B.Tech – IV Year I Semester

S. No.	Category	Title	L	T	P	Credits
1	Professional Core	CAD/CAM	2	0	0	2
2	Management Course- II	Operations Research	2	0	0	2
3	Professional Core	CAD/CAE/CAM Lab	0	0	2	1
4	Professional Elective	Professional Elective-IV	3	0	0	3
5	Professional Elective	Professional Elective-V	3	0	0	3
6	Open Elective - III	1. Finite Element Methods 2. Introduction to Mechatronics 3. Product design and development 4. Advanced Materials 5. Smart Manufacturing 6. NPTEL	3	0	0	3
7	Open Elective - IV	1. Optimization Techniques 2. Quantum Technology 3. Total Quality Management 4. Operations Management 5. Energy Auditing 6. NPTEL	3	0	0	3
8	Skill Enhancement Course	Mechatronics Lab	0	0	4	2
9	Audit Course	Constitution of India	2	0	0	-
10	Internship	Evaluation of Industry Internship	-	-	-	2
		Total	**18**	**0**	**6**	**21**

Professional Elective – IV

1. Mechatronics
2. Computational Fluid Dynamics
3. Functional Materials
4. Embedded Systems and Programming
5. NPTEL

Professional Elective-V

1. Hydrogen and Fuel Cell Technology
2. Smart manufacturing
3. Cryogenics
4. Electrical drives and actuators
5. Quantum Science and Technology
6. NPTEL

B.Tech. – IV Year II Semester

S. No.	Category	Title	L	T	P	Credits
1	PR	Internship and Project	-	-	24	12

IV Year-I Semester	CAD/CAM	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES: To enable the students to

1. Understand the basic fundamentals of computer aided design and manufacturing.
2. Learn 2D &.3D transformations of the basic entities like line, circle, ellipse etc.
3. Understand the different geometric modeling techniques like solid modeling,
4. Explain surface modeling, feature based modeling etc.
5. Learn the part programming, importance of group technology, computer aided process planning, computer aided quality control
6. To learn the overall configuration and elements of computer integrated manufacturing systems.

UNIT I

INTRODUCTION: Fundamentals of CAD, CAM, Automation, design process, Application of computers for design, Benefits of CAD, Product Design and CAD- Comparison, benefits of using CAD in product design and product development cycle.

COMPUTER GRAPHICS: Raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 3D transformations, mathematics of projections.

UNIT II

WIRE FRAME MODELLING: Definition, advantages, dis-advantages, w1re frame entities- analytic entities and synthetic entities.

SURFACE MODELLING: Definition, advantages, disadvantages, surface entities-analytic entities and synthetic entities.

SOLID MODELLING: Definition, constructive solid geometry, advantages, modelling entities. Curve representation: Implicit and explicit forms of straight line, circle, ellipse, cubic spline and Bezier curve, differences between Bezier curve and, cubic spline curve and Introduction to Data exchange formats.

UNIT III

PART PROGRAMMING: NC, NC modes, NC elements, CNC machine tools and their applications, Parts and power transmission in CNC machine tools, features of Machining center, turning center, CNC Part Programming: fundamentals, Computer Aided Part Programming- APT language, simple problems in Computer Aided Part Programming. Direct Numerical Control, Adaptive Control.

UNIT IV

GROUP TECHNOLOGY: Part family, coding and classification, Optiz and MICLASS classification system, benefits of group technology - production flow analysis, types and advantages.

FMS: Introduction, types of FMS, Equipment, Tool management systems, Layouts, FMS control.

UNITV

COMPUTER INTEGRATED MANUFACTURING SYSTEMS: Types of manufacturing systems, machine tools and related equipment, material handling systems, material requirement planning, MRP, Enterprise resource planning, computer control systems, human labor in manufacturing systems, CIMS benefits, computer aided quality control, Computer aided processes planning - variant process planning and generative process planning-Implementation considerations.

TEXT BOOKS:

1. Automation, Production systems & Computer integrated Manufacturing/ M.P. Groover/Pearson Education
2. Mastering CAD/CAM - Ibrahim Zeid / McGraw-Hill

REFERENCES:

1. CAD / CAM Principles and Applications/PN Rao / McGraw-Hill
2. Principles of Computer Aided Design and Manufacturing / Farid Amirouche /Pearson
3. Computer Numerical Control Concepts and programming / Warren S Seames /Thomson leaming, Inc
4. Product manufacturing and cost estimation using CAD/CAE/ Kuang Hua Chang/Elsevier Publishers

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

CO1: Understand the basic fundamentals of computer aided design and manufacturing.
CO2: Learn 2D &.3D transformations of the basic entities like line, circle, ellipse etc
CO3: Understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication
CO4: Learn the part programming, importance of group technology, computer aided process planning, computer aided quality control
CO5: Learn the overall configuration and elements of computer integrated manufacturing systems.

IV Year-I Semester	OPERATIONS RESEARCH	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES: The student will acquire the knowledge

1. Understand Linear Programming models
2. Interpret Transportation and sequencing problems
3. Solve replacement problems and analyze queuing models
4. Understand game theory and inventory problems
5. Interpret dynamic programming and simulation.

UNIT I

INTRODUCTION: Definition- characteristics and phases - types of operation research models - applications.

LINEAR PROGRAMMING: Linear programming problem formulation – graphical solution - simplex method - artificial variables techniques -two-phase method, big-M method - duality principle.

UNIT II

TRANSPORTATION PROBLEM: Formulation optimal solution, unbalanced transportation problem - degefieracy, assignment problem - formulation – optimal solution - variants of assignment problem- travelling salesman problem.

SEQUENCING: Introduction - flow -shop sequencing - n jobs through two machines - n jobs through three machines - job shop sequencing - two jobs through 'm' machines.

UNIT III

REPLACEMENT: Introduction - replacement of items that deteriorate with time - when money value is not counted and counted - replacement of items that fail completely, group replacement.

GAME THEORY: Introduction - mini. max (max. mini) - criterion and optimal strategy - solution of games with saddle points - rectangular games without saddle points - 2 x2 games - dominance principle - m x 2 & 2x n games -graphical method.

UNIT IV

QUEUEING THEORY: Introduction - single channel - poison arrivals – exponential service times - with infinite population and finite population models- multichannel - poison arrivals - exponential service times with infinite population single channel.

INVENTORY CONTROL: Introduction - single item - deterministic models - purchase inventory models with one price break and multiple price breaks - shortages are not allowed - stochastic models - demand may be discrete variable or continuous variable, Instantaneous demand and continuous demand and no set up cost. ABC & VED Analysis.

UNIT V

DYNAMIC PROGRAMMING: Introduction - Bellman's principle of optimality – PERT, CPM methods, shortest path problem.

SIMULATION: Definition - types of simulation models - phases of simulation - applications of simulation - inventory problems.

TEXT BOOKS:

1. Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
2. Operations Research -Theory &, publications / S.D. Sharma- Kedarnath /McMillan publishers India Ltd

REFERENCES:

1. Introduction to O.R/Hiller & Libermann/TMH
2. Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, Arhur Yaspan& Lawrence Friedman/Wiley
4. Operations Research / R. Pannerselvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.
6. Operation Research /J.K. Sharma/MacMilan Publ.
7. Operations Research/ Pai / Oxford Publications
8. Operations Research/S Kalavathy / Vikas Publishers
9. Operations Research / DS Cheemaf university Science Press
10. Operations Research / Ravindran, Philips, Solberg / Wiley publishers

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

CO1: Understand Linear Programming models
CO2: Interpret Transportation and sequencing problems
CO3: Solve replacement problems and analyze queuing models
CO4: Understand game theory and inventory problems
CO5: Interpret dynamic programming and simulation.

IV Year-I Semester	CAD/CAM&CAE LAB	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1 To give exposure to software tools needed to analyze engineering problems.
2. To expose the students to different applications of simulation and analysis tools.

