Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Biomedical Engineering

(Applicable from the academic session 2018-2019)

SEMESTER-V

Name of the Course	**THERAPEUTIC EQUIPMENTS & ASSISTIVEE DEVICES**
Course Code: PC-BME501	**Semester: Fifth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**
Objectives:	
1	To enable the students to gain knowledge on the working and safety standards of therapeutic clinical equipment.
2	To learn the principles of cardiac assist devices and equipment for neonatal care unit.
3	To develop clear understanding of the physiotherapy and diathermy equipment and their operation.
4	To understand the need and use of lasers in medicine and drug delivery system.
Pre-Requisite: Engineering Physiology & Anatomy (PCBME302), Biophysics & Biochemistry (PCBME303), Biomedical Instrumentation (PCBME402)	

M#	Content	Hrs
1	**Cardiac Pacemakers & Defibrillators:** Effects of electric field on cardiac muscles and laws of stimulation, need for pacemaker, external pacemakers, implantable pacemakers and types, codes for pacemakers, pulse generator and power sources, electrodes and leads system, pacing system analyzers, programmable pacemakers, rate-responsive and ventricular synchronous pacemakers, microprocessor based modern pacemakers, need for defibrillators, DC defibrillator, synchronous operation, implantable defibrillators, defibrillator analyzers and safety.	11
2	**Ventilators & Anaesthetic System:** Artificial ventilations, ventilators and types, terminology of ventilators, classification of ventilators and modern ventilators, need for anaesthesia, anaesthesia gases and vapors, anaesthesia delivery system, humidifiers, nebulizers and aspirators.	6
3	**Physiotherapy & Electrotherapy Equipment:** IR diathermy, UV diathermy, short wave diathermy, microwave diathermy, ultrasonic diathermy, electrotherapy and different waveforms, electrode system, electrical stimulators and types, nerve-muscle stimulators, ultrasonic stimulators, pain relief through electrical stimulators, hazards and safety procedure.	8
4	**Surgical Diathermy & LASER:** Principles and applications of surgical diathermy, electrosurgery machine, electrosurgery circuits, different electrodes, electrosurgery techniques, solid state electrosurgery, generator circuits, testing of electrosurgery units, electrosurgery safety, basic principle of ultrasonic lithotripter and extracorporeal shock wave lithotripter, principles of cryogenic technique and applications, principle of operation of LASER, laser tissue interactions, various application of CO_2, Ar, He-Ne, Nd-YAG and pulsed ruby LASER, application of LASER in surgery, laser safety procedure.	11
5	**Neonatal Care & Drug Delivery Systems:** Baby incubator, radiant warmer and phototherapy unit, suction apparatus, infusion pumps, syringe pumps, peristaltic pumps, implantable infusion pumps, programmable volumetric pumps, automated drug delivery system.	4

COURSE OUTCOMES

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

1. Demonstrate the working of therapeutic equipment and assistive devices.
2. Classify and recommend suitable therapeutic devices for specific applications.
3. Analyze differenttypesoftherapeutic devicesincludingpediatric applicationsandsupport.
4. Justifythe application oflasersand laser in surgery.
5. Outline the potential electrical hazards for therapeutic equipment and evaluate the patient safety.
6. Plan and contribute in design, development and effective usage of therapeutic equipment and assistive devices.

Text/Reference Books:

1. R.S.Khandpur"HandbookofBio-MedicalInstrumentation",2nd Edition,TMH.
2. J.J.Carr&J.M.Brown,"IntroductiontoBiomedicalEquipmentTechnology"PearsonEducation,Asia.
3. J.Webster, "Bioinstrumentation", Wiley &Sons
4. JosephBronzino,"BiomedicalEngineering&Instrumentation"PWSEngg.Boston.
5. Willard Van Nostrand, ".Instrumental Methods ofAnalysis"-
6. Sharms, "Instrumental Methods", S Chand &Co.
7. HarryBronzinoE,"HandbookofBiomedicalEngineeringandMeasurements",Reston, Virginia.
8. Jacobson &Websler, " Medicine & ClinicalEngg"
9. Leslie Cromwell, " Biomedical Instrumentation andMeasurements"

Name of the Course	**MEDICAL IMAGING TECHNIQUES**
Course Code: PC-BME502	**Semester: Fifth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**

Objectives:	
1	To expose the student on different medical imaging techniques for diagnosis of internal organs and structures.
2	To understandthephysicsand principles of underlying operation ofdifferentmedicalimaging equipment.
3	To gain knowledge on radiographic and ultrasonographic medical imaging system.
4	To learn the preferred medical imaging methods and safety considerations for routine clinical applications.

