B.TECH 2nd YEAR

OPEN ELECTIVE COURSES

(Effective from the Session 2023-24)

SEMESTER - III/IV

S.No.	Subject Codes	Subject	To be offered to
1.	BOE301/BOE401 BOE301H/BOE401H	Electric and Hybrid Vehicles	Any Engg. Branch except ME and allied branches
2.	BOE302/ BOE402 BOE302H/BOE402H	Automation and Robotics	Any Engg. Branch except ME and allied branches
3.	BOE303/ BOE403 BOE303H/BOE403H	Material Science	Any Engg. Branch except ME/CE/AG and alliedbranches
4.	BOE304/ BOE404 BOE304H/BOE404H	Energy Science & Engineering	Any Engg. Branch except EE and allied branches
5.	BOE305/ BOE405 BOE305H/BOE405H	Sensor & Instrumentation	Any Engg. Branch except EE and allied branches
6.	BOE306/ BOE406 BOE306H/BOE406H	Basics Data Structure &Algorithms	Any Engg. Branch except CSE and allied branches
7.	BOE307/ BOE407 BOE307H/BOE407H	Basics of Database Management Systems	Any Engg. Branch except CSE and allied branches
8.	BOE308/ BOE408 BOE308H/BOE408H	Analog Electronics Circuits	Any Engg. Branch except EC and allied branches
9.	BOE309/ BOE409 BOE309H/BOE409H	Electronics Engineering	Any Engg. Branch except EC and allied branches
10.	BOE310/ BOE410 BOE310H/BOE410H	Digital Electronics	Any Engg. Branch except EC and allied branches
11.	BOE311/ BOE411 BOE311H/BOE411H	Polymer Science and Technology	Any Engg. Branch except Chemical Engg and Chemical Technology and allied branches
12.	BOE312/ BOE412 BOE312H/BOE412H	Laser System and Applications	Any Engg. Branch
13.	BOE313/ BOE413 BOE313H/BOE413H	Food Science and Nutrition	Any Engg. Branch except Food Technology/ Chemical Technology and allied branches
14.	BOE314/ BOE414 BOE314H/BOE414H	Building Science and Engineering	Any Engg. Branch except CE and allied branches

Important Note: Students of BT/TX Engg. and allied branches can be offered any of the above listed courses.

BOE301/ BOE401/BOE301H/ BOE401H ELECTRIC AND HYBRID VEHICLES

CO-1 (K2) : Students will be able to understand the layout and functioning of major systems of an automobile.
CO-2 (K2) : Students will be able to understand the working of electric vehicle.
CO-3 (K2) : Students will learn about the drive system of electric vehicle.
CO-4 (K2) : Students will understand the fundamentals of controller, energy storage system and charging of an electric vehicle.
CO-5 (K2) : Students will ensure troubleshooting of an electric vehicle and setting-up of startup.

Unit I

Definition of an Automobile, Body and Chassis, Basic Layout of an Automobile, Functions of Major Assemblies / Sub-assemblies of an automobile(with respect to 4-wheeler and without construction detaile.g. Engine, Clutch, Gear Box, Propeller Shaft, Universal Joint, Differential, Axle and Shafts, Wheel, Rim);Functioning of Major Systems of an Automobile (with respect to 4-wheeler and without construction detail e.g. Starting, Ignition, Lubrication, Cooling, Braking, Air-conditioning)

Unit II

Introduction to electric and hybrid vehicles, Merit / Demerit / Advantage / Dis-advantage / Social /Environmental importance of electric and hybrid vehicles, Construction detail and working of Major Components of electric & hybrid vehicle (Battery, Controller, Motor, Charger etc.)

Unit III

Introduction to electric components used in hybrid and electric vehicles, Configuration and control ofDC Motor drives, Configuration and control of Induction Motor drives, Configuration and control ofPermanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drivesystem efficiency, Sizing the propulsion motor

Unit IV

Introduction and working of controller, Introduction to Energy Storage Requirements in Hybrid andElectric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and itsanalysis, Super Capacitor based energy, selecting the energy storage technology

Unit V

Introduction and working of EV Charger, Charging of Electric Vehicle, Assembly of 2-wheeler Electric Vehicle, Repair and Maintenance, Precautions and Trouble Shooting, Method of setting-up of Startup, Registration of Start-up, Financial Support / Government Funding schemes

Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press , 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press , 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley , 2003.
4. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd., 2011.

BOE302/ BOE402/BOE302H/ BOE402H AUTOMATION AND ROBOTICS

Upon Completion of the course the students will be able to

CO1	Understand the concept of automation, its classification and terminology	K2
CO2	Understand the concept of basic principles of Robots.	K2
CO3	Understand and interpret the components of Industrial Automation	K2
CO4	Understand the basic elements of Automation in manufacturing.	K2
CO5	Apply the concept of Automation & Robotics in different industrial applications	K3

Unit I: Introduction to Automation

Brief history of automation, Requirement of automation systems, classification & level of automation, Industrial Automation, benefits of Industrial Automation, closed loop & open loop system, role of automation in Industry 4.0.

Unit II: Introduction to Robotics

Overview: History, Definition and scope of robotics, laws of robotics, classification, advantages and disadvantages of Robot, applications of robots.

Robot components: Joints, links, end-effectors, degrees of freedom, brief introduction to forward and inverse kinematics.

Robot Ethics: Social impact of robots in society, ethical implications of robotics and automation.

Unit III: Industrial Automation Architecture

Input Devices: Transducers &sensors, Classification of sensors and applications.