Note: Student shall perform at least three experiments from each section

CONTENTS

1. Experiments to determine stresses, deflection, natural frequencies, harmonic analysis, HT analysis and buckling analysis.
   a) Determination of deflection and stresses in2D and 3D trusses and beams.
   b) Determination of principal and Von-mises stresses in plane stress, plane strain and axisymmetric components.
   c) Determination of stresses in 3D and shell structures (at least one example in each case)
   d) Estimation of natural frequencies and mode shapes, harmonic response of 2D beam.
   e) Steady state heat transfer analysis of plane and axisymmetric components.
   f) Buckling analysis

2. Study of CNC part programming fundamentals and write part programmes for simple components on CNC lathe and Mill and study of RP machine.
   a) CNC part programming for turned components
      (i) Plain turning and facing
      (ii) Step Turning Operation
      (iii) Taper turning
   b) CNC programming for milled components
      (i) Circular interpolation
      (ii) End milling
      (iii) Pocket milling

3. Automated CNC Tool path and G-Code generation using CAM packages.
4. Study and demonstration of RP machine-creation of simple parts.
5. Virtual 3D Printing Simulation lab using Vlabs.
   https://3dp-dei.vlabs.ac.in/List%20of%20experiments.html

COURSE OURCOMES: At the end of the course, student wilt be able to

CO1: Generate CNC Turning and Milling codes for different operations using standard CAM packages.
CO2: Apply rapid prototyping concepts in engineering and real time applications

IV Year-I Semester	MECHATRONICS (Professional Elective-IV)	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES: The student will acquire the knowledge

1. To understand the use the various mechatronics systems, measurement systems, sensors and transducers.
2. To apply the concepts of solid state electronic devices.
3. To identify the components in the design of electro mechanical systems.
4. To apply the concepts of digital electronics and applications of PLCs for control.
5. To understand system interfacing, data acquisition and design of mechatronics systems.

UNIT I

MECHATRONICS SYSTEMS: Elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT II

SOLID STATE ELECTRONIC DEVICES: PN junction diode, BJT, FET, DIAC, TRIAC and LEDs. Analog signal conditioning, operational amplifiers, noise reduction, filtering

UNIT III

HYDRAULIC AND PNEUMATIC ACTUATING SYSTEMS: Fluid systems, Hydraulic systems, and pneumatic systems, components, Hydraulic and Pneumaticactuators, control valves, electro pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

UNIT IV

DIGITAL ELECTRONICS AND SYSTEMS: Digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT V:

SYSTEM AND INTERFACING AND DATA ACQUISITION: Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing - data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives. Design of mechatronics systems & future trends.

TEXT BOOKS:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan& MS Balasundaram/WllEY India Edition

REFERENCES:

1. Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press
2. Mechatronics Source Book / Newton C Braga/Thomson Publications, Chennai.
3. Mechatronics - N. Shanmugam / Anuradha Agencies Publishers.
4. Mechatronics System Design / Devdasshetty/Richard/Thomson.

5. Mechatronics/M.D. Singh/J.G.JoshiiPHI.
6. Mechatronics - Electronic Control Systems in Mechanical and Electrical Enoo 4th Edition / W. Bolton/ Pearson, 2012
7. Mechatronics - Principles and Application / Godfrey C. Onwubolur/Elsevier, Indianprint

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

CO1: Understand the use the various mechatronics systems, measurement systems, sensors and transducers.
CO2: Apply the concepts of solid state electronic devices.
CO3: Identify the components in the design of electro mechanical systems.
CO4: Apply the concepts of digital electronics and applications of PLCs for control.
CO5: Understand system interfacing, data acquisition and design of mechatronics systems.

IV Year-I Semester	COMPUTATIONAL FLUID DYNAMICS (Professional Elective-IV)	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES: The student will acquire the knowledge

1. To explain elementary details and numerical techniques for solving various engineering problems involving fluid flow.
2. To solve problems of fluid flow using applied numerical methods and understand equations governing fluid flow and heat transfer
3. To interpret fluid flow problems with steady flow and finite difference in heat conduction and convention
4. To understand the concepts of finite differences, discretization, consistency, stability and fundamentals of fluid flow modelling\To understand the concepts of finite element method applied to heat transfer problems.

UNIT I:

CLASSIFICATION OF PDE - REVIEW OF EQUATIONS GOVERNING FLUID FLOW AND IIEAT TRANSFER: Introduction, conservation of mass, Newton's second law of motion, expanded forms of Navier-stokes equations (Derivation), conservation of energy principle, special forms of the Navier-stokes equations.

APPLIED NUMERICAL METHODS: Solution of a system of simultaneous linear algebraic equations, iterative schemes of matrix inversion, direct methods for matrix inversion, direct methods for banded matrices, TDMA - Algorithms.

UNIT II

Steady flow, dimensionless form of momentum and energy equations, stokes equation, conservative body force fields, stream function - vorticity formulation. Finite difference applications in heat conduction and convention –heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer, closure.

UNIT III

Finite differences, discretization, consistency, stability, and fundamentals of fluid flow modelling: introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods.

UNIT IV

FINITE ELEMENT METHOD: Introduction weighted Residual and Variational Formulations - Rayleigh-Ritz Method - Interpolation – One dimensional and two dimensional regions - Error Control – Applications of FEM to One dimensional Problems (Steady and Transient) – Two dimensional problems

UNIT V

INTRODUCTION TO FIRST ORDER WAVE EQUATION: Stability of hyperbolic and elliptic equations, fundamentals of fluid flow modelling, conservative property, the upwind scheme.

FINITE VOLUME METHOD: Approximation of surface integrals, volume integrals, interpolation and differentiation practices, upwind interpolation, linear interpolation and quadratic interpolation.

TEXT BOOKS:

1. Numerical heat transfer and fluid flo#Suhas V. Patankar/Butter-worth Publishers
2. Computational fluid dynamics-Basics with applications/John.D.Anderson/McGrawHill.

REFERENCES:

1. Computational Fluid Flow and Heat Transfer/ Niyogi/Pearson Publications
2. Introduction to CFD: Finite Volume Method H. Versteeg and W. Malalasekahara
3. Fundamentals of Computational Fluid Dynamics /Tapan K.Sengupta /Universities Press.
4. Computational fluid dynamics: An introduction. 3'd edition/John.F Wendt/Springer publishers

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

CO1: Find elementary details and numerical techniques for solving various engineering problems involving fluid flow.

CO2: Solve problems of fluid flow using applied numerical methods and understand equations goveming fluid flow and heat transfer.

CO3: Interpret fluid flow problems with steady flow and finite difference in heat conduction and convection.

CO4: Understand the concepts of finite differences, discretization, consistency, stability and fundamentals of fluid flow modeling.

CO5: Understand the concepts of first order wave equation and finite volume method.

IV Year-I Semester	FUNCTIONAL MATERIALS (Professional Elective-IV)	L	T	P	C
		0	0	2	1

COURSE OBJECTMS: The student will acquire the knowledge:

1. To make the students to understand the basics of crystallography and its importance in studying materials properties.
2. To understand the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials.
3. To instil knowledge on physics of semiconductors, determination of charge carriers.
4. To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications
5. To inculcate an idea of significance of nano structures, quantum confinement.

UNIT I

CRYSTALLOGRAPHY: Crystal structures: BCC, FCC and HCP - directions and planes - linear and planar densities - crystal imperfections- edge and screw dislocations - grain and twin boundaries - Burgers vector and elastic strain energy- Slip systems, plastic deformation of materials - Polymorphism - phase changes.

UNIT II

ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS: Classical free electron theory - Expression for electrical conductivity - Thermal conductivity, expression - Quantum free electron theory :Tunneling - degenerate states - Fermi- Dirac statistics – Density of energy states - Electron in periodic potential - Energy bands in solids - tight binding approximation - Electron effective mass - concept of hole. Magnetic materials: Dia, para and ferromagnetic effects paramagnetism in the conduction electrons in metals – exchange interaction and ferromagnetism - quantum interference devices - GMR devices.

UNIT III

SEMICOI\DUCTORS AND TRANSPORT PIIYSICS: Intrinsic Semiconductors – Energy band diagram - direct and indirect band gap semiconductors - Carrier concentration in intrinsic semiconductors - extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors - Variation of carrier concentration with temperature - Carrier transport in Semiconductors: Drift, mobility and diffusion - Hall effect and devices - Ohmic contacts - Schottky diode

UNIT IV

OPTICAL PROPERTIES OF MATERIALS: Classification of optical materials – Optical processes in semiconductors: optical. Absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells - Optoelectronic devices: light detectors and solar cells -.light emitting diode - laser diode - optical processes in organic semiconductor devices -excitonic state - Elecho-optics and nonlinear optics: Modulators and switching devices - plasmonics.

UNIT V

NANOELECTRONIC MATERIALS: Quantum confinement - Quantum structures - quantum wells, wires and dots - Zener-Bloch oscillations - Resonant tunneling – quantum interference effects - mesoscopic structures - Single electron phenomena - Single electron Transistor. Semiconductor

photonic structures - 1D, 2D and 3D photonic crystal. Active and passive optoelectronic devices - photo processes - spintronics - carbon nanotubes: Properties and applications.

TEXT BOOKS:

1. V.Raghavan. Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited, 201 5.
2. S.O. Kasap, Principles of Electronic Materials and Devices, Mc-Graw Hill, 2018.
3. Jasprit Singh, Semiconductor Devices: Basic Principles, Wiley (India), 2007.
4. Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, Mc-Graw Hill India (2019)
5. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009

REFERENCES:

1. R.Bala subramaniam, Callister's Materials Science and Engineering. Wiley (Indian Edition), 2014.
2. Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 20l3.
3. Robert F.Pierret, Semiconductor Device Fundamentals, Pearson, 2006
4. Pallab Bhattacharya, Semiconductor optoelectronic Devices, Pearson, 2017
5. Ben Rogers, Jesse Adams and Sumita Pennathur, Nanotechnolory: Understanding Small Systems, CRC Press, 2017.