Pre-Requisite: Engineering Physiology & Anatomy (PCBME302), Biophysics & Biochemistry (PCBME303), Biomedical Instrumentation (PCBME402)

M#	**Content**	**Hrs**
1	**X-ray Machine*:*** Physics and production of X-rays, soft X-rays and hard X-rays, X-ray equipment-block diagram, X-ray tube and tube enclosure, stationary and rotating anode tube, stator-rotor assembly, rating charts of X-ray tubes, causes of X-ray tube failure, conventional electrical circuit of X-ray machine, power supply-high voltage generation, high frequency generator X-ray machine, control circuits-high voltage control, filament control and tube current, exposure timing, automatic exposure control, collimators and Bucky grids, mammographic and dental X-ray machines, portable and mobile X-ray units.	12
2	**X-ray Image & Radiotherapy:** X-ray screen-film system, film sensitometry, radiographic film image formation, dark room accessories-developer and fixer, image quality factors, MTF, X-ray image intensifier, digital radiography, flat panel detector,detector quantum efficiency, radiation doses, dose equivalent and REM, radiation protection and radiation measuring instruments, radiotherapy principles and types, external beam radiotherapy, dose measurement and treatment planning.	9
3	**Fluoroscopy & Angiography:** Fluoroscopic imaging system, digital fluoroscopy-c-arm system, angiography, cine angiography, digital subtraction angiography (DSA), digital subtraction programming, angioplasty.	5
4	**Infra-Red Imaging**: Physics of thermography, Infrared detectors, Infrared imaging systems, clinical themography, liquid crystal thermography, modern application.	3
5	**Ultra-Sound Imaging**: Physics and production of ultrasound, medical ultrasound, acoustic impedance, absorption and attenuation of ultrasound energy, pulse geometry, ultrasonic field, ultrasonic transducers and probe design, types of probes, beam steering, principles of image formation, image processing, display systems and applications: A-mode, B-mode and M-mode, real-time ultrasonic imaging systems, electronic scanners, image artifacts, Doppler ultra sound and colour velocity mapping, duplex ultrasound and power doppler, bio-effects and safety levels.	11

COURSE OUTCOMES

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

1. Classify differentimaging techniques andsuggest suitable imaging methodology for specific applications.
2. Demonstrate the physics and principles of operationofX-ray and ultrasound imagingmodality.
3. Explaintheprinciplesofimageformationand implement various techniques to analyze the medical images for clinical purposes.
4. Identify and interpret the most effective imaging modality for particular examination.
5. Apply the tools for different problems in medical imaging and respond technically.
6. Demonstratethepotentialradiation hazardsandimplementrelevantprotectivesystems.

Text/Reference Books:

1. R.S.Khandpur"HandbookofBio-MedicalInstrumentation",2nd Edition,TMH.
2. J.J.Carr&J.M.Brown,"IntroductiontoBiomedicalEquipmentTechnology"PearsonEducation,Asia.
3. J.Webster, "Bioinstrumentation", Wiley &Sons
4. Dowsett,Kenny&Johnston,"ThePhysicsofDiagnosticImaging",Chapman&HallMedical,Madras/London.
5. Brown, Smallwood, Barber, Lawford& Hose, "Medical Physics and Biomedical Engineering", Institute of Physics Publishing, Bristol.
6. Massey&Meredith,"FundamentalPhysics ofRadiology",JohnWright&Sons.
7. S. Webb, "The Physics of Medical Imaging", Ada m Hilger,Bristol.
8. SybilM Stockley,"AManual of Radiographic Equipments",Churchill Livingstones.
9. Chistrmis, "Physics of DiagnosticRadiology"

Name of the Course	**TELEHEALTH TECHNOLOGY**
Course Code: PE-BME501	**Semester: Fifth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**
Objectives:	
1	To acquire knowledge on the basic concepts of telemedicine and the technology used in healthcare system.
2	Tostudytheneedfordigitalimagingandpicturearchivingandcommunicationsystems(PACS)
3	To learn telemedical standards, security, mobile telemedicine and its applications
4	To know scope, benefits and limitations of telemedicine.
Pre-Requisite: Mathematics**,** Signals & Systems in Biomedical Engineering (PCBME301), Analog & Digital Electronics, Biomedical Instrumentation (PCBME402)	

M#	**Content**	**Hrs**
1	**Fundamental of Telemedicine& Types of Information :** History of telemedicine, definition of telemedicine, telemedicine systems, telehealth, telecare, origins and development of telemedicine, scope, benefits and limitations of telemedicine, audio, video, still images, text and data fax.	6
2	**Communication& Network System:** Public switched telephone network, plain old telephone services, integrated services, digital network, asynchronous transfer mode, internet, wireless communications: GSM, satellite and micro wave, mobile health and ubiquitous healthcare, real-time telemedicine.	9
3	**Picture Archiving & Communication System:** Introduction to radiology information system, image acquisition system, display system, communication network, interpretation, types of image format, DICOM standard, PACS strategic plan and needs assessment, technical issues, and PACS architecture.	9
4	**Applications of Telemedicine:** Teleradiology, teleaudiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e-health and cyber medicine, acute care and monitoring for elderly care, virtual doctor systems for medical practices.	8
5	**Ethical &Legal Aspects:** Confidentiality and law, patient rights and consent, patient-doctor relationship, access to medical records, consent treatment, data protection and security, jurisdictional issues, intellectual property rights.	8

COURSE OUTCOMES

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

1. Demonstrate the types of communication and network systems used in tele health technology.
2. Explain the communication standards, ethical and legal issues involved in telehealth system.
3. Apply telemedicine and e-health services in professional field.
4. Identify the conditions for successful implementation of telemedicine and e-health systems and services.
5. Promote and introduce telemedicine and e-health services and programmes.
6. Plan and contribute in the design, implementation and use of telemedicine and e-health systems.

