Nano Tubes)- Various Synthesis procedure, characterization procedure and principles involved, properties and applications of Nano Wires, Types of Nano Tubes, Synthesis procedure, characterization properties and applications of Nano Tubes.

UNIT-IV

Nano Fabrication: Introduction, Basic fabrication techniques (Lithography, thin film deposition, and doping) MEMS fabrication techniques, Nano fabrication techniques (E-beam Nano-imprint fabrication, Epitaxy and strain engineering, Scanned probe techniques).

UNIT-V

Special Nano Materials: Nano Composites: Introduction, Synthesis procedures, various systems (metal-polymer, metal- ceramics and polymer-Ceramics), Characterization procedures, applications. Nano Biomaterials: Introduction, Biocompatibility, anti-bacterial activity, principles involved, applications.

Suggested Reading:

1. A.K.Bandyopadyay, Nano Materials, New Age Publications, 2007.
2. T. Pradeep, Nano: The Essentials: Understanding Nanoscience and Nanotechnolgy, Tata McGraw-Hill, 2008.
3. Carl. C. Koch, Nano Materials Synthesis, Properties and Applications, Jaico Publishing House,2008.
4. Willia Illsey Atkinson, NanoTechnology, Jaico Publishing House, 2009.

Course Code	Course Title						Course Type
OE702ME	START UP ENTREPRENEURSHIP						Open elective
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 motivate students to take up entrepreneurship in future
- To learn nuances of starting an enterprise & project management
- To understand the behavioural aspects of entrepreneurs and time management

Course Outcomes: Student will

1. Understand the behavioural aspects of entrepreneurs and time management
2. Creative thinking and transform ideas into reality
3. Importance of innovation in new business opportunities
4. Create a complete business plan and workout the budget plan.
5. write a project proposal with budget statement

UNIT I

Creativity & Discovery: Definition of Creativity, self-test creativity, discovery and delivery skills, The imagination threshold, Building creativity ladder, Collection of wild ideas, Bench marking the ideas, Innovative to borrow or adopt, choosing the best of many ideas, management of trade-off between discovery and delivery, Sharpening observation skills, reinventing self, Inspire and aspire through success stories

UNIT II

From Idea to Start up: Introduction to think ahead backward, Validation of ideas using cost and strategy, visualizing the business through value profile, activity mapping, Risks as opportunities, building your own road map

UNIT III

Innovation career lessons: Growing & Sharing Knowledge, The Role of Failure In Achieving Success, Creating vision, Strategy, Action & Resistance: Differentiated Market Transforming Strategy; Dare to Take Action; Fighting Resistance; All About the start up Ecosystem; Building a Team; Keeping it Simple and Working
Hard.

UNIT IV

Action driven business plan: Creating a completed non-business plan (a series of actions each of which moves your idea toward implementation), including a list of the activities to be undertaken, with degrees of importance (scale of 1 to 3, where 1 is 'most important'). A revision of the original product or service idea, in light of information gathered in the process, beginning to design the business or organization that will successfully implement your creative idea. Preparing an activity map.

UNIT V

Start up financing cycle: Preparing an initial cash flow statement, showing money flowing out (operations; capital) and flowing in. Estimate your capital needs realistically. Prepare a bootstrapping option (self-financing). Prepare a risk map. Prepare a business plan comprising five sections: The Need; The Product; Unique Features; The Market; Future Developments. Include a Gantt chart (project plan – detailed activities and starting and ending dates); and a project budget.

Suggested Readings:

1. Vasant Desai, "Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 1997.
2. Prasanna Chandra, "Project – Planning, Analysis, Selection, Implementation and Review", Tata Mc Graw-Hill Publishing Company Ltd., 1995.
3. B. Badhai, "Entrepreneurship for Engineers", Dhanpath Rai & Co., Delhi, 2001.
4. Stephen R. Covey and A. Roger Merrill, "First Things First", Simon and Schuster, 2002.
5. Robert D. Hisrich and Michael P.Peters, " Entrepreneurship", Tata McGRaw Hill Edition, 2002.