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

CO1: Know basics of crystallography and its importance for varied materials properties
CO2: Gain knowledge on the electrical and magnetic properties of materials and their applications
CO3: Understand clearly of semiconductor physics and functioning of semiconductor devices
CO4: Understand the optical properties of materials and working principles of various optical devices
CO5: Appreciate the importance of functional Nano electronic devices.

IV Year-I Semester	EMBEDDED SYSTEMS AND PROGRAMMING (Professional Elective-IY)	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES: The student will acquire the knowledge:

1. To familiarize the architecture and fundamental units of microcontroller.
2. To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.
3. To design the interface circuit and programming of VO devices, sensors and actuators.
4. To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.
5. To acquaint the knowledge of real time embedded operating system for advanced system developments

UNIT I

INTRODUCTION TO MICROCONTROLLER: Fundamentals Functions of ALU - Microprocessor - Microcontrollers - CISC and RISC - Types Microcontroller – 8051 Family - Architecture - Features and Specifications - Memory Organization – Instruction Sets - Addressing Modes.

UNIT II

PROGRAMMING AND COMMIINICATION: Fundamentals of Assembly Language Programming - Instruction to Assembler - Compiler and IDE - C Programming for 8051 Microcontroller - Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts - Interfacing and Programming of Serial Communication,I2C, SPI and CAN of 8051 Microcontroller - Bluetooth and WI-FI interfacing of 8051 Microcontroller.

UNIT III

PERIPHERAL INTERFACING: VO Programming - Interfacing of Memory, Key Board and Displays - Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming - Closed Loop Control Programming of Servomotor - Traffic Light

UNIT IV

ARM PROCESSOR: Introduction ARM 7 Processor - Internal Architecture - Modes of Operations * Register Set - Instruction Sets - ARM Thumb - Thumb State Registers -
Pipelining - basic programming of ARM 7 - Applications. . ,

UNIT V

SINGLE BOARD COMPUTERS AND PROGRAMMING: System on Chip Broadcom BCM27L1 SoC - SBC architecture - Models and Languages – Embedded Design - Real Time Embedded Operating Systems - Real Time Programming Languages - Python for Embedded Systems- GPIO Programming – Interfacing

TEXT BOOKS:

1. Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley. Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture and Programming Applications", 2003.

REFERENCES:

1. Muhammad Ali Mazidi and Janice GillispicMazdi,"The 8051 Microcontroller and Embedded Systems", Pearson Education, 2006.
2. Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Pyhon McGraw Hill TAB;2nd edition,2O15
3. James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
4. John B. Peatman, "Design with Microcontrollers", McGraw Hill International, USA, 2005.

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

CO1: Know the various functional units of microcontroller, processors and system-on-chip based on the features and specifications.

CO2: Recognize the role of each functional units in microcontroller, processors and system- on-chip based on the features and specifications

CO3: Interface the sensors, actuators and other I/O's with microcontroller, processors and system on chip based interfacing

CO4: Design the circuit and write the programming microcontroller, processors and system on ch

CO5: Develop the applications using embedded system.

IV Year-I Semester	HYDROGEN AND FUEL CELL TECHNOLOGY (Professional Elective-V)	L	T	P	C
		0	0	2	1

COURSE OBJECTWES: The student will acquire the knowledge:

1. To introduce the fundamentals of the hydrogen economy, including hydrogen production, storage, and transportation methods.
2. To explore various hydrogen production methods and in-depth knowledge of hydrogen storage technologies and materials.
3. To understand the principles, types, and working mechanisms of various fuel cells and their components.
4. To study hydrogen and lithium storage systems and their applications in energy systems.
5. To analyze green hydrogen technologies with emphasis on sustainable production, storage, and utilization methods.

UNIT I

HYDROGEN PRODUCTION: Hydrogen economy introduction to hydrogen economy production. Storage and transportation systems hydrogen from fossil fuels electrolysis of water thermochemical cycles - baseline and alternative thermochemical cycles.

UNIT II

HYDROGEN STORAGE TECHNOLOGY: Hydrogen production methods. Purification, hydrogen storage methods and materials: metal hydrides and metal-organic framework materials. Volumetric and gravimetric storage capacities. Hydriding and dehydriding kinetics, high enthalpy formations and thermal management during hydriding reaction. Multiple catalytic degradation of sorption properties" automotive applications.

UNIT III

FUEL CELL TECHNOLOGY: Fuel cell Principles. Types of fuel cells (Alkaline Electrolyte. Phosphoric acid. Molten Carbonate, solid oxide and direct methanol and Proton exchange fuel cells), Principle and operation of Proton Exchange Membrane (PEM) fuel cell, Materials and fabrication methods for fuel cell technology, micro fuel cell sources, Biofuels.

UNIT IV

ENERGY APPLICATIONS: Lithium & Hydrogen adsorption & storages, Fuel cell applications and energy storage- Safety aspects of Fuel cell.

UNIT V

GREEN HYDROGEN TECHNOLOGIES: Green Hydrogen Production. Storage. Utilization and Purification.

TEXT BOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507 -6, SPRINGER

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons,1998
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

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

CO1: Explain various hydrogen production methods such as electrolysis, fossil-fuel based processes, and thermochemical cycles, and their role in the hydrogen economy.

CO2: Evaluate hydrogen storage materials such as metal hydrides and MOFs based on their thermodynamic and kinetic properties for automotive and energy applications.

CO3: Compare different types of fuel cells and demonstrate the working principles and fabrication techniques of Proton Exchange Membrane (PEM) fuel cells.

CO4: Assess energy storage systems utilizing lithium and hydrogen adsorption technologies and their relevance in modern energy applications.

CO5: Design a sustainable green hydrogen production and purification process and assess its feasibility for real-world energy systems.

IV Year-I Semester	SMART MANUFACTURING (Professional Elective-V)	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES: The students will acquire the knowledge:

1. To define smart manufacturing and understand its key characteristics, corporate adaptation processes, and the role of Industry 4.0 technologies in minimizing the Six Big Losses in manufacturing.
2. To explore the role and applications of smart machines and sensors in IIoT, focusing on their function, ecosystem, and integration within industrial processes.
3. To understand the 5C architecture of Cyber-Physical Systems (CPS) and its role in enhancing manufacturing processes in Industry 4.0 environments.
4. To introduce Digital Twin technology, explore its applications in manufacturing, and understand the integration of Machine Learning (ML), AI, and predictive maintenance in enhancing industrial operations.
5. To study the IoT communication infrastructure and protocols required for Industry 4.0, focusing on connectivity standards and the selection of appropriate IoT protocols for industrial applications.

UNIT I

CONCEPTS OF SMART MANUFACTURING: Definition and key characteristics of smart manufacturing, Corporate adaptation processes, manufacturing challenges, challenges vs technologies, Overview of circular manufacturing, Stages in smart manufacturing. Minimizing six big losses in manufacturing with Industry 4.O, Industry 5.0, and their benefits

UNIT II

SMART MACHINES AND SMART SENSORS: Concept and Functions of a Smart, Machine Salient features and Critical Subsystems of a Smart Machine, Smart sensors; smart sensors ecosystem, need, benefits and applications of sensors in industry, Sensing for Manufacturing Process in IIoT, Block Diagram of an IoT Sensing Device, Sensors in IIoT Applications, Smart Machine Interfaces

UNIT III

ARCHITECTURE OF CYBER-PHYSICAL SYSTEM (CPS): Functions of CPS, 5C Architecture; Smart Connection Level, Data-to- Information Level, Cyber Level, Cognition Level, Configuration Level. Design of PHM based CPS systems. Comparison of today's factory and Industry 4.0 factory by the implementation of 5C CPS architecture.

UNIT IV

DIGITAL TWIN: Introduction, applications of digital twirls, impact zones of digital twins in manufacturing (factories/plants and OEMs), advantages of digital twins, basic steps of digital twin technology, Multiverse and AR and VR.

MACHINE LEARNING (ML) AND ARTIFICIAL INTELLIGENCE (AI) IN MANUFACTURING: Introduction, benefits and applications of ML in industries, common approaches of ML; supervised and unsupervised, semi-supervised and reinforced ML, Application of AI and ML for predictive maintenance.