Text/Reference Books:

1. A.C. Norris, Essential of Telemedicine and Telecare, John Wiley & Sons, 2002
2. Olga Ferrer-Roca, M.SosaLudicissa, Handbook of Telemedicine, IOS press 2002.
3. Bernard Fong, ACM Fong, CK Li, Telemedicine Technologies: Information Technologies in Medicine and Telehealth, Wiley, 1st edition, 2015.
4. GeorgiGGraschew, Stefan rakowsky, Telemedicine Techniques and Applications, In Tech, 1st edition, 2011.
5. HalitEren, John G Webster, The E-Medicine, E-Health, Telemedicine, and Telehealth Handbook, CRC Press, 1st edition, 2015.
6. Khandpur R S, Telemedicine-Technology and Applications, PHI Learning Pvt. Ltd., New Delhi, 2017.
7. H K Huang, PACS and Imaging Informatics: Basic Principles and Applications, Wiley, New Jersey, 2010.

Name of the Course	**COMMUNICATION ENGINEERING & BIO-TELEMETRY**
Course Code: PE-BME502	**Semester: Fifth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**

Objectives:	
1	To study and understand the principles of electronic communication.
2	To gain knowledge about transmission of analog and digital information usingvarious modulation techniques and methods of enabling secured communication.
3	To learn data and pulse communication techniques.
4	To study wireless communication network and understand basics of bio-telemetry systems.

Pre-Requisite: Mathematics**,** Signals & Systems in Biomedical Engineering (PCBME301), Analog & Digital Electronics, Biomedical Instrumentation (PCBME402)

M#	Content	Hrs
1	**Introduction:** Elements of analog and digital communication system, baseband communication, carrier communication, concept of modulation, source coding, channel coding.	2
2	**Analog Communication:** Amplitude modulation (AM)-Frequency domain and time domain representation, modulation index, transmission bandwidth, single tone and multi-tone modulation, power calculation for single tone, types and advantages of AM: DSB-SC and SSB-SC, generation and demodulation of AM-square law modulator and envelope detector, super heterodyne receiver for AM Radio, angle Modulation(FM/PM)- frequency modulation, phase modulation, time and frequency domain representation of FM, narrow band and wideband FM, generation of FM-Armstrong's method, introduction to Phase-Locked-Loop (PLL), demodulation of FM using PLL.	13
3	**Digital Communication:** Concept of sampling, pulse amplitude modulation (PAM), pulse code modulation (PCM), line coding- unipolar, polar, NRZ, RZ, Manchester and AMI, coding control, digital modulation techniques-ASK, PSK, FSK and QPSK, multiple access: FDMA, TDMA and CDMA.	13
4	**Wireless Communication Networks:** Introduction to **c**ommunication networks,centralized network-GSM, ad-hoc network-Bluetooth, introduction to PACS, PACS architecture, DICOM network.	5
5	**Bio-Telemetry System:** Components of telemetry system, bio-telemetry and its importance, single and multi-channel biotelemetry, ECGtelemetry system, temperature telemetry system, telemetry of ECG and respiration, sports telemetry, multi-patient telemetry, ambulatory patient monitoring, implantable telemetry systems, transmission of physiological signals over telephone line, telemedicine and applications.	7

COURSE OUTCOMES

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

1. Choose and apply different modulation techniques for various applications.
2. Analyze the performance of communication system in terms of error rate and spectral efficiency.

3. Demonstrate the concepts of sampling, pulse modulation techniques and their comparison.
4. Inspect recent trend and performance issues for different digital modulation techniques
5. Identify the types of devices and their uses on a digital imaging network.
6. Design and evaluate the biotelemetry system.

Text/Reference Books:

1. P Ramakrishna Rao , "Analog Communication",., Mc-GrawHill
2. B.P.Lathi -Communication Systems- BSPublications
3. V Chandra Sekar – Analog Communication- Oxford UniversityPress
4. S. Haykin, - Digital Communications, WileyIndia.
5. R.S.Khandpur"HandbookofBio-MedicalInstrumentation",2ndEd.TMH.
6. A.B.Carlson—Communication System,4/e ,Mc-GrawHill
7. Proakis&Salehi Fundamentals of Communication Systems-Pearson
8. P K Ghosh- Principles of Electrical Communications- UniversityPress
9. S Sharma, Analog Communication Systems- KatsonBooksMillman&Halkias,
10. B.P.LathiandZ.Ding,ModernDigitalandAnalogCommunicationSystems,
11. GeorgiGGraschew, Stefan rakowsky, Telemedicine Techniques and Applications, In Tech, 1st edition, 2011.
12. HalitEren, John G Webster, The E-Medicine, E-Health, Telemedicine, and Telehealth Handbook, CRC Press, 1st edition, 2015

Name of the Course	**MICROPROCEESOR & MICROCONTROLLER**
Course Code: OE-EI501	**Semester: Fifth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**
Objectives:	
1	To introduce the architecture and organization of typical microprocessors and microcontroller.
2	To develop assembly language programming skill of microprocessor and microcontrolleralong with applications.
3	To familiarize the technique for interfacing memory and peripheral devices tomicroprocessor, including several specific standard I/O devices.
4	To understand the hardware/software trade-offs involved in the design of microprocessorbased systems.
Pre-Requisite: Digital Electronics and Integrated Circuits (ESEC401)	