Controllers: Classification of controllers in Industrial Automation, principles of hard wire system and PLC, Types of PLC, I/O: Analog and Digital, Ladder programming for logic functions.

Actuators: Basics of Hydraulic, Pneumatic and Electric actuators, merits and demerits.

Unit IV: Automation in Manufacturing

Fundamentals of Computer Integrated Manufacturing, elements of a CIM system, benefits of CIM, types of automation in production system, fundamentals of Group Technology and Flexible Manufacturing System. Types and components of FMS.

Unit V: Industrial Applications

Industrial Applications of Automation and Robotics for material handling, welding, Spray painting, medical, mining, space, defence, security, domestic, entertainment.

Text Books

1. Gary Dunning, “Introduction to Programmable Logic Controllers” Thomson Learning, 2001.
2. Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011. 5.Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015
3. Introduction to Robotics (Mechanics and control), Niku, Wiley 2013.
4. Introduction to Robotics by S K Saha, McGraw Hill Education
5. R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi,2003.

Reference book

1. Introduction to Robotics (Mechanics and control), J.J.Craig Pearson Education Asia 2002.
2. Program logic controllers, W.Bolton ,Elsevier 2009.

BOE303/ BOE403/BOE303H/ BOE403H MATERIAL SCIENCE

UNIT-I:

Phase Diagrams:

Solid solutions – Hume Rothery's rules – the phase rule – single component system – one-component systemof iron – binary phase diagrams – isomorphous systems – the tie-line rule – the lever rule – application to isomorphous system – eutectic phase diagram – peritectic phase diagram – other invariant reactions – free energy composition curves for binary systems – microstructural change during cooling.

UNIT-II:

Ferrous Alloys:

The iron-carbon equilibrium diagram – phases, invariant reactions – microstructure of slowly cooled steels – eutectoid steel, hypo and hypereutectoid steels – effect of alloying elements on the Fe-C system – diffusion in solids – Fick's laws – phase transformations – T-T-T-diagram for eutectoid steel – pearlitic, baintic and martensitic transformations – tempering of martensite – steels – stainless steels – cast irons.

UNIT-III:

Mechanical Properties:

Tensile test – plastic deformation mechanisms – slip and twinning – role of dislocations in slip – strengthening methods – strain hardening – refinement of the grain size – solid solution strengthening – precipitation hardening – creep resistance – creep curves – mechanisms of creep – creep-resistant materials – fracture – the Griffith criterion – critical stress intensity factor and its determination – fatigue failure – fatigue tests – methods of increasing fatigue life – hardness – Rockwell and Brinell hardness – Knoop and Vickers microhardness.

UNIT-IV:

Magnetic, Dielectric & Superconducting Materials:

Ferromagnetism – domain theory – types of energy – hysteresis – hard and soft magnetic materials – ferrites – dielectric materials – types of polarization – Langevin-Debye equation – frequency effects on polarization – dielectric breakdown – insulating materials – Ferroelectric materials – superconducting materials and their properties.

UNIT-V:

New Materials:

Ceramics – types and applications – composites: classification, role of matrix and reinforcement, processing of fiber reinforced plastics – metallic glasses: types , glass forming ability of alloys, melt spinning process, applications – shape memory alloys: phases, shape memory effect, pseudoelastic effect, NiTi alloy, applications – nanomaterials: preparation (bottom up and top down approaches), properties and applications – carbon nanotubes: type.

Text Books & References:

1. Balasubramanian, R. —Callister's Materials Science and Engineering‖. Wiley India Pvt. Ltd., 2014.
2. Raghavan, V. —Physical Metallurgy: Principles and Practice‖. PHI Learning, 2015.
3. Raghavan, V. —Materials Science and Engineering: A First course‖. PHI Learning, 2015.
4. Askeland, D. —Materials Science and Engineering‖. Brooks/Cole, 2010.
5. Smith, W.F., Hashemi, J. & Prakash, R. —Materials Science and Engineering‖. Tata McGraw Hill Education Pvt. Ltd., 2014.
6. Wahab, M.A. —Solid State Physics: Structure and Properties of Materials‖. Narosa Publishing House, 2009.

BOE304/ BOE404/ BOE304H/ BOE404H ENERGY SCIENCE AND ENGINEERING

Unit-I Energy and its Usage: Units and scales of energy use, Mechanical energy and transport, Heat energy: Conversion between heat and mechanical energy, Electromagnetic energy: Storage,conversion, transmission and radiation, Introduction to the quantum, energy quantization, Energy in chemical systems and processes, flow of CO2, Entropy and temperature, carnot and Stirling heat engines, Phase change energy conversion, refrigeration and heat pumps, Internal combustion engines, Steam and gas power cycles, the physics of power plants. Solid-state phenomenaincluding photo, thermal and electrical aspects

Unit-II Nuclear Energy: Fundamental forces in the universe, Quantum mechanics relevant for nuclear physics, Nuclear forces, energy scales and structure, Nuclear binding energy systematics, reactions and decays, Nuclear fusion, Nuclear fission and fission reactor physics, Nuclear fission reactor design, safety, operation and fuel cycles

Unit-III Solar Energy: Introduction to solar energy, fundamentals of solar radiation and its measurement aspects, Basic physics of semiconductors, Carrier transport, generation and recombination in semiconductors, Semiconductor junctions: metal-semiconductor junction & p-n junction, Essential characteristics of solar photovoltaic devices, First Generation Solar Cells, Second Generation Solar Cells, Third Generation Solar Cells

