SREE VAHINI INSTITUTE OF SCIENCE AND TECHNOLOGY
(AN AUTONOMOUS INSTITUTION)
TIRUVURU – 521 235, NTR Dist, Andhra Pradesh, India
B. TECH MECHANICAL ENGINEERING
(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

B.Tech. – IV Year I Semester

S.No.	Category	Subject code	Title	L	T	P	Credits
1	Professional Core	V231410331	CAD/CAM	2	0	0	2
2	Management Course-II	V2314103M1	Operations Research	2	0	0	2
3	Professional Core	V231410361	CAD/CAM Lab	0	0	2	1
4	Professional Elective - IV	V231410341	Mechatronics	3	0	0	3
		V231410342	Computational Fluid Dynamics				
		V231410343	Functional Materials and Applications				
		V231410344	Drives and Actuators for Robotics				
		V231410345	12 Weeks MOOC swayam / NPTEL course recommended by the BOS				
		V231410346	12 Weeks MOOC swayam / NPTEL course recommended by the BOS				
5	Professional Elective - V	V231410347	Hydrogen and Fuel Cell Technology	3	0	0	3
		V231410348	Smart Manufacturing				
		V231410349	Autonomous Systems				
		V23141034A	Embedded Systems and Programming				
6	Open Elective-III	V231410351	1. Finite Element Methods	3	0	0	3
		V231410352	2. Introduction to Mechatronics				
		V231410353	3. Product design and development				
		V231410354	4. Advanced Materials				
		V231410355	5. Introduction to Smart Manufacturing				
7	Open Elective-IV	V231410356	1. Optimization Techniques	3	0	0	3
		V231410357	2. Advanced Manufacturing Processes				
		V231410358	3. Total Quality Management				
		V231410359	4. Operations Management				

		V23141035A	5. Energy Auditing				
		V23141035B	6. Quantum Science and Technology				
8	Skill Enhancement Course	V231410362	Mechatronics Lab	0	0	4	2
9	Audit Course	V2314103C1	Constitution of India	2	0	0	-
	Internship	V231410381	Evaluation of Industry Internship	-	-	-	2
Total				**18**	**0**	**06**	**21**

B.Tech.–IV Year II Semester

S.No.	Category	Subject code	Title	L	T	P	Credits
1	PR	V2314203A1	Internship and Project	-	-	**24**	**12**

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		L	T	P	C
IV Year I-Semester	**CAD/CAM (V231410331)**	**2**	**0**	**0**	**2**

Course Objectives: The student will acquire the knowledge

- Introduce fundamentals of CAD/CAM and computer graphics used in product design.
- Explain wire frame and surface modeling techniques with their applications.
- Provide understanding of solid modeling and basics of CNC part programming.
- Introduce group technology concepts and flexible manufacturing systems.
- Explain computer-integrated manufacturing systems and process planning strategies.

UNIT	CONTENTS
UNIT– 1	**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– 2	**WIRE FRAME MODELING**: Definition, advantages, dis-advantages, wire frame entities- analytic entities and synthetic entities. **SURFACE MODELING**: Definition, advantages, disadvantages, surface entities-analytic entities and synthetic entities. **SOLID MODELING:** Definition, constructive solid geometry, advantages, modeling 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– 3	**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, manual part programming methods, Computer Aided Part Programming- APT language, simple problems in manual part programming and Computer Aided Part Programming. Direct Numerical Control, Adaptive Control.
UNIT– 4	**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.

UNIT– 5 **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. Grover /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 SS eames/ Thomson learning, 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 Describe the role of CAD in design and apply geometric transformations in graphics.
CO2 Distinguish between modeling types and model basic wire frame and surface Geometries.
CO3 CreatesolidmodelsandgeneratesimpleCNCpartprogramsusingmanualandAPT methods.
CO4 Classify parts using coding systems and explain FMS layouts and control systems.
CO5 Describe components of CIMS and differentiate variant and generative process planning.

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IV Year I-Semester	OPERATIONS RESEARCH (V2314103M1)	L	T	P	C
		2	0	0	2

Course Objectives: The student will acquire the knowledge

- Introduce the fundamentals of operations research and linear programming techniques.
- Teach optimization in transportation, assignment, and sequencing problems.
- Explain models for replacement strategies and decision-making using game theory.
- Provide knowledge on queuing models and inventory control techniques.
- Introduce dynamic programming principles and simulation modeling.

UNIT	CONTENTS
UNIT– 1	**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– 2	**TRANSPORTATION PROBLEM:** Formulation – optimal solution, unbalanced transportation problem – degeneracy, 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– 3	**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. **THEORY OF GAMES:** Introduction–mini.max (max .mini) –criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2 x 2 games – dominance principle – m x 2 & 2 x n games -graphical method.
UNIT– 4	**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– 5 **DYNAMIC PROGRAMMING:** Introduction–Bellman's principle of optimality – 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 ATaha/Pearson publishers
2. OperationsResearch–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/MauriceSaseini, Arhur Yaspan& Lawrence Friedman/Wiley
4. Operations Research/R.Pannerselvam /PHI Publications.
5. Operations Research/Wagner/PHI Publications.
6. Operation Research/J.K.Sharma/Mac MilanPubl.
7. Operations Research/Pai/Oxford Publications
8. Operations Research/S Kalavathy/Vikas Publishers
9. Operations Research/DSCheema/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 Formulate and solve linear programming problems using graphical and simplex methods.
CO2 Solve transportation, assignment, and sequencing problems for efficient operations.
CO3 Analyze replacements cenarios and determine optimal strategies using game theory.
CO4 Apply queuing theory and inventory models to optimize service and stock management.
CO5 Solve multistage decision problems and apply simulation to real-life systems.

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IV Year I-Semester	CAD/CAM LAB (V231410361)	L	T	P	C
		0	0	2	1

Course Objectives: The student will acquire the knowledge

- Introduce students to simulation-based analysis of structural, thermal, and vibration behavior using FEA tools.
- Provide practical knowledge of CNC part programming for lathe and milling operations.
- Familiarize students with CAM software for automatic tool path planning and G-code generation.
- Introduce the concepts and work flow of rapid prototyping using3D printing machines.
- Enable students to simulate and visualize the 3D printing process through online virtual labs.

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

CONTENTS

1. Experiments to determine stresses, deflection, natural frequencies, harmonic analysi analysis and buckling analysis.

   a) Determination of deflection and stresses in 2D and 3D trusses and beams.
   b) Determination of principal and Von-mises stresses in plane stress, plane strain and ax symmetric 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 ax symmetric components.
   f) Buckling analysis

2. Study of CNC part programming fundamentals and write part programmers 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 R P machine-creation of simple parts.
5. Virtual 3D Printing Simulation lab using Vlabs.

https://3dp-dei.vlabs.ac.in/List%20of%20experiments.html

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

CO1	Perform structural, thermal, and buckling analyses using FEA and interpret Stress, deflection, and frequency results.
CO2	Develop and execute CNC part programs for basic lathe and milling operations.
CO3	Generate optimized CNC tool paths and G-codes using CAM packages for given part geometries.
CO4	Create and demonstrate simple3Dmodels using RP machines.
CO5	Perform and analyze virtual 3D printing experiments using online simulation platforms.