M#	**Content**	**Hrs**
1	**8085 Processor:** Architecture, pin description, functional building blocks of processor, memory organization and interfacing, I/O ports and data transfer concepts, timing diagram, interrupts.	8
2	**Programming of 8085 Processor:** Instruction, format and addressingmodes, assembly language format, data transfer, data manipulation and control instructions, programming: Loop structure with counting and indexing, Look up table, subroutine instructions, stack.	10
3	**8051 Micro Controller**: Architecture, pin description, functional building blocks of processor, memory organization and interfacing, I/O ports and data transfer concepts, timing diagram, interrupts.	6
4	**Peripheral Interfacing:**Architecture, configurationand interfacing with ICs: 8255, 8254, 8251, A/D and D/A converters and interfacing with 8085.	6
5	**Micro Controller Programming & Applications:** Data transfer, manipulation, control algorithms and I/O instructions, simpleprogramming exercises key board and display interface.	4
6	**Architecture of Typical 16-Bit Microprocessors (Intel 8086):**Introduction to a 16 bit microprocessor, architecture and register organization, memory address space and data organization.	6

COURSE OUTCOMES

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

1. Construct and analyze assemble language program in 8085 and 8086 microprocessor tosolve various complex engineering problem.
2. Evaluate processing time of program and devise technique to reduce execution time toimprove microprocessor performance.
3. Design interfacing circuits to the microprocessor to communicate with external devices,which can be associated with public safety, health, security and other societal andenvironmental concerns.
4. Design memory devices using memory chips and utilize the knowledge in memory baseddevices used in academics and industry.

5. Design and implement 8051 microcontroller based system for using it in real life applications.
6. Compare memory mapped I/O and peripheral mapped I/O and their interfacing procedure and also compare microprocessor with microcontroller.

Text/Reference Books:

1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085A /8080A", Wiley Eastern Ltd.
2. Mazidi, Mazidi, McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson education, 2011.
3. A.H. Mukhopadhyay, "Microprocessor, Microcomputer and Their Applications", 3rd Edition Alpha Science International Ltd.
4. Soumitra Kumar Mandal, "Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085, 8086, 8051", McGraw Hill Edu, 2013.
5. M. Rafiquzzman: Microprocessors: Theory & Applications (Intel & Motorola), PHI.
6. Berry .B. Bray INTEL 8086/88, 80186, 286, 386, 486, Pentium Pro & Pentium IV.

Name of the Course	**VLSI & EMBEDDED SYSTEM**
Course Code: OE-EI502	**Semester: Fifth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**
Objectives:	
1	To study the fundamental concept and structures of MOS transistor and designing VLSI circuits.
2	To understand the different combinational circuit design, sequential MOS logic gates and CMOS dynamic logic circuits including their transient analysis, design steps and behavior.
3	To study of various semiconductor memory like ROM, RAM with input/output circuits.
4	To develop strong fundamental knowledge on embedded system and RTOS fields.
Pre-Requisite: Analog Electronics Circuits (ESEC301), Digital Electronics & Integrated Circuits (ESEC401)	

M #	Content	Hrs
1	**IntroductiontoMOSFETs&MOSInverter**:MOS-transistorstructure,operation,characteristics, VLSIdesignflowanddesignhierarchy,briefoverviewofcircuitdesigntechniques(hierarchicaldesign,design abstraction,and computer aided design),**s**impleinverterstructure,VTC,criticalvoltages,differenttypesofinverter,noisemargin.	4
2	**CMOS C ombinational& SequentialLogicCircuits:**Basic gates, adder, CMOStransmission gates,simple circuits designwithCMOStransmissiongate,SR Latch,JKLatch, D latch, edge triggered Flip-flops, switching, shortcircuitandleakage powerdissipation, variable threshold CMOScircuits,multiple threshold CMOScircuits, pipeliningand parallelprocessingapproach, switchingactivityestimationand optimization, adiabaticlogic circuits.	10
3	**DynamicLogicCircuits& Subsystem Design:**Basics ofdynamiclogiccircuits pre-chargeandevaluatelogic,cascading problem,domino logic, singlebitadder,serial-parallelmultiplier, RAM, ROM, SRAM, and DRAM.	8
4	**Introduction toEmbedded Systems:** Definition, d ifference between embedded systemand general computingsystems,importance of embedded systems, hardwarearchitectureoftherealtimesystems, differenthardwareunitsandprocessoroverviewfor embedded systems.	4
5	**Programming Concepts for Embedded systems:** ALP and high level language, macros,functions,datatypes,datastructures,modifiers,statements,loops,pointersqueue,stack,listsand orderedlists, compilers and cross compilers.	4
6	**Real TimeOperatingSystems :** Operating systembasics, tasks, processand threads, multiprocessingand multitasking,taskcommunication,tasksynchronization, multiple tasksscheduling inrealtime systems by RTOS	10