UNIT V

IOT CONNECTIVITY FOR INDUSTRY 4.0: Industrial communication requirement and its infrastructure, an overview of different types of networks, mesh network in industrial IoT, IoT protocols and the internet, TCP/P (transmission control protocol/internet protocol) model, IoT connectivity standards: common protocols, application layer protocols, internet/network layer protocols, physical layer IoT protocols.

TEXT BOOKS:

1. Industry 4.0 The Industrial Internet of Things by Alasdair Gilchrist, Apress
2. Industrial Intemet of Things, Cyber Manufacturing System by Sabina Jeschke, Christian Brecher, Houbing Song Danda B. Rawat, Springer

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

CO1: Demonstrate a comprehensive understanding of smart manufacturing and explain how Industry 4.0 minimizes the Six Big Losses in manufacturing processes.

CO2: Analyze and explain the function of smart machines and sensors, including their Integration into IoT and their impact on manufacturing processes.

CO3: Explain the 5C architecture of CPS and how its implementation transforms Manufacturing systems in the context of Industry 4.0.

CO4: Describe the key benefits and applications of Digital Twin technology, ML, AI, and Predictive maintenance in optimizing manufacturing processes.

CO5: Identify and assess various IoT connectivity protocols, selecting the most suitable for Specific industrial IoT applications in the context of Industry 4.0.

IV Year-I Semester	CRYOGENICS (Professional Elective-V)	L	T	P	C
		0	0	2	1

COURSE OBJECTTVES: The students will acquire the knowledge:

1. To understand the different fluid and material properties at low temperatures
2. To impart knowledge of the working principle of various Cryo refrigerators, thermodynamic cycles for attaining low temperature, and gas separation and purification principles
3. To understand the fundamental principles of thermal design of storage vessels and insulation, transfer systems.
4. Understand the cool-down process and heat transfer in cryogenic fluids and the occurrence of two-phase flow and stratification in cryogenic systems.
5. Understand the importance of vacuum requirements in cryogenics, superconductivity, and special phenomena at very low-temperature engineering applications.

UNIT I:

FLUID AND MATERIAL PROPERTIES AT LOW TEMPERATURE APPLICATIONS OF CRYOGENICS: Introduction to cryogenics: Cryogenic temperature scale, Properties of cryogenic fluids, super fluidity of He3 & He 4, properties of engineering materials at cryogenic temperatures, mechanical properties, thermal properties, electric & magnetic properties., super conducting materials.

UNIT II:

CRYOGENIC GAS LIQUIFICATION: Gas liquefaction systems: Introduction, thermodynamically ideal systems, Joule Thomson effect, liquefaction systems such as Linde Hampton, precooled Linde Hampton, Linde dual pressure, cascade system, claude system, Kapitza systiem, Heyland systems using expanders, comparison of liquefaction systems and its performance evaluations.

UNIT III

CRYOGENIC REFRIGERATOR AND CRYOCOOLERS:

Cryogenic Refrigeration System: Ideal isothermal and reversible isobaric source refrigeration cycles, Joule Thomson system, cascade or pre-cooled joule-Thomson refrigeration systems, expansion engine and cold gas refrigeration systems, Sterling refrigerators, Importance of regenerator effectiveness for the Sterling refrigerators, Gifford single volume refrigerator, Gifford double volume refrigerators analysis, Refrigerators using solids as working media: Magnetic cooling, magnetic refrigeration systems, thermal; valves, nuclear demagnetization, dilution refrigerator.

UNIT IV

CRYOGENIC FLUID STORAGE, INSTRUMENTATION, AND INSULATION: Dewar vessel for cryogenic fluid storage, Construction, Inner vessel design, outer vessel design, Temperature - measurements, pressure measurements, flow measurements, level liquid measurements, fluid quality measurements, Cryogenic insulation - expanded foams, gas filled & fibrous insulation, vacuum insulation, evaluated powder & fibrous insulation, opacified powder insulation, multilayer insulation, comparison of performance of various insulations- Safety Aspects.

UNIT V:

Applications of cryogenic systems: Super conductive devices, space technology, space simulation, cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsions.

TEXT BOOKS:

1. Barron, R., 1985, Cryogenic Systems, SI version, Oxford university press.
2. Scott, R. B., 1962, Cryogenic Engineering, D. Van Nostrand Company.

REF'ERBNCES:

1. Timmerhaus, K. D- and Flynn, T.M., r9g9, cryogenic process Engineering, prenum Press.
1. Yance, R. w-, and Duke, w.M., 1962, Appried cryogenic Engineering, John wiley.
2. Sittig, M., 1963, cryogenics Research and Applicaiiois, D. vin Nostrind company.
3. Hands,B.A., 1986, Cryogenic engineering, Academic piess.
4. Flynn, T. M., 2005, Cryogenic Engineering, Marcel Oekker Inc., New.york.

COURSE OURCOMES: At the end of the course, the student able to

CO1: Understand the different fluid and material properties at low temperatures

CO2: Impart knowledge of the working principles of various cryo refrigerators, thermodynamic cycles for attaining low temperature, and gas separation and purification principles

CO3: Understand the fundamental principles of thermal design of storage vessels and insulation, transfer systems.

CO4: Understand the cool-down process and heat transfer in cryogenic fluids and the occurrence of two-phase flow and stratification in cryogenic systems.

CO5: Understand the importance of vacuum requirements in cryogenics, superconductivity, and special phenomena at very low-temperature engineering applications.

IV Year-I Semester	Electrical drives and Actuators (Professional Elective-V)	L	T	P	C
		0	0	2	1

COURSE OBJECTVES: The students will acquire the knowledge:
1. To familiarize a relay and power semiconductor devices
2. To get a knowledge on drive characteristics
3. To obtain the knowledge on DC motors and drives.
4. To obtain the knowledge on AC motors and drives.
5. To obtain the knowledge on Stepper and Servo motor

UNIT I
RELAY AND POWER SEMI-CONDUCTOR DEVICES: Study of Switching Devices - Relay and Types, Switching characteristics -BJT, SC& TRIAC, GTO, MOSFET, IGBT and IGCT-: SCR, MOSFET and IGBT - Triggering and commutation circuit - Introduction to Driver and snubber circuits

UNIT II
CHARACTERISTICS: Electric drive - Equations governing motor load dynamics - steady state stability - multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping - Selection of motor

UNIT III:
DC MOTORS AND DRIVES: DC Servomotor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations - characteristics and control - Drives- H Bridge - Single and Three Phases - 4 quadrant operation - Applications

UNIT IV:
AC MOTORS AI\D DRIVES: Introduction - Induction motor drives - Speed control of 3-phase induction motor - Stator voltage control - Stator frequency control - Stator voltage and frequency control - Stator current control - Static rotor resistance control - Slip power recovery control- VVF drives.

UNIT V:
STEPPER AND SBRVO MOTOR: Stepper Motor: Classifications- Construction and Principle of Operation - Modes of ExcitationDrive System-Logic Sequencer - Applications. Servo Mechanism - DC Servo motor-AC Servo motor - Applications.

TEXT BOOKS:
1. Bimbhra B.S., "Por.ver Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2. Mehta V.K. &Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 20l6.

REFERENCES
1. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 200l.
2. TherajaB.L. &Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2012.
3. Singh M.D. &Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007

COURSE OUTCOMES: At the end of the course, the student able to

CO1: Recognize the principles and working of relays, drives and motors
CO2: Explain the working and characteristics of various drives and motors.
CO3: Apply the solid state switching circuits to operate various types of Motors and Drivers
CO4: Interpret the performance of Motors and Drives.
CO5: Suggest the Motors and Drivers for given applications

IV Year-I Semester	QUANTUM SCIENCE AND TECHNOLOGY (Professional Elective-V)	L	T	P	C
		0	0	2	1

Prerequisites: Basic Physics, Linear Algebra, and Introduction to Modern physics

COURSE OBJECTIVES: The students will acquire the knowledge:

1. To introduce fundamental concepts of quantum mechanics and its mathematical formalism.
2. To explore quantum computing and communication principles and technologies.
3. To understand the physical implementation and limitations of quantum systems.
4. To enable students to relate quantum theory to practical applications in computing, cryptography, and sensing.
5. To familiarize students with the emerging trends in quantum technologies.

UNIT I:

Fundamentals of Quantum Mechanics: Historical background: Blackbody radiation, photoelectric effect, and Compton scattering; Dual nature of light and matter; De Broglie hypothesis; Schrddinger equation; Free particle, infinite potential well, step potential; Operators and observables: position, momentum, Hamlltonian; Commutation relations and uncertainty principle; Quantum postulates and measurement theory; Eigenvalues, eigenfunctions.