Course Code	Course Title							Course Type
PC 651 BM	BASIC CLINICAL SCIENCES -I LAB							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	-	-	-	2	2	25	50	1

COURSEOBJECTIVES:

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

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

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

PARTI-NEPHROLOGY

Demonstration/Practicals

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

PARTII-NEUROLOGY

Demonstration/Practicals

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

Course Code	Course Title							Course Type
PC 652 BM	BASIC CLINICAL SCIENCES –II LAB							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	-	-	-	2	2	25	50	1

COURSE OBJECTIVES:

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

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

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

PARTI-GASTROENTEROLOGY

Demonstration/Practicals

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

PARTII-GENERAL SURGERY

Demonstration/Practicals

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

Course Code	Course Title							Course Type
PC 653 BM	BASIC CLINICAL SCIENCES -III LAB							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	-	-	-	2	2	25	50	1

COURSE OBJECTIVES:

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

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

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

PARTI-IMAGINGSCIENCE&RADIO THERAPY

Demonstration/Practicals

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

PARTII-ANAESTHESIA

Demonstration/Practicals

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

Course Code	Course Title							Course Type
PC 654 BM	BASIC CLINICAL SCIENCES –IV LAB							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	-	-	-	2	2	25	50	1

COURSE OBJECTIVES:

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

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

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

PARTI-CARDIOLOGY

Demonstration/Practicals

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

PARTII-ORTHOPAEDICS

Demonstration/Practicals

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

Course Code	Course Title						Course Type
PW 761 BM	PROJECT WORK - I						core
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	-	-	6	-	50	-	3

Course Objectives:

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic Literature survey and documentation.
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas.

Course Outcomes: After completion of this course, the students shall be able to:

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems.
2. Evaluate different solutions based on economic and technical feasibility.
3. Effectively plan a project and confidently perform all aspects of project management.
4. Demonstrate effective written and oral communication skills.

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

The department will appoint a project coordinator who will coordinate the following:

1. Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
2. Grouping of students (max 3 in a group) Allotment of project guides

The aim of project work is to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. After multiple interactions with guide and based on comprehensive literature survey, the student shall identify the domain and define dissertation objectives. The referred literature should preferably include IEEE/IET/IETE/Springer/Science Direct/ACM journals in the areas of Biomedical Instrumentation, Computing and Processing (Hardware and Software), Circuits-Devices and Systems, Robotics and Control Systems, Signal and Image Processing and Analysis and any other related domain. In case of industry-sponsored projects, the relevant application notes, product catalogues should be referred and reported. Each group has to formalize the project proposal based on their own ideas or as suggested by the project guide.

The coordinator will prepare seminar schedule for all the students from the 5^{th}week to the last week of the semester, which should be strictly adhered.

The seminar presentation should include the following components of the project:

- 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
PW 762 BM	SUMMER INTERNSHIP							Core
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	D	P		CIE	SEE	
	4	-	-	-	3	50	-	2

COURSE OBJECTIVES:

- To enhance practical and professional skills of the students
- To expose the students to hospital/ medical industry practices and team work
- To provide training to the students in soft skills, presentation skills and technical report writing

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

1. Acquire practical knowledge and skills required in a hospital/medical industry.
2. Realize the industry work culture and environment.
3. Prepare and present technical report

Guidelines:

Summer Internship is introduced as part of the curriculum for encouraging students to work on problems of interest to medical professionals. This will be for 6-8 weeks during the summer vacation following the completion of the VI semester. Students may be divided into batches of 3 students. Apart from being exposed to the practical aspects, the students may also work on a specified task or project assigned to them. The work progress will be monitored by one faculty coordinator and one coordinator from hospital/industry.

After the completion of the internship, students will submit a brief technical report the outcome of the internship and present the work through a seminar in the Department during the VII semester. The evaluation and award of credits based on the performance of the students is done by a committee constituted by the Head of the department.

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

SEMESTER - VIII

Syllabus with effect from AY 2025-26

S.No	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	MC 801CE	Mandatory Course-I (Environmental Science)	3	-	-	3	3	40	60	NC
2	MC 80X XX	Mandatory Course-II	3	-	-	3	3	40	60	NC
3	MC 80X XX	Mandatory Course-III	3	-	-	3	3	40	60	NC
Practicals										
4	PW 861 EE	Project Work -II	-	-	12	12	-	50	100	6
		Total	**9**	-	**12**	**21**	**9**	**170**	**280**	**6**