COURSE OUTCOMES

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

1. Describe MOS transistorstructureand operation and write currentvoltage equations for nMOS&pMOS.
2. Explainthe operation ofCMOScombinationaland sequentialcircuits.
3. Solve the problemofstaticand dynamic circuitdesign with CMOS.
4. Generate differentsubsystems usingMOScircuits.
5. State the basicprogrammingconcepts forembeddedsystems.
6. Explain the basicOS fundamentals and theRTOS forembedded systems

Text/Reference Books:

1. NeilH.EWeste, KimHaase, David Harris,A.Banerjee,"CMOSVLSI Design:Acircuits&SystemsPerspective",PearsonEducation.
2. WayneWolf,"Modern VLSI Design – System-on-chip Design", Prentice Hall India/Pearson Education.
3. Sung-Mo Kang &Yusuf Lablebici,"CMOS Digital IntegratedCircuits, Analysis &Design", TataMcGraw-Hill Edition.
4. K.V. Shibu, "Introduction toEmbeddedSystem",TataMcGraw-Hill.
5. F. Vahid, "EmbeddedSystemDesign-A unified hardwareandsoftwareintroduction", John Wiley.
6. F. Vahid, "EmbeddedSystems", TataMcGraw-Hill.

Name of the Course	**DATA STRUCTURE & ALGORITHM**
Course Code: OE-CS501	**Semester: Fifth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**
Objectives:	
1	To impart the basic concepts of data structures and algorithms.
2	To understand concepts about searching and sorting techniques
3	To understand basic concepts about stacks, queues, lists, trees and graphs.
4	To enable them to write algorithms for solving problems with the help offundamental data structures
Pre-Requisite: Mathematics (M101 & M201), Basic Computation and Principles of C (CS 201)	

M#	**Content**	**Hrs**
1	**Introduction:**Basic Terminologies: Elementary DataOrganizations, DataStructure operations:insertion, deletion, traversaletc.; Analysis of an Algorithm,AsymptoticNotations, Time-Spacetrade off. Searching:LinearSearchandBinarySearch Techniques andtheircomplexityanalysis.	6
2	**Stacks& Queues:** ADTStackanditsoperations: Algorithms andtheircomplexity analysis, Applications ofStacks:Expression Conversion and evaluation– correspondingalgorithmsand complexity analysis.ADTqueue,Types ofQueue:SimpleQueue, CircularQueue,Priority Queue; Operationson each types ofQueues: Algorithmsandtheiranalysis.	8
3	**LinkedLists:**Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.	8
4	**Trees:**Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.	6
5	**Sorting, Hashing & Graphs:**Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing. Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.	12

COURSE OUTCOMES

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

1. Select and apply appropriate data structure and algorithmic methods in solving problem.
2. Analyze algorithms to determine the time complexity and justify the correctness.
3. Write algorithms and compare their performance in term of space and time complexity.

4. Implement the computational efficiency of the principal algorithms for sorting, searching, and hashing.
5. Design and implement programs for manipulating stacks,queues,linked lists, trees,andgraphs.
6. Compare and contrast the benefits of dynamic and static data structures implementations.

Text/Reference Books:

1. Ellis Horowitz, SartajSahni, "Fundamentals of Data Structures", Illustrated Edition, Computer Science Press.
2. Robert L. Kruse, Bruce P. Leung, "Data Structures and Program Design In C", 2/E.
3. Ellis Horowitz, SartajSahni, Susan Anderson "Fundamentals of Data Structures of C"
4. Aaron M. Tenenbaum, "Data Structures in C".
5. S. Lipschutz, "Data Structures".
6. ReemaThareja, "Data Structures Using C".
7. A.K. Rath, A. K. Jagadev,"Data Structure Using C", 2/e.
8. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, "Introduction to Algorithms".

Name of the Course	**DATA BASE MANAGEMENT SYSTEM**
Course Code: OE-CS502	**Semester: Fifth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**
Objectives:	
1	To understand the different issues involved in the design and implementation of a database system.
2	To study the physical and logical database designs, database modeling, relational, hierarchical, and networkmodels.
3	To understand and use data manipulation language to query, update, and manage a database.
4	To develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency, distributed database, intelligent database, client/server and datawarehousing.
5	To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.
Pre-Requisite: Mathematics (M101 & M201), Basic Computation and Principles of C (CS 201)	

M#	**Content**	**Hrs**
1	**Database system architecture:** Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML). **Data models:** Entity-relationship model, network model, relational and object oriented data models, integrity constraints, data manipulation operations.	7
2	**Relational query languages:** Relational algebra, Tuple and domain relational calculus, SQL3, DDL and DML constructs, Open source and Commercial DBMS - MYSQL, ORACLE, DB2, SQLserver. **Relationaldatabasedesign:** Domainanddatadependency,Armstrong'saxioms, Normal forms, Dependency preservation, Losslessdesign. **Query processing and optimization:** Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimizationalgorithms.	13
3	**Storage strategies**: Indices, B-trees, hashing.	4
4	**Transaction processing:** Concurrency control, ACID property, Serializability ofscheduling, Locking and timestamp based schedulers, Multi-version and optimistic Concurrency Control schemes, Databaserecovery.	7
5	**Database Security:** Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection,SQL injection.	5
6	**Advanced topics:** Object oriented and object relational databases, Logical databases, Web databases, Distributed databases, Data warehousing and data mining.	4

COURSE OUTCOMES

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

1. Write relational algebra expressions and optimize the developed expressionsfor a given query.
2. Design the databases using E-Rmethod andnormalization for agivenspecification of the requirement.
3. Construct the SQL queriesfor open source and commercial DBMS -MYSQL, ORACLE, andDB2 for a given specification.
4. Optimize its execution using query optimizationalgorithms for a given query.
5. Determine the transaction atomicity, consistency, isolation, anddurability for a given transaction-processing system.
6. Implement the isolation property, including locking, time stamping based on concurrency control and serializability ofscheduling.

