



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

B.Tech.– IVYearI 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/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. Introduction to Smart Manufacturing	3	0	0	3
7	Open Elective-IV	1. Optimization Techniques 2. Advanced Manufacturing Processes 3. Total Quality Management 4. Operations Management 5. Energy Auditing	3	0	0	3
8	Skill Enhancement Course	Mechatronics Lab	0	0	4	2
9	Audit Course	Constitution of India	2	0	0	-
	Internship	Evaluation of Industry Internship	-	-	-	2
Total			18	0	06	21

Professional Elective-IV

5. Mechatronics
6. Computational Fluid Dynamics
7. Functional Materials and Applications
8. Drives and Actuators for Robotics
9. Transducers for instrumentation (nptel course)

Professional Elective-V

5. Hydrogen and Fuel Cell Technology
6. Smart Manufacturing
7. Autonomous Systems
8. Embedded Systems and Programming



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

B.Tech.–IVYearII Semester

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



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	CAD/CAM	L	T	P	C
		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 wireframe 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



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

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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 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** Create solid models and generate simple CNC part programs using manual and APT 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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IVYear I Semester	OPERATIONSRESEARCH	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–2x2 games–dominance principle–mx2 & 2x n games-graphical method.
UNIT– 4	QUEUEING THEORY: Introduction – single channel – poisson arrivals – exponential service times – with infinite population and finite population models– multichannel – poisson 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



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

Text Books:

1. Operations Research-An Introduction/Hamdy ATaha/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 Yasan& 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/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 replacement scenarios and determine optimal strategies using game theory.
- CO4** Apply queuing theory and inventory models to optimize service and stock management.
- CO5** Solve multi stage decision problems and apply simulation to real-life systems.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	CAD/CAM LAB	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 vibrational 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 workflow of rapid prototyping using 3D printing machines.
- Enable students to simulate and visualize the 3D printing process through online virtual labs.

Note: Student shall perform atleast three experiments from each section

List of experiments

1. Experiments to determine stresses, deflection, natural frequencies ,harmonic analysis, HT 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 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 V labs.

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



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

CONTENTS

3. Experimentstodeterminestresses,deflection,natural frequencies,harmonic analysis, HT analysis and buckling analysis.
 - a) Determinationofdeflectionandstressesin2Dand3Dtrussesandbeams.
 - b) DeterminationofprincipalandVon-misesstressesinplanestress,planestrain and axisymmetric components.
 - c) Determination of stresses in 3D and shell structures (at least one example in each case)
 - d) Estimationofnatural frequenciesandmodeshapes,harmonicresponseof2D beam.
 - e) Steadystateheattransfer analysisofplaneandaxisymmetric components.
 - f) Bucklinganalysis
4. Studyof CNC part programming fundamentals and write part programmes for simple components on CNC lathe and Mill and Study of RP machine.
 - C. CNC part programming for turned components
 - (i) Plain turning and facing
 - (ii) StepTurning Operation
 - (iii) Taper turning
 - D. CNC programming for milled components
 - (i) Circular interpolation
 - (ii) End milling
 - (iii) Pocket milling
6. Automated CNC Toolpath and G-Code generation using CAM packages.
7. Study and demonstration of RPmachine-creation of simpleparts.
8. Virtual 3D Printing Simulation lab using Vlabs.

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



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

Course Outcomes : Attend 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 toolpaths and G-codes using CAM packages for given part geometries.
- CO4** Create and demonstrate simple 3D models using RP machines.
- CO5** Perform and analyze virtual 3D printing experiments using online simulation platforms.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	MECHATRONICS (Professional Elective-IV)	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, microcontrollers, 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 microcontrollers, 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



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

References:

2. Mechatronics/Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press
3. Mechatronics Source Book/Newton C Braga/Thomson Publications, Chennai.
4. Mechatronics–N. Shanmugam/Anuradha Agencies Publishers.
5. Mechatronics System Design/Devdasshetty/Richard/Thomson.
6. Mechatronics/M.D. Singh/J.G. Joshi/PHI.
7. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition / W. Bolton/ Pearson, 2012
8. Mechatronics–Principles and Application/Godfrey C. Onwubolu/Elsevier, Indian print

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 operational amplifiers.
- CO3** Analyze hydraulic, pneumatic, and electromechanical actuation systems and their components.
- CO4** Develop basic control logic using microprocessors, microcontrollers, and PLCs.
- CO5** Implement data acquisition, signal processing, and motor drive interfacing in a mechatronic setup.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

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

Course Objectives: The student will acquire the 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 modelling.
- 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, 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- 2	CONDUCTION AND CONVECTION: 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 convection – 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 modelling: introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods.
UNIT- 4	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.
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



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

TextBooks:

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

References:

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



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	FUNCTIONAL MATERIALS AND APPLICATIONS (Professional Elective-IV)	L	T	P	C
		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 nanomaterials 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 – paramagnetism 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, mobility and diffusion – Hall effect and devices – 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 inorganic semiconductor devices – excitonic state – Electro-optics and nonlinear optics: Modulators and switching devices – plasmonics.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