Mandatory Course

S.No.	Code		Course Title
1	MC801CE	**Mandatory Course-I**	Environmental Science
2	MC802HS	**Mandatory Course-II & Mandatory Course-III** (Any 2 courses from the list)	Intellectual Property Rights
3	MC803HS		English for Technical Paper Writing
4	MC804HS		Constitution of India
5	MC805HS		Essence of Indian Traditional Knowledge
6	MC806HS		Stress Management by Yoga
7	MC807HS		Sports

Course Code	Course Title						Course Type
MC-I MC801CE	**ENVIRONMENTAL SCIENCE**						Mandatory course
Prerequisite	**Contact hours per week**			**Duration of SEE (Hours)**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**NC**

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	Comprehend the need of environmental science, ethics and issues
2	Realize the availability and utilization of various natural resources
3	Illustrate the characteristics and functions of Ecosystem
4	Study various environmental pollution effects, prevention and control acts
5	Understand the concepts of Biodiversity and its conservation needs

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Application and awareness of various environmental issues for sustainable society
CO-2	Acquaintance with utilization of various natural resources
CO-3	Capacity to understand and practice for sustainability of ecosystem.
CO-4	Knowledge of social and environment related issues and their preventive measures
CO-5	Ability in conserving and protecting the biodiversity

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	3	2		2		1	3	1	2	1		3	1	2
CO2	3	2		2		1	3	2	1	1		3	1	2
CO3	3	2		2		1	3	1	1	1		1	1	1
CO4	3	2		2		1	3	1	1	1		3	1	1
CO5	3	2		2		1	3	1	1	1		1	1	1

Correlation rating: Low/ Medium/High: 1/2/3 respectively.

UNIT-I

Multidisciplinary nature of Environmental studies:

Definition, scope and importance, Need for public awareness, Environmental ethics: issues and possible solutions, Global Warming and Climate change, Acid rain, Ozone layer depletion. Environment and human health, Population growth, Sustainable development and SDGs

UNIT-II

Natural Resources:

Types of Natural Resources, Role of individual in conservation of natural resources, Equitable use of resources for sustainable life styles, Natural resources and associated problems.

Land Resources: Land as a resource, land degradation, soil erosion and desertification.

Forest resources: Use and Overexploitation, Deforestation, Timber Extraction, Mining, Dams, and their Effects on Forests and Tribal People

Water resources: Water Resources: Use and Overutilization of Surface and Ground Water, Floods, Drought, Conflicts over Water, Dams – Benefits and problems

Mineral Resources: Use and Exploitation, Environmental Effects of Extracting and using Mineral Resources

Food Resources: World Food Problems, Changes Caused by Agriculture and Overgrazing, Effects of Modern Agriculture, Fertilizer-Pesticide Problems, Water Logging, Salinity, Energy Resources.

UNIT-III

Ecosystems:

Concept of an Ecosystem, Types, Structure and function of an ecosystem, Producers, consumers, decomposers. Energy flow in the ecosystems, Ecological succession, Food chains, food webs and ecological pyramids.

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

UNIT-IV

Environmental Pollution:

Definition, Causes, effects and control measures - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards,

Environmental Protection: Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act, Wildlife conservation and protection act, Forest conservation and protection act, Role of an individual's, communities and NGOs in prevention of pollution

Solid waste Management: Causes, effects and control measures of urban and industrial wastes

UNIT-V

Biodiversity and its Conservation:

Definition: genetics, species and ecosystem diversity, Spatial Patterns of Species Richness, Shannon's, Simpson's Diversity Index. Bio-geographically classification of India. Value of biodiversity - consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, national and local level. India as a mega diversity nation. Hot-spots of biodiversity,

Threats to biodiversity: habitats loss, poaching of wild life, man wildlife conflicts. Endangered and endemic spaces of India.

Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity, Biological Diversity Act, 2002.

Suggested Reading:

1.	Erach Bharucha., Textbook of Environmental Studies, UGC, New Delhi and Bharathi Vidyapeeth Institute of Environment Education and Research, Pune.
2.	Mahua Basu and Xavier Savarimuthu SJ., Fundamentals of Environmental Studies,Cambridge University Press, New Delhi, 2017**.**
3.	Mishra D D., Fundamental Concepts in Environmental Studies, S Chand & Co Ltd., New Delhi, 2010.
4.	Botkin and Keller., Environmental Science, Wiley India Pvt., Ltd., New Delhi, 2012.
5.	Gilbert, M. Masters., Introduction to Environmental Engineering and Science, Prentice- Hall of India Pvt., Ltd., New Delhi, 1995.
6.	Sasi Kumar, K. and Sanoop Gopi Krishna., Solid waste Management, Prentice-Hall of India Pvt., Ltd., New Delhi, 2009.
7.	Daniel D. Chiras, Environmental Science, Jones & Bartlett Learning Publishers Inc, Burlington, MA, 2014.