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IV Year I-Semester	MECHATRONICS (Professional Elective-IV) (V231410341)	L	T	P	C
		3	0	0	3

Course Objectives: The student will acquire the knowledge

- Introduce the fundamentals, components, and sensor technologies in mechatronic systems.
- Familiarize students with solid-state devices and analog signal conditioning techniques.
- Provide understanding of fluid-based and mechanical actuation systems in automation.
- Introduce digital control systems, micro controllers, and PLCs in mechatronic applications.
- Teach interfacing techniques, data acquisition, and digital signal processing in mechatronic systems.

UNIT **CONTENTS**

UNIT– 1 **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– 2 **SOLID STATE ELECTRONIC DEVICES:** PN junction diode, BJT,FET, DIAC, TRIAC and LEDs. Analog signal conditioning, operational amplifiers, noise reduction, filtering

UNIT– 3 **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– 4 **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– 5 **SYSTEM AND INTERFACING AND DATA ACQUISITION:** Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital 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 /WILEY India Edition

References:

1. Mechatronics /SmailiA, MradF/ 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/Devdas shetty /Richard/Thomson.
5. Mechatronics /M.D. Singh/J.G.Joshi /PHI.
6. Mechatronics–ElectronicControlSystemsinMechanicalandElectricalEngg.4th Edition / W. Bolton/ Pearson,2012
7. Mechatronics–PrinciplesandApplication/GodfreyC.Onwubolu/Elsevier,Indianprint

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

CO1 Explain the structure of mechatronics systems and identify various sensors used for Measurement and control.

CO2 Describe the working of electronic devices and apply analog signal conditioning using Operation amplifiers.

CO3 Analyze hydraulic, pneumatic, and electro mechanical actuation systems and their components.

CO4 Develop basic control logic using microprocessors, microcontrollers, and PLCs.

CO5 Implement data acquisition, signal processing, and motor drive inter facing in a mechatronic setup.

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IV Year I-Semester	COMPUTATIONAL FLUID DYNAMICS (Professional Elective-IV) (V231410342)	L	T	P	C
		3	0	0	3

Course Objectives: The student will acquire th knowledge

- Introduce PDE classification, fundamental fluid flow equations, and basic numerical solution techniques.
- Explain dimensionless momentum and energy equations and finite difference applications in heat transfer.
- Introduce discretization methods, consistency, and stability in finite difference fluid flow modeling.
- Provide understanding of wave equation stability and finite volume method in CFD.
- Introduce FEM formulation and its application to 1D and 2D fluid flow and heat transfer problems.

UNIT	CONTENTS
UNIT– 1	**CONSERVATION PRINCIPLES:** Introduction, conservation of mass, Newton's second law of motion, expanded forms of Navier-stokes equations (Derivation), conservation of energy principle, and special forms of the Navier-stokes equations. **APPLIED NUMERICAL METHODS:** Solution of a system of simultaneous linear algebraic equations, iterative schemes of matrix in version, direct methods for matrix inversion, direct methods for banded matrices, TDMA–Algorithms.
UNIT– 2	**CONDUCTION AND CONVENTION:** Steady flow, dimensionless form of momentum and energy equations, stokes equation, conservative body force fields, stream function -vortices 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– 3	**EXPLICIT AND IMPLICIT METHODS**: Finite differences, discretization, consistency, stability, and fundamentals of fluid flow modeling: introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods.
UNIT– 4	**INTRODUCTION TO FIRST ORDER WAVE EQUATION: S**tability of Hyperbolic and elliptic equations, fundamentals of fluid flow modeling, conservative property, the upwind scheme. **FINITE VOLUME METHOD:** Approximation of surface integrals, volume integrals, interpolation and differentiation practices, up wind interpolation, linear interpolation and quadratic interpolation.

UNIT– 5 **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

Text Books:

1. Numerical heat transfer and fluid flow/ 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. Malala sekahara
3. Fundamentals of Computational Fluid Dynamics/TapanK. Sengupta/ Universities Press.
4. Computationalfluiddynamics:Anintroduction,3rdedition/John.FWendt/Springer publishers

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

CO1 Derive governing equations of fluid flow and apply numerical methods like TDMA for solving linear systems.

CO2 Analyze steady/transient the at conduction and convective problems using finite difference techniques.

CO3 Apply finite difference methods and assess consistency and stability of numerical Schemes.

CO4 Analyze stability and implement interpolation schemes using finite volume methods For fluid flow problems.

CO5 Solve fluid flow and heat transfer problems using FEM with appropriate Interpolation and error control techniques.

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		L	T	P	C
IV Year I-Semester	**FUNCTIONAL MATERIALS AND APPLICATIONS (Professional Elective-IV)** (V231410343)	**3**	**0**	**0**	**3**

COURSE OBJECTIVES: The student will acquire the knowledge

- Introduce crystal structures, defects, and deformation mechanisms in materials.
- Explain electrical and magnetic behavior of materials using classical and quantum theories.
- Provide understanding of semiconductor physics and charge transport mechanisms.
- Explore optical behavior of materials and principles behind optoelectronic devices.
- Introduce quantum phenomena in nonmaterial and their application in electronics and photonics.

UNIT	CONTENTS
UNIT– 1	**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– 2	**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 – paramagnetic in the conduction electrons in metals – exchange interaction and ferromagnetism – quantum interference devices – GMR devices.
UNIT– 3	**SEMICONDUCTORS AND TRANSPORT PHYSICS**: 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,mobilityanddiffusion–Halleffectanddevices–Ohmic contacts – Schottky diode
UNIT– 4	**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–excitonicstate–Electro-optics and nonlinear optics:

Modulators and switching devices– plasmonics.

UNIT– 5 **NANOELECTRONIC MATERIALS:** Quantum confinement – Quantum structures–quantumwells, wiresanddots–Zener-Blochoscillations–Resonant tunneling – quantum interference effects - macroscopic 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 annotates: Properties and applications.

TEXT BOOKS:

1. V.Raghavan. Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited, 2015.
2. S.O. Kasap, Principles of Electronic Materials and Devices, Mc-GrawHill, 2018.
3. Jasprit Singh, Semiconductor Devices: Basic Principles, Wiley (India), 2007.
4. JaspritSingh, Semiconductor Optoelectronics: Physics and Technology, Mc-GrawHill India (2019)
5. G.W.Hanson. Fundamentals of Nan electronics. Pearson Education (Indian Edition), 2009.

REFERENCES:

1. R.Balasubramaniam, Callister's Materials Science and Engineering. Wiley(Indian Edition), 2014.
2. Wendelin Wright and DonaldAskel and, Essentials of Materials Science and Engineering, CL Engineering, 2013.
3. Robert F. Pierret, Semiconductor Device Fundamentals,Pearson,2006
4. Pallab Bhattacharya, Semiconductor Optoelectronic Devices,Pearson,2017
5. Ben Rogers,Jesse Adams and Sumita Penna thur,Nano technology: Understanding Small Systems, CRC Press, 2017.