Unit-IV Conventional & non-conventional energy source: Biological energy sources and fossil fuels, Fluid dynamics and power in the wind, available resources, fluids, viscosity, types offluid flow, lift, Wind turbine dynamics and design, wind farms, Geothermal power and ocean thermal energy conversion, Tidal/wave/hydro power

Unit-V Systems and Synthesis: Overview of World Energy Scenario, Nuclear radiation, fuel cycles, waste and proliferation, Climate change, Energy storage, Energy conservation. Engineering for Energy conservation: Concept of Green Building and Green Architecture; Green building concepts, LEED ratings; Identification of energy related enterprises that represent the breath of the industry and prioritizing these as candidates; Embodied energy analysis and use as a tool for measuring sustainability. Energy Audit of Facilities and optimization of energy consumption

Reference/Text Books

1. Energy and the Challenge of Sustainability, World Energy Assessment, UNDP, NewYork, (2000).
2. Perspective of Modern Physics, A. Beiser, McGraw-Hill International Editions (1968).
3. Introduction to Modern Physics, H.S. Mani and G.K.Mehta, East-West Press (1988).
4. Introduction to Electrodynamics, D. J. Griffiths, Fourth Edition, Prentice Hall (2013).
5. Introductory Nuclear Physics, R. K. Puri and V.K. Babbar, Narosa Publishing House(1996).
6. Physics of Solar Cells: From Basic Principles to Advanced Concepts by Peter Wurfel,John Wiley & Sons, 2016
7. Principles of Solar Engineering, D.Y. Goswami, F.Kreith and J.F. Kreider, Taylor and Francis, Philadelphia, 2000.

BOE305/ BOE405/ BOE305H/ BOE405H SENSOR AND INSTRUMENTATION

Pre-requisites of course: Basic Electrical Engineering

Course Outcomes:		**Blooms Level**
Upon the completion of the course, the student will be able to:		
CO 1	Apply the use of sensors for measurement of displacement, force and pressure.	K_3
CO2	Employ commonly used sensors in industry for measurement of temperature, position, accelerometer, vibration sensor, flow and level.	K_3
CO3	Demonstrate the use of virtual instrumentation in automation industries.	K_2
CO4	Identify and use data acquisition methods.	K_3
CO5	Comprehend intelligent instrumentation in industrial automation.	K_2

Detailed Syllabus:

Unit- I:
Sensors & Transducer: Definition, Classification & selection of sensors, Measurement of displacement using Potentiometer, LVDT & Optical Encoder, Measurement of force using strain gauge, Measurement of pressure using LVDT based diaphragm & piezoelectric sensor.

Unit-II:
Measurement of temperature using Thermistor, Thermocouple & RTD, Concept of thermal imaging, Measurement of position using Hall effect sensors, Proximity sensors: Inductive & Capacitive, Use of proximity sensor as accelerometer and vibration sensor, Flow Sensors: Ultrasonic & Laser, Level Sensors: Ultrasonic & Capacitive.

Unit -III:
Virtual Instrumentation: Graphical programming techniques, Data types, Advantage of Virtual Instrumentation techniques, Concept of WHILE & FOR loops, Arrays, Clusters & graphs,
Structures: Case, Sequence & Formula nodes, Need of software based instruments for industrial automation.

Unit-IV:
Data Acquisition Methods: Basic block diagram, Analog and Digital IO, Counters, Timers, Types of ADC: successive approximation and sigma-delta, Types of DAC: Weighted Resistor and R-2R Ladder type, Use of Data Sockets for Networked Communication.

Unit V:
Intelligent Sensors: General Structure of smart sensors & its components, Characteristic of smart sensors: Self calibration, Self-testing & self-communicating, Application of smart sensors: Automatic robot control & automobile engine control.

Text Books:

1. DVS Murthy, Transducers and Instrumentation, PHI 2nd Edition 2013
2. D Patranabis, Sensors and Transducers, PHI 2nd Edition 2013.
3. S. Gupta, J.P. Gupta / PC interfacing for Data Acquisition & Process Control, 2nd ED / InstrumentSociety of America, 1994.
4. Gary Johnson / Lab VIEW Graphical Programing II Edition / McGraw Hill 1997.

Reference Books:

1. Arun K. Ghosh, Introduction to measurements and Instrumentation, PHI, 4th Edition 2012.
2. A.D. Helfrick and W.D. cooper,Modern Electronic Instrumentation & Measurement Techniques,PHI, 2001
3. Hermann K.P. Neubert, "Instrument Transducers" 2nd Edition 2012, Oxford University Press.

BOE306/ BOE406/BOE306H/ BOE406H BASICS DATA STRUCTURES AND ALGORITHM

Course Outcome (CO) **Bloom's Level (KL)**

At the end of course , the student will be able to understand

CO 1	Describe how arrays, linked lists, stacks, queues, trees, and graphs are represented in memory, used by the algorithms and their common applications.	**K_1, K_2**
CO 2	Discuss the computational efficiency of the sorting and searching algorithms.	**K_2**
CO 3	Implementation of Trees and Graphs and perform various operations on these data structure.	**K_3**
CO 4	Understanding the concept of recursion, application of recursion and its implementation and removal of recursion.	**K_4**
CO 5	Identify the alternative implementations of data structures with respect to its performance to solve a real world problem.	**K_5, K_6**