Course Code	Course Title					Course Type
MC802HS	**INTELLECTUAL PROPERTY RIGHTS**					Mandatory course
Prerequisite	**Contact hours per week**			**Duration of SEE (Hours)**	**Scheme of Evaluation**	**Credits**
	L	**T**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**NC**

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Acquaint the students with basics of intellectual property rights with special reference to Indian Laws and its practices.
2	Compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.
3	Provide an overview of the statutory, procedural, and case law underlining these processes and their interplay with litigation.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the concept of intellectual property rights.
CO-2	Develop proficiency in trademarks and acquisition of trade mark rights.
CO-3	Understand the skill of acquiring the copy rights, ownership rights and transfer.
CO-4	Able to protect trade secrets, liability for misappropriations of trade secrets.
CO-5	Apply the patents and demonstration of case studies.

Course Articulation Matrix:

Course outcome	Program Outcome					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1						
CO-2						
CO-3						
CO-4						
CO-5						

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

UNIT – II
Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

UNIT – III
Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer**.**

UNIT – IV
Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation. Unfair competition: Misappropriation right of publicity, false advertising.

UNIT –V
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Suggested Reading:

1	Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
2	“Mayall, “Industrial Design”, McGraw Hill,1992
3	“Niebel, “Product Design”, McGraw Hill,1974.
4	“Asimov, “Introduction to Design”, Prentice Hall,1962.
5	“Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”,2016.
6	T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand,2008

Course Code	Course Title						Course Type
MC 803 HS	**ENGLISH FOR TECHNICAL PAPER WRITING**						Mandatory course
Prerequisite	**Contact hours per week**			**Duration of SEE (Hours)**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**NC**

Course Objectives:	
1	Understand that how to improve your writing skills and level of readability. Learn about what to write in each section.
2	Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission.

Course Outcomes:	
1.	Able to plan and prepare paragraphs, avoiding ambiguity and grammatical errors
2.	Writing of abstracts, paraphrasing and plagiarism
3.	Providing critical and thorough review of literature, discussions and conclusions
4.	Able to exhibit key skills for writing titles, introduction, abstract.
5.	Able to show key and necessary skills for paper writing, phrases, results.

UNIT-I

Root Words, Synonyms and Antonyms, One word substitutes, importance of Punctuation, Sentence Structure, Subject Verb Agreement, Noun Pronoun Agreement, Redundancy, Cliche

UNIT-II

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness ,

UNIT-III

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT-IV

Describing, Defining, Classifying, Providing examples or evidence, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check,

UNIT-V

Key skills are needed when writing a Title, Abstract, Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions -Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Suggested Reading:

1. Norman Lewis, Word Power Made Easy, Anchor Books, New York, Reprint Edition, 2014.
2. C.R. Kothari and Gaurav Garg, Research Methodology: Methods and Techniques, 4th Edition, New Age International Publishers, New Delhi, 2019.
3. P.C. Wren and H. Martin, A Comprehensive Grammar of the English Language, Revised and Updated by N.D.V. Prasada Rao, S. Chand Publishing, New Delhi, Latest Edition.
4. Goldbort R, Writing for Science, Yale University Press (available on Google Books), 2006.
5. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006.
6. Highman N Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book. 1998
7. Adrian Wallwork English for Writing Research Papers, Springer New York Dordrecht Heidelberg London. 2011.

Course Code	Course Title						Course Type
MC804HS	**CONSTITUTION OF INDIA**						**Mandatory course**
Prerequisite	**Contact hours per week**			**Duration of SEE (Hours)**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**NC**

Course Objectives:

	Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective
	To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role
	Entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.

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

	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru
	The eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
	Discuss the passage of the Hindu Code Bill of 1956.