UNIT II:

Quantum Information Theory: Classical vs. quantum information; eubit representation using Bloch sphere; euantum superposition and quantum entanglement; Dirac notation (bra-ket), tensor products, and composite systems; Bell states and EPR paradox; Quantum gates: pauli-X, y, z;Hadamard; phase; T; cNor; Quantum circuit models and notation; Measurement in computational basis; euantum teleportation and no-cloning theorem; euantum state tomogiaphy (introductory)

UNIT III: Quantum Computing: Classical cbmputing review and limitations; euantum parallelism and interference; Deutsch and Deutsch-Jozsa algorithms; Grover'i search algorithm, Oracle and amplitude amplification; Shor's factoring algorithm (overview and significance); Quantum Fourier Transform (QFT); Quantum effor correction: Bitflip, phase-flip, and Shor's 9-qubit cbde; Introduction to quantum programming: Qiskit, Cirq, IBM Quantum Experience (overview) ' 1

UNIT IV:

Quantum Communication: Introduction to quantum cryptography; euantum key distribution (QKD): BB84 protocol; Entanglement-based qfO: ntert pritocol (Eglj; Eavesdropping and security of QKD; Quantum teleportation (circuit and protocol); Quantum dense coding; Quantum networks and entanglement swappingi Role of quantum repeaters; Single-photon sources and detectors; Implementation challenges (loss, decoherence, noise)

UNIT V:

Quantum Technologies and Applications: Quantum sensors: magnetometry, gravimetry; Quantum metrology: standard time, atomic clocks; Quantum imaging and lithography; Quantum materials: topological insulators, graphene, quantum dots; NV centers in diamonds for sensing; Hardware platforms: Superconducting qubits, Trapped ions, Photonic quantum processors; Quantum supremacy

and NISQ era; Global initiatives: IBM, Google, D-Wave, IonQ, India's NQM; Ethical concerns and future prospects

TEXT BOOKS:
1. "Quantum Computation and Quantum Information" by Michael A. Nielsen and Isaac L. Chuang
2. "Quantum Mechanics: Concepts and Applications" by Nouredine Zettili

COURSE OUTCOMES: After completing this course, students will be able to.
CO1 Explain core principles of quantum mechanics and their technological implications.
CO2. Analyze quantum phenomena like superposition and entanglement.
CO3. Apply mathematical tools to model and solve quantum systems.
CO4. Demonstrate understanding of quantum algorithms and quantum circuits.
CO5. Evaluate potential applications and challenges in quantum communication and sensing.

IV Year-I Semester	FINITE ELEMENT METHODS (Open Elective - III)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: The student will acquire the knowledge
1. To learn basic principles of finite element analysis procedure
2. To learn the theory and characteristics of finite elements that represent engineering structures of trusses and beams
3. To learn finite element modelling of two dimensional stress analysis
4- To learn the finite modelling for high order and isoparametric elements
5. To learn the usage of finite element method for the steady state heat transfer analysis

UNIT I:
Introduction to finite element method stress and equilibrium, strain displacement relations, stress-strain relations, plane stress and plane strain conditions, variational methods.

UNIT II:
Weighted residual methods, solving differential equations using weighted residual methods, concept of potential energy, one dimensional problems.

UNIT III:
Bar element formulation, Discretization of domain, element shapes, and discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, and local and global coordinates, convergence requirements, and treatrnent of boundary conditions.

UNIT IV:
Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Finite element modeling of four noded rectangular element.

UNIT V:
Higher order and iso-parametric elements: One dimensional, quadratic and cubic elements in natural coordinates, two dimensional four node diso-parametric elements and numerical integration.

TEXT BOOKS:
1. The Finite Element Methods in Engineering /SSRao/Pergamon.

REFERENCES:
1 Finite Element Method with applications in Engiqeenng IYM Desai' Eldho& Shah /Pearson publishers
2 An introduction to Finite Element Method /JNReddy/lvlcGrawHill
3 The Finite Element Method for Engineers-KennethH.Huebner, Donald L.Deu,hirst, Douglas E. Smith and TedG. Byrom/John Wiley &, sons (ASIA)fteltd.
4 Finite Element Analysis: Theory and Application with Ansys, Saeed Moaveniu, Pearson Education
5 Finite Element Methods / Chen

6 Finite Element Analysis: for students & Practicing Engineers IG.LakshmiNarasaiah / BSP Books Pvt. Ltd.

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

CO1 Understand the concepts discretization procedures and convergence requirements
CO2 Identify the application and characteristics of FEA elements such as bars and beams.
CO3 Understand the finite element method for the two dimensional stress analysis.
CO4 Apply FEM for one dimensional and two dimensional higher order and iso-parametric elements
CO5 Identify how the finite element method can apply for steady state heat transfer analysis.

IV Year-I Semester	INTRODUCTION TO MECHATRONICS (Open Elective - III)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: The student will acquire the knowledge

1. To understand the use the various mechatronics systems, measurement systems, sensors and transducers.
2. To apply the concepts of solid state electronic devices_
3. To apply the concepts of digital electronics and applications of PLCs for control.
4. To understand system interfacing, data acquisition and design of mechatronics

UNIT I:

Mechatronics systems - elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT II:

Solid state electronic devices - PN junction diode, BJT, FET, DIAC, TRIAC and Analog LEDs. Signal conditioning, operational amplifiers, noise reduction, filtering

UNIT III:

Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems - basic principles and elements.

UNIT IV:

Digital electronics and systems, digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT V:

System and interfacing and data acquisition - Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital signal processing _ data flow in DSPs, block diagrams, typical layouts, Interfering motor drives Design of mechatronics systems & future trends.

TEXT BOOKS:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan& MS BalasundaramiWllEY India Edition

REFERENCES:

1. Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press
2. Mechatronics Source Book / Newton C Braga/ThomsonPublications, Chennai.
3. Mechatronics -N. Shanmugam / Anuradha Agencies Publishers.
4. Mechatronics System Design / Devdas shetty/Richard/Thomson.

5. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
6. Mechatronics - Electronic Control Systems in Mechanical and Electrical Enoo 4th Edition / W. Bolton/ Pearson, 2012
7. Mechatronics - Principles and Application / Godfrey C. Onwubolu/Elsevier Indian print

COURSE OUTCOMES: At the end of the course, student wilt be able to

CO1 Understand the use the various mechatronics systems, measurement systems, sensors and transducers.
CO2 Apply the concepts of solid state electronic devices.
CO3 Identify the components in the design of electro mechanical systems.
CO4 Apply the concepts of digital electronics and applications of PLCs for control.
CO5 Understand system interfacing, data acquisition and design of mechatronics systems.

IV Year-I Semester	PRODUCT DESIGN AND DEVELOPMENT (Open Elective - III)	L	T	P	C
		3	0	0	3

COURSE OBJECTMS: The student will acquire the knowledge:
1. To introduce the fundamental concepts of the product design and development
2. To develop material specifications, analysis and process.
3. To Learn the Feasibility Studies & reporting of product design and development.
4. To study the new product qualification and Market Survey on similar products of product design and development
5. To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

UNIT I:
FUNDAMENTALS OF PRODUCT DESIGN AND DEVELOPMENT: Introduction - Reading of Drawing - Grid reading, Revisions, ECN (Engg. change Note), Component material grade, Specifications, customer specific requirements --Basics of monitoring of NPD applying Gantt chart, Critical path analysis - Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, oracle ERP Cloud -QFD.

UNIT II:
MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS: Material specification standards - ISO, DIN, JIS, ASTM, EN, etc. - Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis,), Fabrications, Welding process. Qualifications of parts mechanical, physical & chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

UNIT III:
ESSENTIALS oF PRODUCT DESTGN AND DEVEL0PMENT: RFQ (Request of Quotation) Processing - Feasibility Studies & reporting - CFT (Cross function Team) discussion on new product and reporting - Concept design, Machine selection for tool making, Machining - Manufacturing Process selection, Machining Planning, cutting tool selection - various Inspection ,methods - Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

UNIT IV:
CRITERIONS OF PRODUCT DESIGN AND DEVELOPMENT: New product qualification for Dimensions, Mechanical & Physical Properties, internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD (New Product Development).

UNIT V:

REPORTING & FORWARD-THINKING OF NPD: Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) - Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing - resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model - Advantages & Limitation of RE, CE, (Concurrent Engineering) - Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

TEXT BOOKS:

1. Product Development - Sten Jonsson
2. Product Design & Development - Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

REFERENCES:

1. RevolutionizingProduct Development - Steven C Wheelwright & Kim B. Clark
2. ToyotaProduct Development System - James Morgan & Jeffrey K. Liker
3. Winning at New Products - Robert Brands 3rd Edition
4. Product Design & Value Engineering - Dr. M.A. Bulsara &Dr. H.R. Thakkar

COURSE OUTCOMES: At the end of the course' student will be able to

CO1: Discuss fundamental concepts and customer specific requirements of the product design and development

CO2: Discuss the Material specification standards, analysis and fabrication, manufacturing process.