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

CO1 Explain crystal geometries, imperfections, and their influence on material Deformation and phase changes.

CO2 Analyze electrical conductivity, energy bands, and magnetic properties of different Materials.

CO3 Calculate carrier concentration, mobility, and analyze transport phenomenain Intrinsic and extrinsic semiconductors.

CO4 Explain optical transitions, recombination processes, and working of optoelectronic And non linear optical devices.

CO5 Describe quantum confinement, nano structures, and emerging no electronic and Spin tonic devices.

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IV Year I Semester	DRIVES AND ACTUATORS FOR ROBOTICS (Professional Elective-IV) (V231410344)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES : The student will acquire the knowledge

- Introduce switching devices and their characteristics for motor control applications.
- Understand the dynamic behavior and performance characteristics of electric drives.
- Provide knowledge of DC motors, their characteristics, and drive configurations.
- Explain various control methods used in three-phase induction motor drives.
- Introduce step per, servo, and BLDC motors and their applications in
- automation.

UNIT CONTENTS

UNIT– 1 **RELAY AND POWER SEMI-CONDUCTOR DEVICES**: Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT-:SCR, MOSFET and IGBT-Triggering and commutation circuit-Introduction to Driver and snubber circuits

UNIT– 2 **DRIVECHARACTERISTICS**: Electricdrive– Equationsgoverningmotor loaddynamics–steadystatestability–multiquadrantDynamics:acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor

UNIT– 3 **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 –4quadrant operation – Applications

UNIT– 4 **AC MOTORS AND 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.

UNIT– 5 **STEPPER AND SERVO MOTOR**: Stepper Motor: Classifications-Construction and Principle of Operation–Modes of Excitation Drive System-Logic Sequencer-Applications. Servo Mechanism–DC Servo motor-AC Servo motor – Applications.

TEXT BOOKS:

1. Bimbhra B. S.," Power Electronics",5thEdition,Kanna Publishers, New Delhi,2012.
2. Mehta V.K. & Rohit Mehta," Principles of Electrical Machines",2ndEdition, S.Chand & Co. Ltd., New Delhi, 2016.

REFERENCES

1. GobalK.Dubey,"FundamentalsofElectricalDrives",2ndEdition,Narosal Publishing House, New Delhi, 2001.
2. TherajaB.L.&TherajaA.K.,"ATextBookofElectricalTechnology",2ndEdition, S.Chand& Co. Ltd., New Delhi, 2012.
3. SinghM.D.&KanchandhaniK.B.,"PowerElectronics",McGrawHill,NewDelhi, 2007

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

CO1	Explain the working, triggering, and protection of relays, SCRs, MOSFETs, IGBTs, And associated circuits.
CO2	Analyze motor-load dynamics and select suitable motors based on drive requirements.
CO3	Explain DC motor operation and implement single/three-phase drives with H-bridge control.
CO4	Apply different speed control techniques to three-phase induction motors using AC drives.
CO5	Describe construction, operation, and control methods of stepper, servo, and BLDC motors.

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IV Year I Semester	HYDROGEN AND FUEL CELL TECHNOLOGY (Professional Elective-V) (V231410347)	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the fundamental concepts of hydrogen as an energy carrier and its role in a sustainable energy system.
- To provide comprehensive knowledge on various hydrogen production technologies.
- To impart understanding of hydrogen storage technologies and associated challenges.
- To explore various applications of hydrogen in energy conversion devices and engines.
- To explain the principles, types, and performance characteristics of fuel cells.

UNIT CONTENTS

UNIT– 1 **INTRODUCTION OF HYDROGEN ENERGY SYSTEMS:** Properties of hydrogen as fuel, Hydrogen pathways introduction-current uses, general introduction to infrastructure requirement for hydrogen production, storage, dispensing, utilization, safety and hydrogen production plants.

UNIT– 2 **HYDROGEN PRODUCTION PROCESSES**: Thermal-Steam reformation, thermo chemical water splitting, gasification-pyrolysis, nuclear thermal catalytic and partial oxidation methods, Electrochemical-Electrolysis, photo electro chemical, Biological-Anaerobic digestion, fermentation micro-organism, PM based electrolyser.

UNIT– 3 **HYDROGEN STORAGE:** Physical and chemical properties, general storage methods, compressed storage-composite cylinders, glass micro sphere storage, zeo lites, metal hydride storage, chemical hydride storage and cryogenic storage, carbon based materials for hydrogen storage.

UNIT– 4 **HYDROGEN UTILIZATION:** Overview of hydrogen utilization, IC Engines, gas turbines, hydrogen burners, power plant, domestic cooking gas, marine applications, hydrogen dual fuel engines.

UNIT– 5 **FUEL CELLS:** History–principle-working-thermo dynamics and kinetics of fuel cell process –performance evaluation of fuel cell – comparison on battery Vs fuel cell, Types of fuel cells–AFC,PAFC,SOFC,MCFC,DMFC, PEMFC, microbial fuel cells, relative merits and demerits and application of fuel cells.

Text Books:

1. Soren son B, Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorenson, Academic Press (2005).
2. Hordeski MF, Hydrogen and Fuel Cells: Advances in Transportation and Power, The Fairmont Press, Inc. (2009)
3. Bus by RL,Hydrogen and Fuel Cells: A Comprehensive Guide ,Penn Well Books (2005).

Course Outcomes (COs):

CO1: Understand the properties of hydrogen as a fuel and describe the infra structure requirements for its production, storage, and utilization.

CO2: Analyze various hydrogen production methods including thermal, electrochemical, and biological processes.

CO3: Evaluate different hydrogen storage technologies such as compressed, cryogenic, and solid-state systems with their respective merits and challenges.

CO4: Examine the applications of hydrogen in IC engines, power generation, domestic usage, and hybrid fuel systems.

CO5: Understand the working principles, types, performance, and applications of various fuel cells and distinguish them from conventional batteries.

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B. TECH MECHANICAL ENGINEERING
(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	SMART MANUFACTURING (Professional Elective-V) (V231410348)	L	T	P	C
		3	0	0	3

Course Objectives to:

- Introduce the key concepts, characteristics, and challenges of smart and circular manufacturing.
- Explain the role and architecture of smart machines and sensors in industrial environments.
- Provide an understanding of CPS design and the 5C architecture in smart factories.
- Introduce digital twin technology and the use of AI and ML in smart manufacturing.
- Explore IoT communication protocols and connectivity infrastructure for industrial automation.