DETAILED SYLLABUS

Unit	Topic	Lecture
I	**Introduction:** Basic Terminology, Elementary Data Organization, Built in Data Types in C, Efficiency of an Algorithm, Asymptotic notations, Abstract Data Types (ADT) **Arrays**: Definition, Single and Multidimensional Arrays, Representation of Arrays: Row Major Order, and Column Major Order. **Linked lists:** Array Implementation and Pointer Implementation of Singly Linked Lists, Doubly Linked List, Circularly Linked List, Operations on a Linked List. Insertion, Deletion, Traversal, Polynomial Representation and Addition Subtraction & Multiplications of Single variable & Two variables Polynomial.	08
II	**Stacks:** Abstract Data Type, Primitive Stack operations: Push & Pop, Array and Linked Implementation of Stack in C, Application of stack: Prefix and Postfix Expressions, Evaluation of postfix expression, Iteration and Recursion- Principles of recursion, Tail recursion, Fibonacci numbers, and Hanoi towers, Tradeoffs between iteration and recursion. **Queues:** Operations on Queue: Create, Add, Delete, Full and Empty, Circular queues, Array and linked implementation of queues in C, Dequeue and Priority Queue.	08
III	**Searching:** Concept of Searching, Sequential search, Index Sequential Search, Binary Search. Concept of Hashing & Collision resolution Techniques used in Hashing. **Sorting:** Insertion Sort, Selection, Bubble Sort, Quick Sort, Merge Sort, Heap Sort and Radix Sort.	08
IV	**Trees:** Basic terminology used with Tree, Binary Trees, Binary Tree Representation: Binary Search Tree, Strictly Binary Tree, Complete Binary Tree, Extended Binary Trees, Tree Traversal algorithms: Inorder, Preorder and Postorder, Constructing Binary Tree from given Tree Traversal, Insertion , Deletion, Searching & Modification of data in Binary Search tree.	08
V	**Graphs:** Terminology used with Graph, Data Structure for Graph Representations: Adjacency Matrices, Adjacency List, Graph Traversal: Depth First Search and Breadth First Search, Minimum Spanning Trees, Prims and Kruskal algorithm.	08

Text books:

1. Aaron M. Tenenbaum, Yedidyah Langsam and Moshe J. Augenstein, “Data Structures Using C and C++”, PHI Learning Private Limited, Delhi India
2. Gilberg ,Forouzan, Data Structures: A Pseudocode Approach with C 3rd edition , Cengage Learning publication
3. Horowitz and Sahani, “Fundamentals of Data Structures”, Galgotia Publications Pvt Ltd Delhi India.
4. Lipschutz, “Data Structures” Schaum’s Outline Series, Tata McGraw-hill Education (India) Pvt. Ltd.
5. Thareja, “Data Structure Using C” Oxford Higher Education.
6. AK Sharma, “Data Structure Using C”, Pearson Education India.
7. Rajesh K. Shukla, “Data Structure Using C and C++” Wiley Dreamtech Publication.
8. Michael T. Goodrich, Roberto Tamassia, David M. Mount “Data Structures and Algorithms in C++”, Wiley India.
9. P. S. Deshpandey, “C and Data structure”, Wiley Dreamtech Publication.
10. R. Kruse etal, “Data Structures and Program Design in C”, Pearson Education.
11. Berztiss, AT: Data structures, Theory and Practice, Academic Press.
12. Jean Paul Trembley and Paul G. Sorenson, “An Introduction to Data Structures with applications”, McGraw Hill.
13. Adam Drozdek “Data Structures and Algorithm in Java”, Cengage Learning

BOE307/ BOE407/BOE307H/ BOE407H BASICS OF DATABASE MANAGEMENT SYSTEM

Course Outcome (CO)		**Bloom's Level (KL)**
At the end of course , the student will be able to understand		
CO 1	**Acquire** knowledge of database design methodology for real-life applications.	Understanding
CO 2	**Design** an information model using the concept of ER diagram.	Create
CO 3	**Apply** the concept of SQL on real-life databases.	Apply
CO 4	**Analyze** the redundancy problem in the database and reduce it using normalization.	Analyze
CO 5	**Identify** the broad range of database management issues including data integrity, security, and recovery transactions, as well as **enforce** entity integrity, referential integrity, key constraints, and domain constraints on the database.	Analyze

DETAILED SYLLABUS

Unit	**Topic**	**Lecture**
I	**Introduction to Database System:** Database System vs File System, Database System Concept and Architecture, Data Model Schema and Instances, Data Independence and its Types, Overall Database Structure. **Entity Relationship Model:** ER Model Concepts, Notation for ER Diagram, Mapping Constraints, Key attribute, Generalization, Aggregation, Reduction of an ER Diagrams to Tables.	**08**
II	**Relational data Model:** Relational Data Model Concepts, type of keys, Integrity Constraints- Entity integrity and referential integrity, Keys Constraints, Domain Constraints, Relational Algebra-Unary Relational Operations- SELECT and PROJECT, Binary Relational Operations- CROSS, JOIN and DIVISION, Queries in Relational Algebra.	**08**
III	**Database Implementation using SQL:** Introduction to SQL, Characteristics of SQL, SQL Data Types, Basic Queries in SQL- create, select Insert, Delete and Update Statements, concepts of group by and having, order by, Sub Queries, Aggregate Functions, Joins, Unions, Intersection, Minus, Views.	**08**
IV	**Database Design and Normalization:** Functional Dependencies, Inference rules, Closure of attributes, FD equivalence and Minimal cover. **Normalization**: Normal forms, first, second, third normal forms, and BCNF. Lossless join decompositions, Dependency Preservation, Multi-valued Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form.	**08**
V	**Transaction processing:** Transaction and its States**,** ACID property, Transaction Scheduling, Serializability of scheduling, Conflict, and View Serializability **Concurrency Control Techniques:** Concurrency Control, Locking Techniques for Concurrency Control, Two-phase locking techniques for concurrency control, Time Stamping Protocols for Concurrency Control	**08**