Text/Reference Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts" 6thEdition, McGraw-Hill.
2. J. D. Ullman, "Principles of Database and Knowledge-Base Systems", Vol-1, Computer SciencePress.
3. R. Elmasri and S. Navathe, "Fundamentals of Database Systems", 5thEdition, PearsonEducation.
4. Serge Abiteboul, Richard Hull, Victor Vianu, "Foundations of Databases", Reprint Addison-Wesley.
5. R.P.Mahapatra,"DatabaseManagement Systems", KhannaPublishing House, New Delhi(AICTE RecommendedTextbook-2018)
6. MartinJames, "PrinciplesofDatabaseManagementSystems",PHI.
7. A.K.Majumder, PritimayBbhattacharjya, "DatabasemanagementSystems",Tata McGraw Hill.

Name of the Course	**ENVIRONMENTAL SCIENCE & SAFETY**
Course Code: MC-ES501	**Semester: Fifth**
L-T-P-C: 2-0-0-0	**Contact: 2 hrs/week**
Objectives:	
1	To study the interrelationship between living organism and environment.
2	To study the integrated themes and biodiversity, natural resources, pollution control and waste management.
3	To find out and implement scientific and technological solutions to environmental problems.
4	To pursue life-long learning to effectively practice within a rapidly evolving, continually changing and increasingly diverse global environment.
Pre-Requisite: Basic Knowledge onBiology and Management	

M#	**Content**	**Hrs**
1	**Introduction to Environmental Science:** Ecologicalconcepts:bioticand abiotic components, ecosystem process: producers, consumers and decomposers, energy flow, food chains, water cycle, oxygen cycle, nitrogen cycle,biodiversity: genetic, species and ecosystem diversity, environmentalgradients,Indian environmental law, chemistry in environmental engineering: atmosphericchemistry andsoilchemistry, water quality standards and parameters, ground water, water conservation, rain water harvesting, renewable and non-renewable energy sources, use of alternateenergysources,differenttypesofenergy.	8
2	**Waste Management & Pollution Control:** Solid Waste Management: Source classification and composition of MSW,separation, storage and transportation, reuse andrecycling, waste minimization techniques, hazardouswasteandtheir generation, hazardous waste management,transportation and treatment, incinerators, inorganicwastetreatment, E.I.A., environmental audit. Waste Water Treatment: CODand BOD in wastewater, pretreatment,primaryandsecondarytreatmentofwaste water, activated sludge treatment-anaerobic digestion, reactor configurationsandmethaneproduction. Noise &Air Pollution: Noise pollution,noise standards, measurement and control, air pollution and pollutants,acid deposition, greenhousegases and global warming,ozone layer depletion, air pollution meteorology, atmospheric dispersion, industrial air emission control, flue gas desulphurization, NOx removal,fugitiveemissions.	12
3	**Safety Management:** Occupational safety and health acts, safetyprocedures, type of accidents, chemical and heat burns, prevention of accidents involvinghazardoussubstances,humanerror and hazard analysis, hazard control measures, fire prevention and detection, extinguishingfire,electricalsafety,product safety, safety management, handling and storage of hazardous materials, corrosive substances, gas cylinders, hydrocarbonsandwastes, personalprotectiveequipment.	6

COURSE OUTCOMES

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

1. Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
2. Assess and demonstrate the importance of interdisciplinary nature of environmental and health risk assessment.
3. Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
4. Identify the major pollutants and devices for environmental management and sustainable development.
5. Make aware of professional development, life-long learning, and current global and contemporary issues in environmental and safety assessment.
6. Make aware of professionalism, ethics, and environmental laws and regulations.

Text/Reference Books:

1. G. Kiely, "Environmental Engineering", Irwin/McGraw Hill International Edition, 1997.
2. Prof B.K. Mohapatra, "Environmental Engineering", DhanpatRai& Co Publication.
3. L. M. Deshmukh, "Industrial Safety Management", Tata McGraw Hill Publication.
4. Arcadio P. Sincero,Gergoria A. Sincero, "Environmental Engineering", PHI Publication.
5. M. L. Davis, S. J. Masen, "Principles of Environmental Engineering and Science", McGraw Hill International Edition, 2004.
6. Curringham&Saigo, "Environmental Science", TMH.
7. Dash & Mishra, "Man and Environment".
8. Gilbert M. Masters & Wendell P. Ela, "An Introduction to Environmental Engineering and Science", PHI Publication.
9. Colling. D A, "Industrial Safety Management and Technology",Prentice Hall, New Delhi.