CONTENTS

UNIT– 1 **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 4.0, Industry 5.0, and their benefits

UNIT– 2 **SMART MACHINES AND SMART SENSORS:** Concept and Functions of a Smart, Machine Salient features and Critical Subsystems of a Smart Machine, Smartsensors;smartsensorsecosystem,need,benefitsandapplicationsofsensors in industry, Sensing for Manufacturing Process in IoT, Block Diagram of a IoT Sensing Device, Sensors in IoT Applications, Smart Machine Interfaces

UNIT– 3 **ARCHITECTUREOFCYBER-PHYSICALSYSTEM(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– 4 **DIGITAL TWIN:** Introduction, applications of digital twins, impact zones of digitaltwinsinmanufacturing(factories/plantsandOEMs),advantagesofdigital twins, basic steps of digital twin technology, Multi verse and AR and VR.
MACHINE LEARNING(ML)AND ARTIFICIAL INTELLIGENCE (AI) IN MANUFACTURING:Introduction,benefitsandapplicationsofMLinindustries,commonapproachesofML;supervisedandunsupervised,semi-Supervised and reinforced ML, Application of AI and ML for predictive maintenance.

UNIT– 5 **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) model, IoT connectivity standards: common protocols, application layer protocols, internet/network layer Proto cols, physical layer IoT protocols.

Text Books:

1 . Industry4.0The Industrial Internet of Things by
2 A. lasdair Gilchrist, Apress Industrial Internet of Things, Cyber Manufacturing System by Sabina Jeschke, Christian Brecher, Houbing Song Dand a
B. Rawat, Springer

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

CO1 Explain the evolution, stages, and benefits of smart manufacturing, Industry4.0and Industry5.0.
CO2 Identify and describe smart sensors, subsystems, and interfaces used in IoT-based Manufacturing.
CO3 Analyze CPS functions and compare traditional manufacturing with Industry4.0CPS-based systems.
CO4 Explain digital twin implementation and apply AI/ML concepts for predictive Maintenance in manufacturing.
CO5 Understand and differentiate IoT network layers and protocols used in Industry 4.0 Applications.

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(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	AUTONOMOUS SYSTEMS (Professional Elective-V) (V231410349)	L	T	P	C
		3	0	0	3

Course Objectives to:

- Introduce the concepts of intelligent agents and multi-agent systems in the context of autonomous systems.
- Provide an understanding of the architectural design and autonomy levels in unmanned systems like AGVs, AUVs, and drones.
- Equip students with knowledge of modeling and control techniques for different types of unmanned ground, aerial, and underwater vehicles.
- Familiarize students with various sensors, actuators, and computing platforms used in autonomous systems.
- Develop a foundational understanding of aerial robot flight concepts, control strategies, motion planning, and communication protocols.

UNIT	CONTENTS
UNIT– 1	**INTRODUCTION TO AGENT SYSTEMS:** Introduction to Agents, Agent Architectures, and Multi-agent Systems and Society of Agents, Distributed Problem Solving and Planning, Case Study: Collaborative Robotics, Robo cup
UNIT– 2	**ARCHITECTURE OF AUTONOMOUS SYSTEMS:** Degree of Autonomy, Reactive Systems, Real-time Systems, Architecture of AGV's , AUV , Drones, Tele-Operation, AR, VR applications
UNIT– 3	**CLASSIFICATION,MODELLING,ANDCONTROLASPECTSOF UNMANNED VEHICLES:** Different types of unmanned vehicles: ground (wheeled and legged), aerial (fixed, flapping, and rotary wings), underwater vehicles , Modeling of unmanned vehicles considering basic forces,kinematics,anddynamics,Discussionondifferenttypesofcontrol for aerial, underwater (fins and propulsion control), ground (biped and quadruped motion control for legged robots)
UNIT– 4	**SENSORS AND ACTUATORS:** Types of sensors used in unmanned vehicles (proximity, IMU, magnetometers, thermal imaging, vision, Li DAR, GPS, RTK, etc.) and their characteristics, Sensor data aggregation, processing, and sensor fusion, Introduction to popular computing platforms for data processing, Types of actuators: motors, servos, harmonic drive, linear actuators
UNIT– 5	**FLIGHT CONCEPTS:** Basic Aerial Robot Flight Concepts, Micro-aerial

vehicle, Frame Rotations and Representations, Aerial robots equations of motion,State-SpaceForm,Time,Motion,andTrajectories,Linearization, 2-D and 3-D control of Aerial robots, PID Control, LQR control, Motion planning, Collision-free Navigation, Sensing and Estimation, Vision-based Guidance for aerial robots, Introduction to Communication and Networking Protocols.

Textbooks:

1. Rol and Siegwart,Illah RezaNourbakhsh, Davide Scaramuzza(2018),
2. Introductiontoautonomousmobilerobots,MITpress.2.GerhardWeissed.(2013), Multiagent System, Second Edition, MIT Press
3. C.Venkatesan,(2014),FundamentalsofHelicopterDynamics,1stEdition,CRCPress 2.JohnD.Anderson,(2015),IntroductiontoFlight,8thEdition,McGraw-Hill Education

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

CO1: Understand the structure and functioning of intelligent agents and multi-agent systems for collaborative autonomous tasks.
CO2: Analyze and differentiate the architectural features and levels of autonomy in ground ,aerial, and under water autonomous systems.
CO3: Model and apply control techniques to different types of unmanned vehicles considering dynamics and motion constraints.
CO4: Identify and evaluate suitable sensors and actuators used in autonomous systems, and implement basic sensor fusion techniques.
CO5: Apply control algorithms and motion planning strategies for aerial robots including trajectory tracking, guidance, and navigation.

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(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	EMBEDDED SYSTEMS AND PROGRAMMING (Professional Elective-IV) (V23141034A)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: The students will acquire the knowledge:

- Introduce microcontrollers, their architecture, instruction sets, and memory organization.
- Develop programming skills in assembly and embedded C with communication interfaces.
- Teach interfacing of microcontrollers with external peripherals and actuators.
- Introduce ARM architecture, instruction sets, and its basic programming.
- Explainsystem-on-chiparchitectureandembeddedprogrammingusingPythononSBCs.

UNIT CONTENTS

UNIT– 1 **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– 2 **PROGRAMMING AND COMMUNICATION**: 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– 3 **PERIPHERAL INTERFACING:**I/O Programming– Interfacing of Memory, Key Board and Displays–Alpha numeric 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– 4 **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– 5 **SINGLE BOARD COMPUTERS AND PROGRAMMING**: System on Chip - Broadcom BCM2711 So C – SBC architecture - Models and Languages – Embedded Design – Real Time Embedded Operating Systems - Real Time Programming Languages -– Python for Embedded Systems- GPIO Programming – Interfacing

TEXTBOOKS:

1. Frank Vahid and Tony Givag is, "Embedded System Design", 2011, Wiley.
2. KennethJ. Aylala," The 8051Microcontroller, the Architecture and Programming Applications", 2003.

REFERENCES:

1. Muhammad AliMazidi and Janice Gilli spic Mazdi," The8051Microcontroller and Embedded Systems", Pearson Education, 2006.
2. SimonMonk, Programming the RaspberryPi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition,2015
3. JamesW.Stewart,"The8051Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
4. JohnB. Peatman," Design with Microcontrollers", McGraw Hill International, USA, 2005.