Text books:

1. Elmasri, Navathe, " Fundamentals of Database Systems", Addision Wesley
2. Korth, Silbertz, Sudarshan," Database Concepts", McGraw Hill
3. Date C J, "An Introduction to Database Systems", Addision Wesley Reference Books
4. Bipin C. Desai, "An Introduction to Database Systems", Gagotia Publications 8. Majumdar & Bhattacharya, "Database Management System", TMH
5. RAMAKRISHNAN"Database Management Systems", McGraw Hill

BOE308/ BOE408/BOE308H/ BOE408H ANALOG ELECTRONICS CIRCUITS

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the characteristics of diodes and transistors.
2. Design and analyze various rectifier and amplifier circuits.
3. Design sinusoidal and non-sinusoidal oscillators.
4. Understand the functioning of OP-AMP and design OP-AMP based circuits.
5. Design LPF, HPF, BPF, BSF.

Unit	Topics	Lectures
I	Diode circuits, amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. biasing schemes for BJT and FET amplifiers, bias stability, various configurations (such as CE/CS, CB/CG, CC/CD) and their features, small signal analysis, low frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers.	8
II	High frequency transistor models, frequency response of single stage and multistage amplifiers, cascode amplifier, various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues, feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin.	8
III	Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), non-sinusoidal oscillators.	8
IV	Current mirror: Basic topology and its variants, V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load, differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR, Op-Amp design: Design of differential amplifier for a given specification, design of gain stages and output stages, compensation.	8
V	Op-Amp applications: Review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, precision rectifier, Schmitt trigger and its applications, active filters: Low pass, high pass, band pass and band stop, design guidelines.	8

Text/Reference Books:

1. J.V. Wait, L.P. Huelsman and GA Korn, "Introduction to Operational Amplifier theory and applications," McGraw Hill, 1992.
2. J. Millman and A. Grabel, "Microelectronics," 2nd edition, McGraw Hill, 1988.
3. P. Horowitz and W. Hill, "The Art of Electronics," 2nd edition, Cambridge UniversityPress, 1989.
4. A.S. Sedra and K.C. Smith, "Microelectronic Circuits,"Saunder's College11 Publishing,4th edition.
5. Paul R. Gray and Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits," John Wiley, 3rd edition.
6. Muhammad H. Rashid, "Electronic Devices and Circuits," Cengage publication, 2014.

BOE309/ BOE409/BOE309H/ BOE409H ELECTRONICS ENGINEERING

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of PN junction and special purpose diodes.
2. Study the application of conventional diode and semiconductor diode.
3. Analyse the I-V characteristics of BJT and FET.
4. Analyzethe of Op-Amp, amplifiers, integrator, and differentiator.
5. Understand the concept of digital storage oscilloscope and compare of DSO with analogoscilloscope

Unit	Topics	Lectures
I	PN junction diode: Introduction of semiconductor materials; Semiconductor diode: Depletion layer, V-I characteristics, ideal and practical, diode resistance, capacitance, diode equivalent circuits, transition and diffusion capacitance, Zener diodes breakdown mechanism (Zener and avalanche).	8
II	Diode application: Series, parallel and series, parallel diode configuration, half and full wave rectification, clippers, clampers, Zener diode as shunt regulator, voltage-multiplier circuits special purpose two terminal devices : light-emitting diodes, Varactor (Varicap) diodes, tunnel diodes, liquid-crystal displays.	8
III	Bipolar junction transistors and field effect transistor: Bipolar junction transistor: Transistor construction, operation, amplification action, common base, common emitter, common collector configuration dc biasing BJTs: operating point, fixed-bias, emitter bias, voltage-divider bias configuration. Collector feedback, emitter-follower configuration. Bias stabilization. CE, CB, CC amplifiers and AC analysis of single stage CE amplifier (re Model), Field effect transistor: Construction and characteristic of JFETs. AC analysis of CS amplifier, MOSFET (depletion and enhancement) type, transfer characteristic.	8
IV	Operational amplifiers: Introduction and block diagram of Op-Amp, ideal & practical characteristics of Op-Amp, differential amplifier circuits, practical Op-Amp circuits (inverting amplifier, non-inverting amplifier, unity gain amplifier, summing amplifier, integrator, differentiator), Op- Amp parameters: input offset voltage, output offset voltage, input biased current, input offset current differential and common-mode operation.	8
V	Electronic instrumentation and measurements: Digital voltmeter: Introduction, RAMP techniques digital multimeters: Introduction Oscilloscope: introduction, basic principle, CRT, block diagram of oscilloscope, simple, measurement of voltage, current phase and frequency using CRO, introduction of digital storage oscilloscope and comparison of DSO with analog oscilloscope.	8

Text /Reference Books:

1. Robert L. Boylestand / Louis Nashelsky, “Electronic Devices and Circuit Theory,” Latest Edition, Pearson Education.
2. H S Kalsi, “Electronic Instrumentation”, Latest Edition, TMH Publication.
3. Meetidehran/ A.K. singh “fundamental of electronics Engineering”, New age international publisher.