CO3: Develop Feasibility Studies & reporling of product design and development

CO4: Analyzing the New product qualification and Market Survey on similar products of new product development

CO5: Develop Reverse Engineering..Cloud points generation, converting cloud data to 3D model

lV Year-I Semester	ADVANCED MATERIALS (Open Elective - III)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: The students will acquire the knowledge
1. To classify the composite materials and identifr the applications
2. To understand manufacturing methods of pMC, MMC & CCC and their applications
3. To understand macro-mechanical analysis of a lamina
4. To interpret the functionally graded materials and their properties
5. To understand types of nano materials and their properties

UNIT I:
METALS & ALLOYS:
Metallic materials- super alloys, Aluminium, Magnesium, titanium and Nickel based alloys and inter metallics, Materials for cryogenic application, Materials for space environment, Evaluation of materials for extreme environment, Introduction to metallic foams.

UNIT II:
Polymers: Natural Polymers-Synthetic polymers- Chemical & Physical structure, properties glass-Transition temperature-Thermosets-Thermoplastics- characteristics & applications of polymers-Elastomers- Processing of plastics. Ceramics: Applications - characteristics- classification-Processing of ceramics- powder preparations- consolidation- hot compaction-drying- sintering-finishing of ceramics-Areas of application.

UNIT III:
INTRODUCTION TO COMPOSITE MATERIALS: Introduction, classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon*carbon composites, fiber-reinforced composites and nature-made composites, and applications
REINFORCEMENTS: Fibres- glass, silica, keviar, carbon, boron, silicon carbide and born carbide fibres.

UNIT IV:
SHAPE MEMORY ALLOYS: Introduction-shape memory effect-classification of shape memory alloys-composition-properties and applications of shape memory alloys.
FUNCTIONALLY GRADED MATERIALS: Types of functionally graded materials classification different systems-preparation-properties and applications oi functionally graded materials.

UNIT V:
NANO MATERIALS: Introduction-properties at nano's'cales-advantages & disadvantages applications in comparison with bulk materials (nano - structure. wires, tubes, composites). state of art nano advanced- topic delivered by student.

TEXT BOOKS:
1. Nano material /A.K. Band,vopadl,'ay/Nerv age Publishers
2. N4aterial science and Technology': A corrprehensive treatment/Robert W.Calm./VCH
3. Enginec-ring Mechanics of Composite N4aterials / lsaac and M Daniel/Oxfbrd University Press

REFERENCES:

1. Mechar-rics of Cornposite Materials / R. M. Jones/ Mc Graw Hill Company, Ner.v York. 1975.
2. Analysis of Lanrir"rated Composile Structures / L. R. Calcote/Van NostrandRainfbld.NY I 969
3. Analysis and perlbrmance olfibre Composites /8. D. Agarrval and l-. J. llroutman /Wiley-Inlerscience, Ner,v York. 1980
4. Mechanics of Composite Malerials - Second Edition (Mechanical Engineering.l /ALrtarK.Kaiv /CRC Press

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

CO1: Classify the composite materials and identify the applications
CO2: Identify the aerospace materials and their applications
CO3: Understand macro-mechanical analysis of a lamina
CO4: Interpret the functionally graded materials and their properties
CO5: Understand types of nano materials and their properties

IV Year-I Semester	SMART MANUFACTURING (Open Elective - III)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: The students will acquire the knowledge:
1. To define smart manufacturing and understand its key characteristics, corporate adaptation processes, and the role of Industry 4.0 technologies in minimizing the Six Big Losses in manufacturing.
2. To explore the role and applications of smart machines and sensors in IIoT, focusing on their function, ecosystem, and integration within industrial processes.
3. To understand the 5C architecture of Cyber-Physical Systems (CPS) and its role in enhancing manufacturing processes in Industry 4.0 environments.
4. To introduce Digital rwin technology, explore its applications in manufacturing, and understand the integration of Machine Learning (ML), AI, and predictive maintenance in enhancing industrial operations.
5. To study the IoT communication infrastructure and protocols required for Industry 4.0, focusing on connectivity standards and the selection of appropriate IoT protocols for industrial applications

UNIT I:
Concepts of Smart Manufacturing: Definition and key characteristics of smart manufacturing, corporate adaptation processes, manufacturing challenges, challenges vs technologies, Stages in smart manufacturing. Minimizing Six 1ig losses in manufacturing with Industry 4.0, and their benefits

UNIT II:
Smart Machines and Smart Sensors: Concept and Functions of a Smart, Machine Salient features and Critical Subsystems of a Smart Machine, Smart ,"rrror.; smart sensors ecosystem, need, benefits and applications of sensors in industry, Sensing for Manufacturing Process in IIoT, Block Diagram of aIoT Sensing Device, Sensors in IIoT Applications, Smart Machine Interfaces

UNIT III:
Architecture of Cyber- Physical system (CPS): Functions of CPS, 5C Architecture; Smart Connection Level, Data-to- Information Level, Cyber Level, Cognition Level, configuration Level. Design of PHM based CPS systems. Comparison of today's factory and Industry 4.0 factory by the implementation of 5C CPS architecture

UNIT IV:
Digital Twin: Introduction, applications of digital twins, impact zones of digital twins in manufacturing (factories/plants and OEMs), advantages of digital twins, basic steps of digital twin technology
Machine Learning (ML) and Artificial Intelligence (AI) in Manufacturing: Introduction, benefits and applications of ML in industries, common approaches of ML; supervised and unsupervised, semi-supervised and reinforced ML
Predictive Maintenance: Introduction of predictive maintenance, difference between preventive and predictive maintenance.., working and various components of predictive maintenance, benefits and tools of predictive maintenance. Common approaches to IoT predictive maintenance; Rule-based (condition monitoring) and AI (artificial intelligence) based predictive maintenance. Augmented Reality in Maintenance (Electrical & Mechanical)

UNIT V:

IoT connectivity for Industry 4.0: Industrial communication requirement and its infrastructure, an overview of different types of networks, mesh network in industrial IoT, IoT protocols and the internet, TCP/IP (transmission control protocol/internet protocol) Lodel, IoT connectivity standards: common protocols, application layer protocols, internet/network layer protocols, physical layer IoT protocols, choosing the right IoT connectivity Protocol

TEXT BOOKS:

1. Industry 4.0 The Industrial Internet of Things by Alasdair Gilchrist, Apress
2. Industrial Internet of Things, Cyber Manufacturing System by Sabina Jeschke, Christian Brecher, Houbing Song Danda B. Rawat, Springer

COURSE OITCOMES: At the end of the course, student will be able to

- CO1 Demonstrate a comprehensive understanding of smart manufacturing and explain how Industry 4.0 minimizes the Six Big Losses in manufacturing processes'
- CO2 Analyze and explain the function of smart machines and sensors, including their integration into IIoT and their impact on manufacturing processes.
- CO3 Explain the 5C architecture of CPS and how its implementation transforms manufacturing systems in the context of Industry 4'0'
- CO4 Describe the ley benefits and applications of Digital Twin technology, ML, AI, and predictive maintenance in optimizing manufacturing processes.
- CO5 Identify and assess various IoT connectivity protocols, selecting the most suitable for specific industrial IoT applications in the context of Industry 4.0.

IV Year-l Semester	OPTIMIZATION TECHNIQUES (Open Elective - IV)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES: The student will acquire the knowledge
CO1: Understand classification of optimization problem and apply' classical optimization Techniques.
CO2: Apply unconstrained optimization techniques using various methods
CO3: Understand the characteristics and approaches of constrained optimization techniques
CO4: Identify optimized solutions using constrained and unconstrained geometric programming
CO5: Understand integer programming methods.

UNIT-1: INTRODUCTION TO OPTIMIZATION: Engineering applications of optimization statement of an optimization problem- classification of optimization problem- optimization techniques. **CLASSICAL OPTIMIZATION TECHNIQUES:** Single variable optimization multivariable optimization with equality constraints- multivariable optimization with Inequality constraints.

UNIT-2: UNCONSTRAINED OPTIMIZATION TECHNIQUES: Pattern search method Rosenbrock's method of rotating coordinates- Simplex method- Descent methods- Gradient of function- Steepest Descent method.

UNIT-3: CONSTRAINED OPTIMIZATION TECHNIQUES: Characteristics of constrained problem methods of feasible directions - basic approach in the penalty function method interior penalty function method- convex programming problem- exterior penalty function method.

UNIT-4: GEOMETRIC PROGRAMMING (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. Primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G. P.P). Complimentary geometric programming (C.G. P).

UNIT-5: INTEGER PROGRAMMING (I.P): Graphical representation. Gomory's cutting plane method. Algorithm for zero-one programming problem. Integer non-linear programming.