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

CO1 Explain 8051architecture, instruction formats, addressing modes, and memory Organization.

CO2 Write programs in assembly/Cfor8051 and interface serial/I2C/SPI/CAN,Bluetooth, And Wi-Fi modules.

CO3 Interface 8051with memory, displays, motors, sensors, and write closed-loop control Programs.

CO4 Describe ARM7 architecture and write basic programs using ARM instruction sets.

CO5 Apply GPIO programming and interface peripherals using Python on single-board computers.

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(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I-Semester	FINITE ELEMENT METHODS (Open Elective–III) (V231410351)	L	T	P	C
		3	0	0	3

Course Objectives: The student will acquire the knowledge

- Introduce fundamentals of FEM including stress-strain relations and variational methods.
- Teach weighted residual methods and energy principles for solving1D problems.
- Introduce bar element formulation and discretization techniques in FEM.
- Teach2D finite element modeling using CST and rectangular elements.
- Introduce higher order and iso-parametric elements with natural co-ordinates and numerical integration.

UNIT	CONTENTS
UNIT– 1	**VARIATIONAL METHODS:** Introduction to finite element method, stress and equilibrium, strain –displacement relations, stress–strain relations, plane stress and plane strain conditions, variational methods.
UNIT– 2	**WEIGHTED RESIDUAL METHODS:** solving differential equations using weighted residual methods, concept of potential energy, one dimensional problem.
UNIT– 3	**1D-ELEMENTS:** Bar element formulation, Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.
UNIT– 4	**2D-ELEMENTS:** Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Finite element modeling off our nodded rectangular element.
UNIT– 5	**HIGHER ORDER AND ISO-PARAMETRIC ELEMENTS:** One dimensional, quadratic and cubic elements in natural co-ordinates, two dimensional four nodes-parametric elements and numerical integration.

Text Books:

1. The Finite Element Methods in Engineering/SS Rao/ Pergamon.

References:

1. Finite Element Method with applications in Engineering/YMDesai, Eldho &Shah /Pearson publishers
2. An introduction to Finite Element Method/JNReddy/ McGraw Hill
3. The Finite Element Method for Engineers–Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and TedG. Byrom/John Wiley& sons (ASIA)PteLtd.

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 / G.Lakshmi Narasaiah / BSP Books Pvt. Ltd.

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

CO1 Explain stress-strain relations and apply variational methods in FEM formulations.
CO2 Apply weighted residual methods and potential energy principles to1DFEM problems.
CO3 Formulate bar element stiffness matrix and perform mesh generation with appropriate boundary conditions.
CO4 Model 2D stress problems using CST and four-node rectangular elements with boundary conditions.
CO5 Apply quadratic, cubic, and iso-parametric elements using numerical integration in FEM.

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(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I-Semester	INTRODUCTION TO MECHATRONICS (Open Elective-III) (V231410352)	L	T	P	C
		3	0	0	3

Course Objectives: The student will acquire the knowledge

- Introduce mechatronics systems, their components, and various sensors used for measurement.
- Explain solid-state devices and analog signal conditioning using-amps.
- Explore fluid power and mechanical actuation systems with their control mechanisms.
- Teach digital electronics, microcontrollers, and PLC-based control systems.
- Introduce data acquisition, digital signal processing, and mechatronic system design.

UNIT	CONTENTS
JNIT– 1	**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– 2	**SOLID STATE ELECTRONIC DEVICES:** PN junction diode, BJT,FET, DIAC, TRIAC and LEDs. Analog signal conditioning, operational amplifiers, noise reduction, filtering
UNIT– 3	**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– 4	**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– 5	**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/KPRamachandran, GK Vijaya Raghavan& MS Balasundaram/WILEY India Edition

References:

1. Mechatronics/SmailiA,MradF/ Oxford Higher Education,Oxford University Press
2. Mechatronics Source Book/Newton CBraga/ Thomson Publications,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 Engg.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 will be able to

CO1 Identify components of mechatronics systems and explain working principles of Various sensors.

CO2 Analyze characteristics of electronic devices and apply signal conditioning techniques.

CO3 Describe operation of hydraulic, pneumatic, and mechanical actuating systems.

CO4 Develop basic logic control systems using microcontrollers and PLCs.

CO5 Design basic mechatronic systems in corporation data acquisition and interfacing techniques.

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B. TECH MECHANICAL ENGINEERING
(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I-Semester	PRODUCT DESIGN AND DEVELOPMENT (Open Elective-III) (V231410353)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: The student will acquire the knowledge

- Introduce fundamental tools, standards, and practices in product design, engineering drawings, BOM, and project management.
- Familiarize student swith global material standards, manufacturing processes, and product analysis tools.
- Teach the structured approach to product design from RFQ to initial sample submission with relevant documentation.
- Emphasis equality testing, customer validation, and risk assessment in new product qualification.
- Highlight the importance of standardized reporting, prototyping, reverse engineering, and concurrent engineering in NPD.

UNIT	CONTENTS
UNIT–1	**FUNDAMENTALSOFPRODUCTDESIGNANDDEVELOPMENT**: 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 soft ware and their application in Industries like SAP, MS Dynamics, and Oracle ERP Cloud – QFD.
UNIT–2	**MATERIAL SPECIFICATIONS, ANALYSIS &PROCESS**: Material specificationstandards–ISO,DIN,JIS,ASTM,EN,etc.–Awarenessonvarious manufacturingprocesslikeMetalcastings&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–3	**ESSENTIALS OF PRODUCT DESIGN AND DEVELOPMENT**: 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 programming. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

UNIT–4 **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 Surveyor similar products, Risk analysis, validating samples with simulation results, Lesson Learned &Horizontal deployment in NPD (New Product Development).

UNIT–5 **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–KarlT. Ulrich, MariaC. Young, Steven D. Eppinger

REFERENCES:

1. Revolutionizing Product Development–Steven C Wheelwright &Kim B.Clark
2. Toyota Product Development System–James Morgan &Jeffrey K.Liker
3. Winning at New Products–Robert Brands3rd 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 Understand drawing interpretation, BOM structure, Gantt charts, QFD, and industrial MIS tools like SAP and Oracle ERP.

CO2 Identify material standards, manufacturing methods, and apply DFMEA,PFMEA, and FEA fundamentals in product evaluation.

CO3 Demonstrate the ability to process RFQs, select tools/machines, plan manufacturing, and prepare PPAP documents.

CO4 Evaluate product performance using testing methods and apply lessons learned for NPD improvement.

CO5 Prepare comprehensive reports (PPAP,APQP), utilize prototyping /RPTtools,and Apply RE &CE to enhance product development.