BOE310/ BOE410/BOE310H/ BOE410H DIGITAL ELECTRONICS

Course Outcomes:		**Knowledge Level, KL**
Upon the completion of the course, the student will be able to:		
CO 1	Apply concepts of Digital Binary System and implementation of Gates.	K_3
CO2	Analyze and design of Combinational logic circuits.	K_4
CO3	Analyze and design of Sequential logic circuits with their applications.	K_4
CO4	Implement the Design procedure of Synchronous & Asynchronous Sequential Circuits.	K_3
CO5	Apply the concept of Digital Logic Families with circuit implementation.	K_3

Detailed Syllabus

UNIT I

Digital System And Binary Numbers: Number System and its arithmetic Signed binary numbers, Logic simplification and combinational logic design: Binary codes, code conversion, review of Boolean algebra and Demorgans theorem, SOP & POS forms, Canonical forms, Karnaugh maps method up to five variable, Don't care conditions, POS simplification, NAND and NOR implementation, Quine McClusky method (Tabular method).

UNIT II

Combinational Logic: MSI devices like Magnitude comparator, Multiplexers, Demultiplexers, Decoders, Encoders. Multiplexed display, half and full adders, subtractors, serial and parallel adders, BCD adder

UNIT III

Sequential Logic And Its Applications: Storage elements: latches & flip flops, Characteristic Equations of Flip Flops, Flip Flop Conversion, Shift Registers, Ripple Counters, Synchronous Counters, Other Counters:Johnson & Ring Counter.

UNIT IV

Synchronous & Asynchronous Sequential Circuits: Analysis of clocked sequential circuits with state machine designing, State reduction and assignments, Design procedure. Analysis procedure of Asynchronous sequential circuits, circuit with latches, Design procedure, Reduction of state and flow table,Race-free state assignment, Hazards.

UNIT V

Memory & Programmable Logic Devices: Digital Logic Families: DTL, DCTL, TTL, ECL & CMOS etc., Fan Out, Fan in, Noise Margin; RAM, ROM, PLA, PAL; Circuits of Logic Families, Interfacing of DigitalLogic Families, Circuit Implementation using ROM, PLA and PAL

Text Books:

1. M. Morris Mano and M. D. Ciletti, "Digital Design", Pearson Education.
2. Digital Circuits and Design, S. Salivahanan, Oxford University Press
3. David J. Comer, "Digital Logic & State Machine Design", Oxford University Press.
4. RP Jain, "Modern Digital Electronics", McGraw Hill Publication.
5. A. Anand Kumar, "Fundamental of Digital Circuits," PHI 4th edition, 2018.
6. D.V. Hall, "Digital Circuits and Systems," McGraw Hill, 1989.

BOE311/ BOE411/BOE311H/ BOE411H POLYMER SCIENCE & TECHNOLOGY

Course Aim

The aim of this course is to provide students with a comprehensive view of polymer science and technology, including the chemical structure of various polymers, methods of measuring the molecular weight, polymerization kinetics, and polymer processing technologies. The focus is mainly on processing of polymers as well as on the behavior and technical applications of different polymeric materials.

Course Objectives:

To provide fundamental and applied knowledge of polymers and their synthesis, manufacturing, processing, characterization and applications of polymers in space, oceans, electronics, agriculture, automobile, sports and building constructions.

Course Outcomes:

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

Units	Course Outcomes	Bloom's Level
CO-1	Understand the concept of polymer synthesis, Functionality, Crystallinity, Calculation of average molecular weight, reaction kinetics, physical properties and factors affecting the strength of polymers.	K4
CO-2	Understand the properties of polymers, types and mechanism of polymerization.	K3
CO-3	Understand and apply the various processing and manufacturing techniques, high performance polymer and polymer composites.	K3
CO-4	Understand the preparation, properties and technical applications of polymers.	K3
CO-5	Understand the applications of different polymeric materials in current scenario of development.	K3

Unit	Topics	Lectures/ Hours
1	Introduction, Chemistry of Polymer Synthesis, Classification, Functionality, Tacticity, Crystallinity in Polymers and its Effect on Properties of Polymers, Concepts of Average Molecular Weight in Polymers, Polymer Reaction Kinetics, Physical Properties, Factors Affecting Strength.	8
2	Effect of Structure on Properties of Polymers, Organic Polymers, Step Growth and Chain Growth Polymerization and its Mechanism, Coordination Polymerization, Copolymerization.	8
3	Polymer Processing, Injection, Moulding, Blow Moulding, Compression Moulding, Introduction to High Performance Polymers and Polymer Composites.	8
4	Preparation, Properties and Technical Applications of Thermoplastic (PVC, PVA, PTEE), Thermostats (PF, UF, MF) and Elastomers (SBR, Nitril Rubber, Butyl Rubber, Polychloroprene), Vulcanization of Rubber and its advantages, Biopolymers and Degradation of Polymers.	8
5	Epoxy Resins, Silicones, Application of Polymer in Space, Ocean, Electronics, Medical, Agriculture, Automobile, Sports and Building Construction.	8

Text Books:

1. Polymer Science, Wiley & Sons, 3rd Edition, By Billmeyer, F.W. Jr. ISBN: 978-8126511105 (2007).
2. Fundamentals of Polymers, McGraw Hill By Kumar, A., Gupta, R. K. ISBN: 0-8247-0867-9 (2003).

3. Polymer Science and Technology, 3rd Edition, Prentice Hall By Joel R Fried, ISBN: 978-0- 13-703955-5, (2014).
4. Polymer Science and Technology, 1st Edition, CRC Press Inc By Robert O Ebewele, ISBN: 978-0849389399 (2000).
5. Polymer Science and Technology, 3rd Edition, McGraw Hill Education (India) Private Limited, By Ghosh Premamoy, ISBN: 978-0070707047 (2011).