TEXT BOOKS:

1. Optimization Theory and Applications S.S.Rao/Wile_v Eastern Lirnited. Ner,v Delhi.

REFERENCES:

1. Engineering Optimization / Kal.vanrnanai Deb/Prentice Hall of lndia, Nerv Delhi.
2. Optimization Techniques-Theory and applications/C.Mohan&Kusum Deepa New Age International.
3. Operations Research /S.D.Sharma / MacMillan Publishers.

IV Year-l Semester	QUANTUM TECHNOLOGY (Open Elective - IV)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES: After completing this course, students will be able to:
CO1: Explain core principles of quantum mechanics and their technological implications.
CO2: Analyze quantum phenomena like superposition and entanglement.
CO3: Apply mathematical tools to model and solve quantum systems.
CO4: Demonstrate understanding of quantum algorithms and quantum circuits'
CO5: Evaluate potential applications and challenges in quantum communication and sensing.

UNIT-1: Fundamentals of Quantum Mechanics: Historical background: Blackbody radiation, photoelectric effect, and Compton scattering; Dual nature of light and matter; De Broglie hypothesis; Schrodinger equation; Free particle, infinite potential well, step potential; Operators and observables: position, momentum, Hamiltonian; Commutation relations and uncertainty principle; Quantum postulates and measurement theory; Eigenvalues, Eigen functions.

UNIT-2: Quantum Information Theory: classical vs. quantum information; Qubit representation using Bloch sphere; Quantum superposition and quantum entanglement; Dirac notation (bra-ket), tensor products, and composite systems; Bell states and EPR paradox; Quantum gates: Pauli-X, Y, Z;Hadamard; Phase; T; CNOT; Quantum circuit models and notation; Measurement in computational basis; Quantum teleportation and no-cloning theorem; Quantum state tomography (introductory).

UNIT-3: Quantum Computing: Classical computing review and limitations; Quantum parallelism and interference; Deutsch and Deutsch-Jozsa algorithms; Grover's search algorithm, Oracle and amplitude amplification; Shor's factoring algorithm (overview and significance); Quantum Fourier Transform (QFT); Quantum effort correction: Bit flip, phase-flip, and shor's 9-qubit code; Introduction to quantum programming: Qiskit, Cirq, IBM Quantum Experience (overview).

UNIT-4: Quantum Communication: Introduction to quantum cryptography; Quantum key distribution (QKD): BB84 protocol; Entanglement-based Q'KD: Ekert protocol (E91); Eavesdropping and security of QKD; Quantum teleportation (circuit and protocol); Quantum dense coding; Quantum networks and entanglement swapping; Role of quantum repeaters; Single-photon sources and detectors; Implementation challenges (loss, decoherence, noise)

UNIT-5: Quantum Technologies and Applications: Quantum sensors: magnetometry, gravimetuy; Quantum metrology: standard time, atomic clocks; Quantum imaging and lithography; Quantum materials: topological insulators, graphene, quantum dots; NV centers in diamonds for sensing; Hardware platforms: Superconducting qubits' Trapped ions, Photonic quantum processors; Quantum supremacy and NISQ era; Global initiatives: IBM, Google, D-Wave, IonQ, India's NQM; Ethical concerns and future prospects

TEXT BOOKS:

1. "Quantum Computation and Quantum Information" by Michael A. Nielsen and Isaac L. Chuang
2. "Quantum Mechanics: Concepts and Applications" by Nouredirc Zettlli

IV Year-l Semester	TOTAL QUALITY MANAGEMENT (Open Elective - IV)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES: After completing this course, students will be able to:
CO1: Understand the concepts of TQM, Quality and Business performance.
CO2: Understand importance of customer satisfaction and loyalty
CO3: Analyze Organizing for quality implementation.
CO4: learn the concept of cost of quality
CO5: Understand ISO 9000 universal standards of quality.

UNIT-1: INTRODUCTION: -The concept of TQM, Quality and Business performance. Attitude and involvement of top management. Communication. Culture and management systems. Management of Process Quality,' Definition of quality. Quality Control- a brief history, Product inspection vs. Process Control. Statistical Quality Control. Control Charts and Acceptance Sampling**.**

UNIT-2: CUSTOMER FOCUS AND SATISFACTION: The importance of customer satisfaction and loyalty- Crating satisfied customers. Understanding the customer needs- Process Vs. Customer. Internal customer conflict. Quality focus. Customer Satisfaction, role of Marketing and Sales. Buyer Supplier relationships. Bench marketing: Evolution o1'Bench of marketing. Meaning of' Bench marketing. Benefits of- bench marketing. The bench marketing process. Pitfalls of bench marketing.

UNIT-3: ORGANIZING For TQM: The systems approach. Organizing for- quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering: The leverage of Productivity and Quality. Management systems vs. Technology, Measuring Productivity. Improving Productivity Re-engineering.

UNIT-4: 3-D 0BJECT REPRESENTATION: spline representation, Hermitem THE COST of QUALITY: Definition of the Cost of quantity. Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

UNIT-5: IS09000: Universal Standards of Quality-v: ISO around the world. The ISO9000 ANSI/ASQCQ-Series Standards. Benefits o1'ISO9000 certification. The third party. Audit. Documentation lSO9000 and services, the cost of certification implementing the system

TEXT BOOKS:

1. Total Quality Managemenl / Joel E.Ross/Taylor and Franscis Limited.
2. Total Quality ManagementlP.N.Mukherjee/PHl

REFERENCES:

1. Beyond TQM / Robert L.Flood
2. Statistical Quality Control I F..L. Grant / McGraw Hill.
3. Total Quality Management- A Practical Approach/H. Lal.
4. Quality' Management/KanishkaBedi/Orfbrd University Press/2011
5. Total Engineering Quality, Management/Sunil Sharma/Macmillan

IV Year-l Semester	OPERATIONS MANAGEMENT (Open Elective - IV)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES: After completing this course, students will be able to:
CO1: Apply appropriate forecasting techniques & Aggregate plans to schedule
CO2: Apply Materials management analysis and inventory control techniques
CO3: Apply quality management principles proposed by Taguachi, Juran & Demigs
CO4: Apply optimization to LP model & transportation and assignment problems

UNIT-1: FORECASTING: Introduction, types of forecasting and their uses, General principles of forecasting, forecasting techniques: qualitative and quantitative methods of Forecasting.
PRODUCTION SYSTEMS: Types of production systems: job, batch, mass and flow type production.
AGGREGATE PLANNING: Introduction, aggregate planning strategies, aggregate planning methods, problems.

UNIT-2: SCHEDULING: Introduction, difference with loading, scheduling policies, techniques, standard scheduling methods.
MATERIALS MANAGEMENT: Introduction, functions of materials management, inventory, inventory management, types of inventories, Selective inventory control techniques: ABC analysis, VED analysis.

UNIT-3: INVENTORY CONTROL: P and Q Systems, Basic Economic Order Quantity model, Price break model, assumptions and problems Material Requirement Planning: Introduction, Inputs, outputs and MRP logic. Contemporary management techniques: Introduction to Lean, JIT, ERP and Supply chain Management**.**

UNIT-4: QUALITY MANAGEMENT: Quality engineering, Taguchi Principles, SQC - X bar, p and c charts, problems, Juran's principles Introduction to quality acceptance sampling. Deming's Philosophy, Introduction to total quality management, Quality Function Deployment, Introduction to six sigma and ISO 9000 2015 standards.

UNIT-5: OPTIMIZATION: Linear Programming - Graphical and simplex method - problems, Demonstration of Transportation and Assignment Models, Travelling Salesman problem.

TEXT BOOKS:

1. Modern Production/ operations managements / Baffa & Rakesh Sarin
2. Operations Management - an Integrated Approach, Intemational student Version, R. Dan Reid and Nada R. Sanders, John Wiley & Sons.
3. Production and Operations management by K. C. Jain, Wiley.
4. Operations Management by William J. Stevenson, McGraw-Hill Companies 2015
5. Operations Management by Jay Heizer, Barry Render, Chuck Munson, Amit Sachan Twelfth Edition, Pearson, 2017

REFERENCES:

1. Maynard's Industrial Engineering Handbook, KjellB. Zandin, Fifth Edition 2001, the McGraw-Hill Companies, Inc.
2. Operations Management S.N. Chary.
3. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller.

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IV Year-l Semester	ENERGY AUDITING (Open Elective - IV)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES: After completing this course, students will be able to:

CO1: Analyze the global and regional energy scenario and demonstrate the need and methodology of energy auditing in industries.

CO2: Interpret electricity tariff structures and apply demand-side management techniques to reduce energy costs in electrical supply systems.

CO3: Evaluate energy conservation methods in thermal utilities including boilers, furnaces, and steam systems with a focus on combustion and waste heat recovery.

CO4: Identify and implement energy-saving measures in electrical utilities such as motors, fans, pumps, HVAC, and lighting systems.