Course Articulation Matrix:

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features.
UNIT – II
Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT – III
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications. Powers and Functions.
UNIT – IV
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Panchayat raj: Introduction, PRI: Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.
UNIT – V
Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

References:

1	*"The Constitution of India",* 1950 (Bare Act), Government Publication.
2	Dr. S. N. Busi, *"Dr. B. R. Ambedkar framing of Indian Constitution",* 1st Edition, 2015.
3	M. P. Jain, "*Indian Constitution Law",* 7th Edn., Lexis Nexis, 2014.
4	D.D. Basu, *"Introduction to the Constitution of India",* Lexis Nexis, 2015.

Course Code	Course Title						Course Type
MC 805HS	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE						Mandatory course
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	NC

Course Objectives:

The course aims at enabling the students to

1. Comprehend the Basic fundamental aspects of Society, Culture and Heritage.
2. Understand the significant aspects of Traditional Hindu Social Organization and vedic literature both at individual level and societal level.
3. Inculcate a philosophical insight through shad darshanas and a spiritual outlook through Yoga Sutras.
4. Realize the significance and the utilitarian aspect of the traditional knowledge system through case studies.
5. Appreciate the significance and necessity for the preservation of traditional knowledge system.

Course Outcomes: Student will be able to

1. Know the fundamental concepts of Society with regard to values, norms, cultural and nature of Indian culture.
2. Understand the connect between the vedic literature and the traditional structural organization guiding at the various phases of life of an individual.
3. Recognize the importance of Darshanas and significance of Yoga sutra in building up a holistic life perspective.
4. To inculcate a pursuit of looking deeper into IKS for addressing the multi faceted contemporary issues both at local and global platform.
5. Analyze the significance and the measures for the preservation of Traditional Knowledge System.

UNIT - I

Fundamental Concepts : Society, Definition and its Characteristics; Values- Norms, Role-Status, Order and Stability, Habits, Custom; Understanding difference between Belief and Ritual, Tradition and Heritage; Culture : Definition and its Characteristics; Characteristics of Indian Culture; Concept of Unity in Diversity;.

UNIT - II

Indian Traditional System: Traditional Hindu Organization: Purusharthas, Varna Dharma and Ashrama Dharma. Indian Traditional Scriptures and their Classification; General Understanding of Vedas : Rig veda, Sama veda, Yajur Veda, and Atharva veda, Upanishads; Smritis : Itihasa, Puranas, Agamas, Upvedas, and Vedangas.

UNIT - III

Traditional Philosophies / School of thoughts: Darshanas : philosophies of 6 Schools : Nyaya, Vaisheshika, Samkhya, Yoga, Mimamsa and Vedanta; Nastika School of Philosophy : Charvaka, Jainism and Bhuddhism; Yoga and Spirituality.

UNIT - IV

Traditional Knowledge System : Definition of Traditional knowledge, Indigenous Knowledge

System; Case studies of Ancient traditional Knowledge System Astronomy,Vastu-Shatras, Wootz Steel lost technology of IKS, Water Management, and Agriculture.

UNIT - V

Protection of Traditional Knowledge - Significance and Need of Protection of Traditional Knowledge ; and measure for protection of TK, Role of the Government to harness TK. Documentation and Preservation of IKS , Approaches for conservation and Management of nature and bio-resources, Approaches and strategies to protection and conservation of IKS.

Suggested Books for Reference:

1. V. Sivaramnkrishna (Ed.). Cultural Heritage of Lndia-Course Material, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014
2. Swami Jirntmanand. Modern Physics and Vedant, Bharati yaV idya Bhavan
3. Fritzof Capra. Tao of Physics
4. Fritzof Capra, The wave of Life
5. V N Jba (Eng. Trans.). Tarkasangraha of Annam Bhana, lnernational Chinmay Foundation, Velliamad. Amaku.am
6. Yoga Sutra of Patanjali, Ramakrishna Mission. Kolkatta
7. GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya. Vidyanidhi Prakasham, Delhi, 2016
8. RN Jha. Science of Consciousness Psychotherapy and Yoga Practices. Vidya nidhi Prakasham, Delhi. 2016
9. P R Sha.min (English translation). Shodashang Hridayam

Course Code	Course Title						Course Type
MC 806HS	STRESS MANAGEMENT BY YOGA						Mandatory course
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	NC

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Creating awareness about different types of stress and the role of yoga in the management of stress.
2	Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
3	Prevention of stress related health problems by yoga practice.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	To understand yoga and its benefits.
CO-2	Enhance Physical strength and flexibility.
CO-3	Learn to relax and focus.
CO-4	Relieve physical and mental tension through Asanas
CO-5	Improve work performance and efficiency.