Reference Books:

1. Principles of Polymer Processing, 2nd Edition, Wiley Interscience, Tadmo, Z; Gogos, C.G., ISBN: 0-471-38770-3 (2006).
2. Polymer Science and Engineering, Prentice Hall of India, Williams, D. J., ISBN: 978-0136856368 (1971).
3. Handbook of Polymer Science and Technology, 1st Volume, 1st Edition, CBS Publication By Ferry MH, ISBN: 978-8123911328 (2012).

BOE312/ BOE412/BOE312H/ BOE412H LASER SYSTEMS AND ITS APPLICATIONS

Course Outcomes:

On completion of course the students are able :

CO No.	CO Statement	BTL
CO1	To understand the basic concept of coherence , absorption and emission process of radiation.	Understanding
CO2	To understand the concept of population inversion necessary for laser action and laser gain and optical cavities.	Understanding, Analyze
CO3	To understand the laser action in various energy levels.	Understanding, Apply
CO4	To study different types of lasers such as gas laser liquid laser solid laser, semiconductor laser with examples.	Understanding, **A**pply
CO5	To know the application of laser in different fields such as medical, industrial, communication etc. applications along with safety consideration.	**A**pply

Unit –I Laser Introduction, Energy Levels and Transition:

Introduction, Definition, Properties of laser beams, Concept of coherence, Temporal coherence, Spatial coherence, Longitudinal Coherence length, Transverse Coherence length, Absorption, Spontaneous Emission and Stimulated emission processes with its characteristics, Einstein's A and B coefficients and Relation between these coefficient. [8]

Unit –II Laser Amplifiers and Oscillations

Population inversion, Meta stable state, Pumping- types, Optical pumping methods, Two, three and four level pumping schemes, Gain in lasers, Gain factor, Optical Cavities/Resonators, Fabry-Perot optical resonator, Loop gain, Gain at threshold, Stability, Stability diagram. [9]

Unit –III Laser component, Principle and Types.

Main components of Laser, Principle of Laser action, Introduction to general lasers and their types. Two, Three & Four level Lasers, CW Lasers, Pulsed Lasers, Method of Short pulse generation and its Measurement. [6]

Unit –IV Specific Laser Systems:

Atomic gas Lasers – He-Ne laser, Argon Ion Laser; Molecular Gas Lasers- Carbon dioxide laser, excimer laser; Liquid Lasers- Organic dye lasers, Solid Sate Lasers- Ruby lasers, Nd-YAG Laser, Semiconductor diode laser. [9]

UNIT-V Applications and Hazards and Safety Consideration :

Laser applications in medicine and surgery- effect of laser on biological tissues, diagnostic of disease, ophthalmology, general surgery, dermatology, dentistry, advantages and disadvantages; Laser applications in materials processing – hole drilling, cutting, laser hardening, advantage and disadvantage of laser in material processing; Laser applications in optical communication; Laser applications in metrology; Laser applications in LIDAR; Laser applications in holography; Laser hazards and safety consideration. [10]

Reference Books:

1. K.R. Nambiar, "Laser Principles, Types and Application" New Age International.
2. S. A. Ahmad, "Laser concepts and Applications" New Age International.
3. A. K. Katiyar, C. K. Pandey and Manisha Bajpai, Fundamentals of Laser Systems and Applications.
4. B. B. Laud, "Lasers and Non Linear Optics" New Age International.

BOE313/ BOE413/BOE313H/ BOE413H FOOD SCIENCE & NUTRITION

OBJECTIVE: To provide basic knowledge of basic fundamental aspects of Food Science,Food Composition, Nutritional value, Food Processing & Preservation operations. A basic idea of Food Packaging and Quality and Safety of Foods . It also includes an overview of the status of Food Processing Sector in India.

COURSE OUTCOME: After successful completion of the course the students will be able to:

- Understand the scope and status of Food Processing sector in India.
- Understand the basics of Food com[position and Nutritional value of foods
- Be familiar with the importance of Balanced diet and nutritional deficiency diseases.
- Have a basic idea of Food Processing & Preservation operations.
- Gain insight into the Quality and Safety aspects of foods .

COURSE DETAILS:

Units	S.No.	Contents	Lecture
1.	1.1	Introduction to Food Science. Functions of Foods. Food Groups. Food Pyramid. Chemical constituents of foods and their properties.	**5**
	1.2	Concept of Food Nutrition, Relation of Nutrition to good health. Malnutrition: Causes and Effects. Common Nutritional deficiency diseases.	**4**
2.	2.1	Energy requirements of the body. Determination of won energy needs. Calorific value of foods. Digestion process and Utilization of nutrients in the human body.	**5**
	2.2	Diets during a normal Life cycle. Nutritional requirements for various age groups. Recommended Dietary Allowances (RDA) or Intakes (RDI). Balanced diet.	**4**
3.	3.1	Basic concept of Food Processing and Food Preservation. Commonly used terms as Cooking, Roasting, Broiling, Poaching, Stewing, Simmering, Marinating, Blanching, Baking, Pasteurization etc..	**6**
	3.2.	General Principles of Food Preservation. A brief outline about methods employed for Food Preservation	**6**
4.	4.1	Quality: Various definitions of Quality, Quality Attributes of foods. Quailty Control Cycle. Concept of Total Quality Management (TQM). Names of Regulatory and Accreditation Bodies.	**4**
	4.2	Food Security and Food safety, Meaning and its significance. Food Borne Illness. Adulteration in Foods, Concept of HACCP.	**4**
5.	5.1	Food Packaging. Types of Packages. Desirable attributes of Food Package, Food Package Label and its declaration. Brief Guidelines regarding the same.	**4**
	5.2	Food Processing Sector in India: Various types of Food Processing Industries, Growth, Opportunities and Challenges. Present status.	**3**
			45