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(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I-Semester	ADVANCED MATERIALS (Open Elective-III) (V231410354)	L	T	P	C
		3	0	0	3

Course Objectives: The students will acquire the knowledge:

- Introduce various metallic materials, their applications in extreme environments, and innovative forms like metallic foams.
- Provide knowledge of natural and synthetic polymers, ceramics, their structures, processing, and industrial applications.
- Explain the fundamentals, classifications, and reinforcements of composite materials and their engineering relevance.
- Introduce shape memory alloys and functionally graded materials, focusing on their effects, properties, and applications.
- Explore the principles, unique properties, and applications of nano materials compared to their bulk counterparts.

UNIT	CONTENTS
UNIT– 1	**ADVANCED METALS & ALLOYS:** Metallic materials- super alloys, 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– 2	**CERAMICS**: Applications - characteristics- classification-Processing of ceramics- Powder preparations- consolidation- hot compaction-drying-sintering-finishing of ceramics, Al_2O_3,silicon nitride Si3N4 and Cermets, Areas of applications.
UNIT– 3	**COMPOSITE MATERIALS**: Introduction, polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon–carbon composites, fiber- reinforced composites and nature-made composites, and applications. **REINFORCEMENTS:** Fibers- glass, silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibers.
UNIT– 4	**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 of functionally graded materials.
UNIT– 5	**NANOMATERIALS:** Introduction- properties at nano scales -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. Nonmaterial/ A.K.Bandyopadyay /Newage Publishers
2. Material science and Technology: A comprehensive treatment /Robert W.Cahn,/VCH
3. Engineering Mechanics of Composite Materials /Isaac and M Daniel/Oxford University Press

References:

1. Mechanics of Composite Materials/R.M.Jones/McGrawHillCompany,NewYork, 1975.
2. Analysis of Laminated Composite Structures/L.R.Calcote/VanNostr and Rainfold,NY 1969
3. Analys is and performance offered Composites/B.D. Agarwal and L. J. Broutman /Wiley- Interscience, New York,1980
4. Mechanics of Composite Materials- Second Edition (Mechanical Engineering) /Autar K.Kaw/ CRC Press

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

CO1	Identify and evaluate high-performance metals and alloys used in aerospace, cryogenics, And advanced engineering applications.
CO2	Classify and compare polymers and ceramics based on properties, processing techniques, And their functional uses.
CO3	Distinguish between various composite systems and reinforcement types, and identify Their specific industrial applications.
CO4	Understand the composition, classification, and application areas of SMAs and FGM sin Modern materials engineering.
CO5	Analyze nano-scale material behavior, assess their benefits and limitations, and present Advanced nano topics through seminars.

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IV Year I-Semester	INTRODUCTION TO SMART MANUFACTURING (Open Elective-III) (V231410355)	L	T	P	C
		3	0	0	3

Course Objectives: The students will acquire the knowledge:

- Introduce the fundamentals and evolution of smart manufacturing with Industry 4.0 technologies.
- Explain the structure and functions of smart machines and sensors in industrial applications.
- Introduce CPS and its 5Carchitecture for implementing intelligent manufacturing systems.
- Teach digital twin technology, machine learning, and predictive maintenance in smart factories.
- Provide knowledge on IoT networking protocols and connectivity infra structure for industrial automation.

UNIT	CONTENTS
UNIT– 1	**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 big losses in manufacturing with Industry4.0,and their benefits
UNIT– 2	**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 co system, 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– 3	**ARCHI TECTURE 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– 4	**DIGITAL TWINS:** 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.

UNIT– 5 **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) model, 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. Industry4.0The Industrial Internet of Things by Alasdair Gilchrist, Apress
2. Industrial InternetofThings, 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 Explain the stages, challenges, and benefits of smart manufacturing and methods to Reduce production losses.

CO2 Identify smart machine components and describe sensor roles and interfaces in IoT-Based manufacturing systems.

CO3 Analyze CPS architecture and compare traditional and Industry 4.0 factories using 5C Implementation.

CO4 Apply digital twins, ML/ AI techniques, and predictive maintenance tools including AR For system reliability.

CO5 Evaluate IoT communication protocols and select suitable connectivity models for smart Manufacturing.

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(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I-Semester	OPTIMIZATION TECHNIQUES (Open Elective-IV) (V231410356)	L	T	P	C
		3	0	0	3

Course Objectives: The student will acquire the knowledge

- Introduce basic concepts, types, and formulations of optimization problems with classical solution methods.
- Explore numerical techniques for solving unconstrained optimization problems.
- Present methods for solving optimization problems with equality and inequality constraints.
- Teach the theory and solution techniques for unconstrained and constrained geometric programming problems.
- Introduce integer programming and zero-one programming with solution strategies.

UNIT	CONTENTS
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- multi variable optimization with equality constraints- multivariable optimization with inequality constraints.
UNIT– 2	**UN CONSTRAINED OPTIMIZATION TECHNIQUES:** Pattern search Method –Rosen rock'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 BOOK:

1. Optimization Theory and Applications/S.S.Rao/ Wiley Eastern Limited, New Delhi.

REFERENCES:

1. Engineering Optimization/ KalyanmanaiDeb/ Prentice Hall of India, New Delhi.
2. Optimization Techniques-Theory and applications/C.Mohan & Kusum Deep/ New Age International
3. Operations Research/S.D.Sharma/ MacMillan Publishers

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

CO1	Classify optimization problems and apply classical techniques for single and multivariable optimization.
CO2	Solve un constrained problems using methods like pattern search, Rosen brock's, simplex, and steepest descent.
CO3	Apply penalty methods, feasible direction methods, and solve convex programming Problems.
CO4	Solve G.P.and C.G. Problems using primal-dual concepts and differential or Arithmetic methods.
CO5	Solve integer and zero-one programming problems using Gomory's cutting plane And other algorithms.

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B. TECH MECHANICAL ENGINEERING
(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I-Semester	ADVANCED MANUFACTURING PROCESSES (Open Elective-IV) (V231410357)	L	T	P	C
		3	0	0	3

Course Objectives: The student will acquire the knowledge

- Introduce various surface coating methods, their applications, and economic aspects.
- Explain the processing methods for ceramics and composites used in engineering applications.
- Explore microelectronics fabrication steps from wafer preparation to packaging and CAD.
- Introduce nano-materials, their synthesis techniques, and applications in manufacturing.
- Provide knowledge of rapid prototyping techniques and their use in product development.

UNIT	CONTENTS
UNIT– 1	**COATING TECHNIQUES:** Scope, Cleaners, Methods of cleaning, Surface coating types, ceramic and organic methods of coating, and economics of coating. Electro forming, Chemical vapor deposition, Physical vapor deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.
UNIT– 2	**PROCESSING OF CERAMICS:** Applications, characteristics, classification, Processing of particulate ceramics, Powder preparations, consolidation, hot compaction, drying, sintering, and finishing of ceramics, Areas of application. **PROCESSING OF COMPOSITES:** Composite Layers, Particulate and fiber reinforced composites, Elasto-mers, Reinforced plastics, MMC, CMC, Polymer matrix composites.
UNIT– 3	**FABRICATION OF MICROELECTRONIC DEVICES**: Crystal growth and Wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro electronics, surface mount technology, Integrated circuit economics.
UNIT–4	**NANO-MANUFACTURING:**Nanotubes,Nanoparticles,nanowires,Lithography, Electro-spinning, mechanical milling, Inert gas condensation, sputtering, laser ablation, Arc discharge, Sol-gel methods, working, applications, advantages.
UNIT– 5	**RAPID PROTOTYPING:** Working Principles, Methods, Stereo Lithography, Laser Sintering, Fused Deposition Method, Applications and Limitations, Rapid tooling, Techniques of rapid manufacturing.