Course Articulation Matrix:

Course outcome	Program Outcome					
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	-	-	-	-	
CO-2	-	-	-	-	-	1
CO-3	-	-	-	1	-	1
CO-4	-	-	-	-	1	1
CO-5	-	-	-	-	1	1

UNIT – I
Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

UNIT – II

Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT – III
Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

UNIT – IV
Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.

UNIT – V
Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama – Kapalabhati-Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.
Meditation techniques: Om Meditation - Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT).

Suggested Reading:

1	"Yogic Asanas for Group Training - Part-I": Janardhan Swami Yogabhyasi Mandal, Nagpur
2	"Rajayoga or Conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
3	Nagendra H.R nad Nagaratna R, "Yoga Perspective in Stress Management", Bangalore, Swami Vivekananda Yoga Prakashan

Web resource:

1	https://onlinecourses.nptel.ac.in/noc16_ge04/preview
2	https://freevideolectures.com/course/3539/indian-philosophy/11

Course Code	Course Title						Course Type
MC 807 HS	SPORTS						Mandatory course
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	NC

Course Objectives:

1. To develop an understanding of the importance of sport in the pursuit of a healthy and active lifestyle at the College and beyond.
2. To develop an appreciation of the concepts of fair play, honest competition and good sportsmanship.
3. To develop leadership skills and foster qualities of co-operation, tolerance, consideration, trust and responsibility when faced with group and team problem-solving tasks.
4. To develop the capacity to maintain interest in a sport or sports and to persevere in order to achieve success.
5. To prepare each student to be able to participate fully in the competitive, recreational and leisure opportunities offered outside the school environment.

Course Outcomes:

- Students' sports activities are an essential aspect of university education, one of the most efficient means to develop one's character and personal qualities, promote the fair game principles, and form an active life position.
- Over the past year, sports have become much more popular among our students. Let us remember the most memorable events related to sports and physical training.
- Special attention was paid to team sports. Our male and female games and sports have achieved remarkable progress at a number of competitions.
- Our teams in the main sports took part in regional and national competitions. Special thanks to our team in track and field athletics, which has been revitalized this year at ICT and which has won Javelin competition.
- Staff of our faculties and students of Sports, Physical Development, & Healthy Lifestyle of Faculty congratulates everyone on the upcoming New Year and wishes you robust health and new victories in whatever you conceive.

I. Requirements:

i) Track Paint (students should bring)
ii) Shoes
iii) Volley Ball, Foot Ball and Badminton (Shuttle)
iv) Ground, Court, indoor stadium and swimming pool

II. Evaluation Process:

Total Marks 50

i) 20 marks for internal exam (continuous evaluation)
   a) 8 marks for viva
   b) 12 marks for sports & fitness

ii) 30 marks for end exam
   a) 10 marks for viva
   b) 20 marks for sports & fitness

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Course Code	Course Title						Course Type
PW 861 BM	PROJECT WORK - II						Mandatory course
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	-	-	12	-	50	100	6

Course Objectives

- To enhance practical and professional skills
- To familiarize tools and techniques of systematic Literature survey and documentation.
- To expose the students to industry practices and teamwork.
- To encourage students to work with innovative and entrepreneurial ideas.

Course Outcomes: After completion of this course, the students shall be able to:

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems.
2. Evaluate different solutions based on economic and technical feasibility.
3. Effectively plan a project and confidently perform all aspects of project management.
4. Demonstrate effective written and oral communication skills.

The aim of project stage –II is to implement and evaluate the proposal made as part of project stage - II. Students can also be encouraged to do full time industrial internship as part of project stage -II based on the common guidelines for all the departments. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction.

The department will appoint a project coordinator who will coordinate the following:

1. Re-grouping of students - deletion of internship candidates from groups made as part of project work-I
2. Re-Allotment of internship students to project guides Project monitoring at regular intervals

All re-grouping/re-allotment has to be completed by the 1nd week of VIII-Semester so that students get sufficient time for completion of the project.

All projects (internship and departmental) will be monitored at least twice in a semester through student presentation for the award of sessional marks. Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for 25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction. Common norms will be established for the final documentation of the project report by the respective departments. The students are required to submit draft copies of their project report within one week after completion of instruction.