S.No	Name of Authors / Books / Publishers	
1	Norman N.Potter, Joseph H.Hotchkiss, " Food Science", 5th Edition, CBS Publishers & Distributors Pvt. Ltd.,	2007
2	Shubhangini A. Joshi, Nutrition and Dietetics, 4th Edition , Tata Mc GrawHill Publishing Company Ltd.	2017
3	McWilliams, M., Food Fundamentals, 10TH Edition, Pearson Education	2015
4	B.Srilakshmi, Food Science, 7th Edition, New Age International (P) Ltd., New Delhi	2018

BOE314/ BOE414/BOE314H/ BOE414H BUILDING SCIENCE AND ENGINEERING

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

1. Understand components of building.
2. Explain orientation and planning of building.
3. Explain drinking water parameters.
4. Understand safe masonry building construction requirements.
5. Explain the features of a smart city.

UNIT –I **Components of Building**

Various Components of Building: Foundation, Plinth, Column, Beam, Wall, Staircase, Lintel, Slab, Door, Window etc.

Types of Buildings: Residential/ Commercial, Frame Structure/ Load Bearing.

Building materials: Brick, Cement, Sand, Reinforcement, Stone, Tiles, Wood etc. Preparation of mortar and concrete. Use of waste as building material

Bathroom Fittings: WC, Cistern, Wash Basin, Bib Cock, Pillar Cock, Shower, Mixer etc.

Low cost housing, Acoustics in building, Rain Water Harvesting in building

UNIT –II **Orientation and Planning of Building**

Orientation and planning of building for energy saving, Energy efficient buildings and related building rating system in India:Green Rating for Integrated Habitat Assessment (GRIHA), Leadership in Energy and Environment Design (LEED) and Indian Green Building Council (IGBC) Rating System.

UNIT-III **Requirementof Drinking Water in Buildings**

Water resources, Water demand, Drinking water requirement, Drinking water characteristics: Organoleptic and Physical Parameters: Colour, Odour, pH, Total dissolved solids, General Parameters Concerning Substances Undesirable in Excessive Amounts: Fluoride, Free residual chlorine, Iron, Magnesium, Sulphate, Total alkalinity, Total hardness, Parameters Concerning Toxic Substances: Pesticides, Arsenic, Chromium, Parameters Concerning Radioactive Substances, Pesticide Residues Limits and Test Method, Bacteriological Quality of Drinking Water: E. coli, Total coliform bacteria,Water Borne Diseases, Hygienic Practices, Controlling Water Borne Diseases

UNIT-IV **Earthquake Zones and Safe Masonry Building Requirements**

Introduction to earthquake resistant buildings, Seismic Zonesin India, Importance factor of building, Earthquake resistant construction of masonry load bearing house, Separation Section, Crumple Section, Categories of buildings, Mortar, Walls, Masonry Bond, Openings in Bearing Walls, Separation of Adjoining Structures, General Principles: Lightness, Continuity of Construction, Projecting and Suspended Parts, Building Configuration, Seismic Strengthening Arrangements Recommended for Masonry Buildings, Band: Lintel band, Roof band, Gable band, Section and Reinforcement of Band, Vertical Steel Reinforcement in Masonry Walls

UNIT-V **Smart City Features**

Smart city concept and necessity, features and elements, evolution of smart cities, urban characteristics, Integration of urban dimensions-Technological, Human, and Institutional, Introduction to Integrated Command and Control Centre, Applications managing various sensors (like Video Management System, Parking Management System, VMD Management System, ITMS, etc.), Applications catering to Civic Services to Citizens/Businesses like Building Permission

Management System, Birth/Death Record Management System, License Management System, Property Tax System, Water Billing System, etc. Applications for various city infrastructure monitoring/management like Hospital Management, School Education Management, Theatre/Open Space Management, City Bus Management, Street Light Management, etc. Applications for effective management of internal functions like Human Resource Management System, Asset Management System, Legal Case Management System, Finance, Project Systems, AI/Data Analytics, GIS based Visualization, Predictive Modeling

Text Books & References :

1. Purushothama Raj, "Building Construction Materials & Techniques" Pearson Edu.
2. PC Varghese, "Building Materials" PHI
3. Rangwala, "Building Materials" Charotar Publishing House.
4. Sushil Kumar, "Building Construction" Standard Publisher.
5. BC Punmia, "Building Construction" Laxmi Publication
6. Chudley, R. Greeno, Building Construction Handbook, Butterworth
7. Green Building : Principles & Practices,Dr. Adv. HarshulSavla, Notion Press
8. Vulnerable India: A Geographical Study of Disasters- By: ArunKapur, SAGE Publications India Pvt Ltd
9. Disaster management in India- By Rajendra Kumar Pandey, SAGE Publications India Pvt Ltd
10. IS 10500: Drinking Water — Specification
11. IS 4326: Earthquake Resistant Design and Construction of Buildings — Code of Practice
12. IS 1893 (Part-1): Criteria For Earthquake Resistant Design of Structures: General Provisions and Buildings
13. https://beeindia.gov.in/en/programmesenergy-efficiency-in-buildings/star-rating-for-buildings
14. https://www.commercialdesignindia.com/tags/green-building-code
15. https://bis.gov.in/wp-content/uploads/2022/08/Booklet-Guide-for-Using-NBC-2016.pdf
16. https://igbc.in/
17. https://smartcities.gov.in/