TEXT BOOKS:

1. Manufacturing Engineering and Technology Kalpakijian/ Addison Wesley, 1995.
2. Process and Materials of Manufacturing/R. A. Lind burg/ 1thedition, PHI 1990.

REFERENCES:

1. Microelectronic packaging hand book/Rao.R. Thummala and Eugene,J.Rymaszewski/ Van Nostr and Renihold,
2. MEMS &Micro Systems Design and manufacture/ Tai—Run Hsu/ TMGH
3. Advanced Machining Processes /V.K.Jain /Allied Publications.
4. Introduction to Manufacturing Processes/John AScheyIMc Graw Hill.

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

CO1	Apply and distinguish different coating techniques such as CVD, PVD, thermal spraying, and ion implantation for industrial surfaces.
CO2	Understand and apply the manufacturing processes of ceramics and composite materials, including powder consolidation and reinforcement types.
CO3	Analyze and describe the manufacturing sequence of microelectronic devices Including lithography, PCB design, and surface mount technology.
CO4	Understand various nano-manufacturing techniques and evaluate their applications, Advantages and working principles.
CO5	Explain the working principles and limitations of rapid prototyping technologies such As stereo lithography and laser sintering.

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B. TECH MECHANICAL ENGINEERING
(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I-Semester	TOTAL QUALITY MANAGEMENT (Open Elective-IV) (V231410358)	L	T	P	C
		3	0	0	3

Course Objectives: The student will acquire the knowledge

- Introduce the fundamentals of TQM and the role of process quality and statistical control in business performance.
- Emphasize customer satisfaction, loyalty, and benchmarking practices for continuous improvement.
- Explain how to organize and transition a company to ward TQM using systems thinking and productivity tools.
- Teach the concept and classification of quality costs and their role in quality management.
- Provide knowledge of ISO9000 standards and the certification process for global quality assurance.

UNIT	CONTENTS
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 Inspections, 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 thecustomerneeds,ProcessVs.Customer,internalcustomerconflict,quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer –Supplier relationships. Bench Marketing: Evolution of Bench 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 OBJECT REPRESENTATION:** spine representation, Herm item **THE COST OF QUALITY:** Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

UNIT– 5 **ISO9000:** Universal Standards of Quality: ISO around the world, The ISO9000ANSI/ASQCQ-Series Standards, benefits of ISO9000 certification, the third party audit, Documentation ISO9000 and services, the cost of certification implementing the system

TEXT BOOKS:

1. Total Quality Management/JoelE.Ross/ Taylorand Franscis Limited
2. Total Quality Management/P.N. Mukherjee/PHI

REFERENCES:

1. Beyond TQM/ RobertL. Flood
2. Statistical Quality Control/E.L.Grant /McGraw Hill.
3. Total Quality Management-APractical Approach/H.Lal
4. Quality Management/Kanishka Bedi/Oxford University Press/2011
5. Total Engineering Quality Management/Sunil Sharma/Macmillan

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

CO1 Understand TQM principles and apply process control tools like control charts and Acceptance sampling.

CO2 Evaluate customer-focused strategies and implement benchmarking processes to Enhance quality.

CO3 Implement organizational changes for TQM and assess productivity improvements Through quality circles and reengineering.

CO4 Analyze and utilize equality cost data to drive managerial decisions and quality Improvements.

CO5 Understand and apply ISO9000 certification procedures and assess their impacton Business quality systems.

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(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I-Semester	OPERATIONS MANAGEMENT (Open Elective- IV) (V231410359)	L	T	P	C
		3	0	0	3

Course Objectives: The student will acquire the knowledge

- Introduce fore casting methods, production system types, and aggregate planning strategies.
- Explain scheduling policies and materials management techniques for effective production control.
- Teach inventory control models, MRP systems, and modern management concepts like Lean and ERP.
- Introduce statistical and philosophical approaches to quality control and management.
- Provide tools for optimization using linear programming, transportation models, and scheduling algorithms.

UNIT	CONTENTS
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 **MATERIALR EQUIREMENT 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, Juan'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, 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 Hand book, KjellB. Zandin, Fifth Edition2001,The McGraw-Hill Companies, Inc.
2. Operations Management S.N. Chary.
3. Inventory Control Theory and Practice/ Martin K.Starr and David W. Miller.

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

CO1 Apply fore casting and aggregate planning techniques to select appropriate production systems.

CO2 Develop scheduling plans and apply inventory classification methods like ABC and VED analysis.

CO3 Analyze inventory decisions using EOQ and implement MRP logic and Lean Concepts.

CO4 Use tools like control charts and sampling to manage quality and understand TQM And Six Sigma principles.

CO5 Solvereal-worldproblemsusingLPP,transportation,assignment,andtravelling Sales man models.

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B. TECH MECHANICAL ENGINEERING
(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I-Semester	ENERGY AUDITING (Open Elective-IV) (V23141035A)	L	T	P	C
		3	0	0	3

COURSEOBJECTIVES

- Introduce global and national energy scenarios, energy auditing needs, and the role of energy managers.
- Explain electricity tariff systems and energy-saving techniques in electrical networks.
- Provide knowledge of combustion and conservation methods in major thermal systems.
- Discuss conservation measures in various electrical utilities and support systems.
- Explain monitoring, targeting, labeling, and economic evaluation of energy projects.

UNIT	CONTENTS
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	**ENERGY CONSERVATION IN MAJOR THERMAL UTILITIES**: Stoichiometry - Combustion principles. Energy conservation in: Boilers - Steam Distribution Systems - Furnaces - Thermal Fluid Heaters – Cooling Towers – D.G. sets. Insulation and Refractoriness - Waste Heat Recovery Devices.
UNIT– 4	**ENERGY CONSER VATION 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 Labeling- Energy Economics–Cost of production and Life Cycle Costing - Economic evaluation techniques – Discounting and Non-Discounting - ESCO concept – PAT scheme

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 administered by Bureau of Energy Efficiency (BEE), statutory body under Ministry of Power, Government of India.

2. K. Naga bhushan Raju, Industrial Energy Conservation Techniques :(concepts, Applications and Case Studies), Atlantic Publishers &Dist, 2007.