Name of the Course	**MEDICAL EQUIPMENTS AND SIMULATION LABORATORY**
Course Code: PC-BME591	**Semester: Fifth**
L-T-P-C: 0-0-2-1	**Contact: 2 hrs/week**
Objectives:	
1	To get familiar with the various types of biomedical analytical and diagnostic equipment and their operation.
2	To understandthefundamentalprinciplesandutilizationofdifferentbiomedicalanalyticaldevices.
3	Tostudytherapeutic equipment using trainer kits and simulated devices.
4	Toemphasison the maintenanceofvarious biomedicalinstruments.

LIST OF EXPERIMENTS:

1. Study oncolorimeter
2. Study on spectrophotometer
3. Study on flamephotometer / infusion pump
4. Study on galvanic skin resistance
5. Study on blood flow velocity measurement - ultrasonicmethod
6. Study on pulseoximeter
7. Studyonpulmonaryfunctionanalyzer-spirometer
8. Study on EMG-muscleThreshold(Fatigue,Twitch, Summation,Incomplete&completeTetanus)
9. Study on Pacemaker Circuits / Pacemakersimulator
10. Study on simulated DCdefibrillator / X-ray simulator
11. Study on ECG simulator and servicing of ECGmachine
12. Study on muscle stimulator and EMG biofeedbacksystem

COURSE OUTCOMES

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

1. Demonstrate the working principle of different analytical and therapeutic devices.
2. Make measurement, interpret the data and produce report technically.
3. Evaluate the performance and carry out the periodic maintenance.
4. Test and calibrate the equipment at par with standard protocol.

Name of the Course	**MEDICAL INSTRUMENTS & SYSTEM LABORATORY**
Course Code: PC-BME592	**Semester: Fifth**
L-T-P-C: 0-0-2-1	**Contact: 2 hrs/week**
Objectives:	
1	To familiarize with the operation of various medical instruments and physiological parameter monitoring system.
2	To understand the monitoring principles and applications of different biomedical instruments and system.
3	Toemphasison the maintenanceand calibration ofvarious biomedicalinstruments.

LIST OF EXPERIMENTS:

1. Study on electronic BP and BP calibration
2. Study on respiratory rate meter & apneadetection
3. StudyonECGheartratemonitoringsystem
4. Study on peripheral pulse rate monitoringsystem
5. Study on digital body/skin temperature monitoringsystem
6. Study on multi-parametermonitoring system
7. Spectral analysis of biopotentials -Physiograph
8. Study on cardiac stressanalysis
9. Study on US Doppler / Foetalmonitor / US diathermy
10. Study on hearing aid and audiometer: air and boneconduction
11. Study on nerve conduction velocity measuringsystem
12. Study on ultrasonic devices-transmitter anddetector/bio-telemetrysystem

COURSE OUTCOMES

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

1. Demonstrate the operation of versatile medical instruments and monitoring of medical parameters.
2. Make measurement, interpret the data and produce report for clinical purposes.
3. Select suitable monitoring instruments and evaluate the performance.
4. Plan and carry out maintenance and calibration of medical instruments.

Name of the Course	**MICROPROCEESOR & MICROCONTROLLER LABORATORY**
Course Code: OE-EI591	**Semester: Fifth**
L-T-P-C: 0-0-2-1	**Contact: 2 hrs/week**

Objectives:	
1	To study programming based on 8086 microprocessor and 8051 microcontroller.
2	To expose students to the operation of typical microprocessor (8085) trainer kit.
3	To learn the design aspects of I/O and memory interfacing circuits.
4	To prepare the students to be able to solve different problems by developing different programs

LIST OF EXPERIMENTS:

1. Familiarization with 8085 & 8051simulator on PC.
2. Study of prewritten programs using basic instruction set (data transfer, Load/Store, Arithmetic, Logical) on the KIT. Assignments based on above
3. Programming using kit and simulator for:
   i) Table look up
   ii) Copying a block of memory
   iii) Shifting a block of memory
   iv) Packing and unpacking of BCD numbers
   v) Addition of BCD numbers
   vi) Binary to ASCII conversion
   vii) String Matching, Multiplication using shift and add method and Booth's Algorithm
4. Program using subroutine calls and IN/OUT instructions using 8255 PPI on the trainer kit e.g. subroutine for delay, reading switch state and glowing LEDs accordingly.
5. Study of timing diagram of an instruction on oscilloscope.
6. Interfacing of 8255: Keyboard and Multi-digit Display with multiplexing using 8255
7. Study of 8051 Micro controller kit and writing programs as mentioned in S/L3. Write programs to interface of Keyboard, DAC and ADC using the kit.
8. Serial communication between two trainer kits.

COURSE OUTCOMES

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

1. Construct and apply the assembly level programming of microprocessor andmicrocontroller.
2. Develop the programming logic and concept with the help of algorithm or flowchart.
3. Troubleshoot assembly language program along with interactions between software andhardware.
4. Practice the interfacing of microprocessor with peripheral devices for various applications.