CO5: Apply energy monitoring, targeting techniques, and economic analysis tools like life cycle costing and PAT schemes for effective energy management.

UNIT-1:

INTRODUCTION: Energy scenario of World, India and TN – Environmental aspects of Energy Generation - Material and Energy balancing - Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Basic instruments for Energy Auditing.

UNIT-2:

ELECTRICAL SUPPLY SYSTEMS: Electricity Tariff structures – Typical Billing - Demand Side Management - HT and LT supply - Power Factor – Energy conservation in Transformers - Harmonics

UNIT-3:

STOICHIOMETRY - Combustion principles. Energy conservation in: Boilers – Steam Distribution Systems - Furnaces - Thermic Fluid Heaters - Cooling Towers - D.G.sets. Insulation and Refractories - Waste Heat Recovery Devices.

UNIT-4:

ENERGY CONSERVATION IN MAJOR ELECTRICAL UTILITIES: Energy conservation in: Motors - Pumps - Fans - Blowers - Compressed Air Systems - Refrigeration and Air Conditioning Systems - Illumination systems

UNIT-5

ENERGY MONITORING, TARGETING, LABELLING AND ECONOMICS: Elements of Monitoring & Targeting System - CUSUM Energy / Cost index diagram - Energy Labelling - Energy Economics - Cost of production and Life Cycle Costing - Economic evaluation techniques - Discounting and Non- Discounting - ESCO concept - PAT scheme- ISO 150001- Significance of Energy Auditing.

TEXT BOOKS:

1. Guide book for National Certification Examination for "Energy Managers and Energy Auditors" (4 Volumes). Available at http://www.em-ea.org/gbook1.asp. This website is

2. Operations Management - an Integrated Approach, International student Version, R. Dan Reid and Nada R. Sanders, John Wiley & Sons.
3. Production and Operations management by K. C. Jain, Wiley.
4. Operations Management by William J. Stevenson, McGraw-Hill Companies 2015
5. Operations Management by Jay Heizer, Barry Render, Chuck Munson, Amit Sachan Twelfth Edition, Pearson, 2017

REFERENCES:

1. Maynard's Industrial Engineering Handbook, KjellB. Zandin, Fifth Edition 2001, the McGraw-Hill Companies, Inc.
2. Operations Management S.N. Chary.
3. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller.

IV Year-I Semester	MECHATRONICS LAB	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES: The student will acquire the knowledge
1. Measure load, displacement and temperature using analogue and digital sensors.
2. Develop PLC programs for control of traffic lights, water level, lifts and coovel, belts.
3. Simulate and analyse PID controllers for a physical system using MATLAB.
4. Develop pneumatic and hydraulic circuits using Automaton studio.

LIST OF EXPERIMENTS:

l. DYNA 1750 Transducers Kit:-
- a. Characteristics of LVDT
- b. Principle & Characteristics of Strain Gauge
- c. Characteristics of Summing Amplifier
- d. Characteristics of Reflective Opto Transducer

2. PLC PROGRAMMING & Simulation of Allen Bradley, Siemens or IEC Ladder Using Automation Studio
- a. Ladder programming on Logic gates Timers (TON,TOFF) &counters (UP,DOWN)
- b. Ladder Programming for digital &Analogy sensors
- c. Ladder programming & Simulations of Virtual System such as Traffic Light control, Washing machine, Garage Door, Water level control, Lift control, Conveyor Belt etc.
- d. Ladder programming to control circuits such as single solenoid spring retum latch circuit, double solenoid Hydraulic / Pneumatic circuits, Self-Reciprocating Hydraulic / Pneumatic Circuit.

3. AUTOMATION STUDIO SOFTWARE (Design, Simulate & Analyze)
- a. Introduction to Automation studio & its control.
- b. Draw & Simulate Hydraulic circuits for series &parallel cylinders connection, Accumulator circuit, Pressure intensifier circuit, Simple Electro- Hydraulic Electro - Pneumatic circuits (Plot Waveforms for different parameters).
- c. Design & Simulate Meter-in, Meter-out, Regenerative circuit, sequencing circuit, traverse and feed hydraulic circuit, hydraulic press and clamping.
- d. Position Control of Proportional Servo Valve Circuit using PID Feedback controller.

4. MATLAB Programming
- a. Sample programmes on Matlab
- b. Simulation and analysis of PID controller using SIMULINK

COURSE OUTCOMES: At the end of the cours€e student will be abfe to
CO1 Understand the Characteristics of LVDT
CO2 Measure load, displacement and temperature using analogue and digital sensors.
CO3 Develop PLC programs for control of traffic lights, water level, lifts and conveyor belts
CO4 Simulate and analyse PID controllers for a physical system using MATLAB.
CO5 Develop pneumatic and hydraulic circuits using Automaton studio.

IV Year-I Semester	CONSTITUTION OF INDIA	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES: The student will acquire the knowledge

1 To enable the student to understand the importance of constitution
2 To understand the structure of executive. Legislature and judiciary, 3. To understand philosophy of fundamental rights and duties 4. To understand the autonomous nature of constitutional bodies like
3 Supreme Court-t and high court controller and auditor general of India and election commission of India.
4 To understand the central and state relation financial and administrative.

UNTT.I

Introduction to lndian Constitution: Constitution meaning of the term Indian Constitution - Sources and constitutional history, Features - Citizenship. Preamble. Fundamental Rights and Duties. Directive Principles of State Policy.

Learning outcomes:

After completion of this unit student will

- Understand the concept of Indian constitution
- Apply the knowledge on directive principle of state policy
- Analyze the History. f-features of Indian constitution
- Evaluate Preamble Fundamental Rights and Duties

UNIT-II

Union Government and its Administration Structure of the Indian Union: Federalism, center- State relationship. President: Role. Power and position, PM and Council of ministers. Cabinet and Central secretariat. LokSabha. RajyaSabha. The Supreme Court and High Court: powers and Functions:

Learning outcomes:-After completion of this unit student will

- Understand the structure of lndian govenrment
- Differentiate between the state and central government
- Explain the-- role of President and Prime Minister
- Know the Structure of supreme court and high court

UNIT-III

State Government and its Administration Governor - Role and Position – CM and Council of ministers" State Secretariat: Organization. Structure and Functions

Learning outcomes:-After completion of this unit student will

- Understand the structure of state government
- Analyze the role Governor and Chief Minister
- Explain the role of state Secretariat

UNIT-IV

A. Local Administration - District's Administration l-lead - Role and importance, Municipalities - Mayor and role of Elected Representative – CEO of Municipal Corporation Panchayat Raj: Functions PRI: Zilla Panchayat. Elected officials and their roles. CEO Zilla Panchayat: Block level

Organizational Hierarch's - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

Learning outcomes: - After completion of this unit student will

- Understand the local Administration
- Compare and contrast district administration role and importance
- Finalize the role of Myer and elected representatives of Municipalities
- Evaluate Zilla Panchayat block level organization

UNIT-V

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissioner ate State Election Commission: Functions of Commissions for tire welfare of SC/ST/OBC and \\'omell

Learning outcomes: - After completion of this unit student will

- Know the role of Election Commission applyknovr,ledge
- Contrast and compare the role of Chief Election commissioner and Commissionerate
- Analyze role of state election commission
- Evaluate various commissions of SC/ST/OBC and Women

REFERENCES:

l)Durga Das Basu, Introduction to lhe Constitution of India, Prentice – ttall o1' India I'}vt. Ltd".NewDelhi
2) SubashKash,vap. Indian Constitr"rtion" National Book Trust
3).f.A. Sirvach. D-vnamics ollndian Govemment & Politics
4) D.C. Gupta, Indian Government and Politics
5)H.M.Sreevai. Constitutional Larv of India. :lth edition in 3 volunres (Universal Law Publication)
6).1.C. .[ohari" Indian Governnent a:rdl'}olitics Hans
7) J. Ra.j IndianGovernment and Politics
8) M.V. Pvlee . Indian Constitulion Durga Das Basu. Human Rights in Constitutional Law, Prentice
9) -Hatl of lndia Pvt. Ltd.. New Del]ri
10)Noorani. A.G.. (South Asia Huntan Rights Documentation Centre). Challenges to Civil Right).Challenges to Cir..il Rights Guarantees in lndia. Oxlbrd University Press 20 i 2

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2. nptel. ac. irlcourses/ 1 09 104045 I
3. nptel.ac.inlcoursesll 0 1 1 04065/
4. www.hss.iitb.ac.irVen/lecture-details
5. www.iitb .ac.in/en/eventl2nd-lecture-institute-lecture-series-indianconstitution

B.Tech. – IV Year II Semester

S. No.	Category	Title	L	T	P	Credits
1	PR	Internship and Project	-	-	24	12