REFERENCES:

1. AbbiYP, ShashankJain., Hand book on Energy Audit and Environment Management, TERI Press, 2006.
2. Albert Thurman and Paul Mehta D,“ Hand book of Energy Engineering”,7thEdition,The Fairmont Press, 2013.
3. Murphy. W.R.and McKay. G,“ Energy Management”, Butterworth, London1982.
4. PaulW.O' Callaghan, Design and management for energy conservation: A hand book for energy managers, plant engineers, and designers, Pergamum Press, 1981.
5. Steve Doty, Wayne Turner, Energy Management Handbook7thEdition,TheFairmont Press, 2009

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

CO1	Analyze energy consumption patterns and perform basic energy audits using suitable tools.
CO2	Evaluate power systems for conservation opportunities and apply DSM and PF improvement strategies.
CO3	Apply energy- saving techniques in boilers, furnaces, steam systems, and waste heat Recovery units.
CO4	Recommend energy- efficient practices for motors, compressors, HVAC, and lighting Systems.
CO5	Performenergyperformanceanalysisusingeconomictoolsandunderstandschemes Like PAT and ESCO.

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(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I- Semester	QUANTUM SCIENCE AND TECHNOLOGY (V23141035B)	L	T	P	C
		3	0	0	3

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

Course Objectives:

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.

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 super position 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 **CONTENTS**

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

Unit 2: Quantum Information Theory: Classical vs. quantum information; Quit representation using Bloch sphere; Quantum superposition and quantum entanglement; Dirac notation (bra-kit), 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); QuantumFourierTransform(QFT);Quantumerrorcorrection:Bit-flip,phase-

flip,andShor's 9-qubit code; Introduction to quantum programming: Visit, Car, IBM Quantum Experience (overview)

Unit 4: Quantum Communication: Introduction to quantum cryptography; Quantum key distribution (QKD): BB84 protocol; Entanglement-based QKD: Eckert 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: magnetometer, gravimetric; Quantum metrology: standard time, atomic clocks; Quantum imaging and lithography; Quantum materials: topological insulators, grapheme, quantum dots; Inventers in diamonds for sensing; Hardware platforms: Superconducting quits, Trapped ions, Photonic quantum processors; Quantum supremacy and NISQ era; Global initiatives: IBM, Google, D-Wave, Ion Q, 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

Online Learning Resources:

1. https://nptel.ac.in/courses/104104082

2.https://nptel.ac.in/courses/11510409
3.https://nptel.ac.in/courses/12210603

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B. TECH MECHANICAL ENGINEERING
(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I-Semester	MECHATRONICS LAB (V231410362)	L	T	P	C
		0	0	4	2

Course Objectives: The student will acquire the knowledge

- To study the characteristics and working principles of basic transducers and signal conditioning elements.
- To develop and simulate PLC ladder logic programs for real- time industrial control systems.
- To design, simulate, and analyze hydraulic and electro-pneumatic circuits using Automation Studio.
- To introduce MAT LAB and SIMULINK for modeling and simulation of control systems.

CONTENTS

List of Experiments

1. DYNA1750 Transducers Kit :-
   a. Characteristics of LVDT
   b. Principle & Characteristics of Strain Gauge
   c. Characteristics of Summing Amplifier
   d. Characteristics of Reflective Op to Transducer

2. PLC PROGRAMMING & Simulation of Allen Bradley, Siemens or IECL adder 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 return latch circuit, double solenoid Hydraulic / Pneumatic circuits, Self-Reciprocating Hydraulic / Pneumatic Circuit.

3. AUTOMATION STUDIOS OF TWARE (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 course, student will be able to

CO1 Analyzeandinterprettheresponseof LVDT,straingauges,optotransducers,and Amplifiers.

CO2 Design and simulate PLC programs for sensors, actuators, and process control Applications.

CO3 Create and simulate control circuits with various hydraulic and pneumatic Configurations including PID-based position control.

CO4 Implement control algorithms and analyze system responses using MATLAB and SIMULINK.

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B. TECH MECHANICAL ENGINEERING
(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I-Semester	CONSTITUTION OF INDIA (V2314103C1)	L	T	P	C
		2	0	0	-

Course Objectives: The student will acquire the knowledge

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

UNIT CONTENTS

UNIT– 1 Introduction to Indian 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, features of Indian constitution
- Evaluate Preamble Fundamental Rights and Duties

UNIT– 2 Union Government and its Administration Structure of the Indian Union: Federalism,Centre-Staterelationship,President:Role,powerandposition, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabah, Rajya Sabah, The Supreme Court and High Court: Powers and Functions;

Learning outcomes:-After completion of this unit student will

- Understand the structure of Indian government
- 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– 3 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
- Differentiate between structure and functions of state secretariat

UNIT–4 A. Local Administration - District's Administration Head - Role and Importance, Municipalities –Mayor and role of Elected Representative -CEO of Municipal Corporation Pachayati Raj: Functions PRI: Zila Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Block level Organizational Hierarchy - (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
- Analyze the role of Myer and elected representatives of Municipalities
- Evaluate Zilla Panchayat block level organization

UNIT–5 Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissioner ate State Election Commission: Functions of Commissions for the welfare of SC/ST/OBC and women

Learning outcomes:- After completion of this unit student will

- Know the role of Election Commission apply knowledge
- Contrast and compare the role of Chief Election commissioner and Commissioner ate
- Analyze role of state election commission
- Evaluate various commissions of viz SC/ST/OBC and women

References*:*

1) Durga DasBasu, Introduction to the Constitution of India, Prentice–Hall of India Pvt.Ltd..New Delhi
2) Subash Kashyap, Indian Constitution, National Book Trust
3) J.A.Siwach, Dynamics of Indian Government &Politics
4) D.C.Gupta, Indian Government and Politics
5) H.M. Sreevai, Constitutional Law of India,4the ditionin 3volumes (Universal Law Publication)
6) J.C.Johari, Indian Government and Politics Hans
7) J. RajIndian Government and Politics
8) M.V.Pylee,Indian Constitution Durga Das Basu, Human Rightsin Constitutional Law,Prentice
9) –Hall of India Pvt.Ltd..New Delhi
10) Noorani,A.G.,(South Asia Human Rights Documentation Centre),Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

E-resources:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details
5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

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

CO1	Understand historical back ground of the constitution making and its importance For building democratic India
CO2	Understand the functioning of three wings of the government i.e., executive, Legislative and judiciary.
CO3	Understand the value of the fundamental rights and duties for becoming good Citizen of India.
CO4	Analyzethedecentralizationofpowerbetweencentral,stateandlocalself-Government.
CO5	Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.
CO6	Know the sources, features and principles of Indian Constitution.
CO7	Learn about Union Government, State government and its administration.
CO8	Get acquainted with Local administration and Pachayati Raj.
CO9	Beware of basic concepts and developments of Human Rights.
CO10	Gain knowledge on roles and functioning of Election Commission.

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(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I-Semester	EVALUATION AND INDUSTRY INTERNSHIP (V231410381)	L	T	P	C
		-	-	-	2

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(V23 – IV YEAR COURSE STRUCTURE & SYLLABUS)

B.Tech.–IV Year II Semester

S.No.	Category	Title	L	T	P	Credits
1	Internship& Project Work	Full semester Internship & Project Work (V2314203A1)	0	0	24	12