Name of the Course	**VLSI & EMBEDDED SYSTEM LABORATORY**
Course Code: OE-EI592	**Semester: Fifth**
L-T-P-C: 0-0-2-1	**Contact: 2 hrs/week**
Objectives:	
1	Toprovideanintroductiontothecharacteristicsofdigitallogicandthedesign,construction,testinganddebuggingofsimpledigitalcircuits.
2	To provideanintroductiontothedevelopmentofapplication usingmicrocontrollers.
3	To learn the concepts and architecture of embedded systems.
4	To learn different design platforms used for an embedded systems application.

LIST OF EXPERIMENTS:

1. Design and simulation ofCMOS AND, NAND, NORgatesbystatic CMOS design.
2. Design and simulation of1bitfulladderandsubtractor.
3. Design and simulation of single stage dynamic circuit(precharge andevaluate).
4. Design and simulation ofaROM circuit.
5. Design and Simulate SR,JKLatchand Flipflop.
6. Basics ofarduinoBoardand differenton boardcomponentidentification.
7. Writea code to performswitchingactivitybyarduino.
8. Writea code to performserialcommunication betweenarduinoand HostPC.
9. Writea code to read sensordataand visualization ofthe data.
10. Writecodetointerface arduinowithrelaywith condition.

COURSE OUTCOMES

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

1. GenerateanyCMOSbasedcircuitstaticaswellasdynamic and simulate.
2. Analyze transient and VTC response of different CMOS logic gates.
3. Evaluate the DRC and LVS of layout of different CMOS circuits.
4. Writeembedded code forcommunication, display data and interfacing.

Name of the Course	**DATA STRUCTURE & ALGORITHM LABORATORY**
Course Code: OE-CS591	**Semester: Fifth**
L-T-P-C: 0-0-2-1	**Contact: 2 hrs/week**
Objectives:	
1	To know the concept of linear data structure like array along with its applications for solving various mathematical problems concerned with different topics like the operations of matrices.
2	To be acquainted with the concept of linked list with its classification and the relevance of the usage of such concepts according to the nature of the problems.
3	To be aware with various algorithms applied for searching and sorting purposes with the differences regarding their working principles.
4	To understand the significance of non-linear data structures by the implementations of operations done by binary search tree and also find the importance of hashing in case of any searching problems.

LIST OF EXPERIMENTS:

1. Implementation of array operations.
2. Stacks and Queues: adding, deleting elements Circular Queue: Adding & deleting elements.
3. Merging Problem : Evaluation of expressions operations on Multiple stacks & queues.
4. Implementation of linked lists: inserting, deleting, and inverting a linked list. Implementation of stacks & queues using linked lists.
5. Polynomial addition, Polynomial multiplication.
6. Sparse Matrices: Multiplication, addition.
7. Recursive and Non-recursive traversal of Trees.
8. Threaded binary tree traversal. AVL tree implementation.
9. Application of Trees. Application of sorting and searching algorithms.
10. Hash tables implementation: searching, inserting and deleting, searching & sorting techniques.

Any experiment specially designed by the college
(Detailed instructions for Laboratory Manual to be followed for further guidance)

COURSE OUTCOMES

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

1. Implement concepts of linear and non-linear data structures.
2. Analyze the concepts of static and dynamic data structure algorithms.
3. Apply different sorting and searching algorithms.
4. Evaluate time complexity of different data structure algorithms.
5. Create data structure and algorithm for real world applications.

Name of the Course	**DATA BASE MANAGEMENT SYSTEM LABORATORY**
Course Code: OE-CS592	**Semester: Fifth**
L-T-P-C: 0-0-2-1	**Contact: 2 hrs/week**
Objectives:	
1	To provide a strong formal foundation in database concepts, technology and practice.
2	To give a good formal foundation on the relational model of data and to present PL/SQL and procedural interfaces to PL/SQL comprehensively.
3	To familiarize with PL/SQL for database creation, manipulation and control.

LIST OF EXPERIMENTS:

Structured Query Language

1. Creating Database:
    - Creating a Database
    - Creating a Table
    - Specifying Relational Data Types
    - Specifying Constraints
    - Creating Indexes
2. Table and Record Handling:
    - INSERT statement
    - Using SELECT and INSERT together
    - DELETE, UPDATE, TRUNCATE statements
    - DROP, ALTER statements
3. Retrieving Data from a Database
    - The SELECT statement
    - Using the WHERE clause
    - Using Logical Operators in the WHERE clause
    - Using IN, BETWEEN, LIKE , ORDER BY, GROUP BY& HAVING clause
    - Using Aggregate Functions
    - Combining Tables Using JOINS
    - Subqueries
4. Database Management
    - Creating Views
    - Creating Column Aliases
    - Creating Database Users
    - Using GRANT and REVOKE

Cursors in Oracle PL / SQL
Writing Oracle PL / SQL Stored Procedures

Any experiment specially designed by the college
(Detailed instructions for Laboratory Manual to be followed for further guidance)

COURSE OUTCOMES

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

1. Design and implement a database schema for given problem.

2. Populate and query a database using SQL DML/DDL commands.
3. Programming PL/SQL including stored procedures, stored functions, cursors, packages.
4. Design and build a GUI application using a 4GL.

Special Remarks:
The above mentioned outcomes are not limited. Institute may redefine course outcomes based on their Program Educational Objectives (PEOs).