UNIT– 5 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 – photoprocesses – spintronics – carbon nanotubes: 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-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, 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 Pennathur, Nanotechnology: 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 phenomena in intrinsic and extrinsic semiconductors.
- CO4** Explain optical transitions, recombination processes, and working of optoelectronic and nonlinear optical devices.
- CO5** Describe quantum confinement, nanostructures, and emerging nanoelectronic and spintronic devices.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
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IV Year I Semester	DRIVES AND ACTUATORS FOR ROBOTICS (Professional Elective-IV)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: The student will acquire the knowledge

- Introduces 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 stepper, 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	DRIVE 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- 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 – 4 quadrant 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 Servomotor- AC Servomotor – Applications.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

TEXT BOOKS:

1. Bimbhra B.S., "Power 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, 2016.

REFERENCES

1. Gopal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosa Publishing House, New Delhi, 2001.
2. Theraja B.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** 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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	HYDROGEN AND FUEL CELL TECHNOLOGY (Professional Elective-V)	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 electrochemical, 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, zeolites, 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 - thermodynamics 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. Sorenson B, Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorenson, Academic Press (2005).
2. Hordesk MF, Hydrogen and Fuel Cells: Advances in Transportation and Power, The Fairmont Press, Inc. (2009)
3. Busby RL, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Books (2005).



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

Course Outcomes (COs):

- CO1:** Understand the properties of hydrogen as a fuel and describe the infrastructure 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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	SMART MANUFACTURING (Professional Elective-V)	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, 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 a IIoT Sensing Device, Sensors in IIoT Applications, Smart Machine Interfaces
- UNIT- 3 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- 4 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, 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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

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:commonprotocols,applicationlayerprotocols,internet/networklayer protocols,physicallayerIoT protocols.

TextBooks:

1. Industry4.0TheIndustrialInternetofThingsbyAlasdairGilchrist, Apress
2. IndustrialInternetofThings,CyberManufacturingSystembySabinaJeschke,Christian Brecher, Houbing Song Danda B. Rawat, Springer

CourseOutcomes:Attheendof thecourse,studentwillbeable to

- CO1** Explaintheevolution,stages,andbenefitsofsmartmanufacturing,Industry4.0and Industry 5.0.
- CO2** Identifyanddescribessmartsensors,subsystems,andinterfacesusedinIIoT-based manufacturing.
- CO3** AnalyzeCPSfunctionsandcomparetraditionalmanufacturingwithIndustry4.0CPS- based systems.
- CO4** ExplaindigitaltwinimplementationandapplyAI/MLconceptsforpredictive maintenance in manufacturing.
- CO5** UnderstandanddifferentiateIoTnetworklayersandprotocolsusedinIndustry4.0 applications.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IVYearISemester	AUTONOMOUS SYSTEMS (Professional Elective-V)	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 modelling 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, Robocup
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, AND CONTROL ASPECTS OF UNMANNED VEHICLES: Different types of unmanned vehicles: ground (wheeled and legged), aerial (fixed, flapping, and rotary wings), underwater vehicles, Modelling of unmanned vehicles considering basic forces, kinematics, and dynamics, Discussion on different types of control 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, LiDAR, 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-Space Form, Time, Motion, and Trajectories, 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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

Textbooks:

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza (2018),
2. Introduction to autonomous mobile robots, MIT press. 2. Gerhard Weiss (2013), Multiagent System, Second Edition, MIT Press
3. C. Venkatesan, (2014), Fundamentals of Helicopter Dynamics, 1st Edition, CRC Press. 2. John D. Anderson, (2015), Introduction to Flight, 8th Edition, McGraw-Hill Education

COURSE OUTCOMES: 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 underwater 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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IVYearISemester	EMBEDDED SYSTEMS AND PROGRAMMING (Professional Elective-IV)	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.
- Explain system-on-chip architecture and embedded programming using Python on SBCs.

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 – 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– 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 SoC – SBC architecture - Models and Languages – Embedded Design – Real Time Embedded Operating Systems - Real Time Programming Languages – Python for Embedded Systems - GPIO Programming – Interfacing



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

TEXT BOOKS:

1. FrankVahidandTonyGivagis, “EmbeddedSystemDesign”,2011, Wiley.
2. KennethJ.Aylala,“The8051Microcontroller,theArchitectureandProgramming Applications”, 2003.

REFERENCES:

1. MuhammadAliMazidiandJaniceGillispicMazdi,“The8051Microcontrollerand Embedded Systems”, Pearson Education, 2006.
2. SimonMonk,ProgrammingtheRaspberryPi,SecondEdition:GettingStartedwith Python McGraw Hill TAB; 2nd edition,2015
3. JamesW.Stewart,“The8051MicrocontrollerHardware,SoftwareandInterfacing”, Regents Prentice Hall, 2003.
4. JohnB.Peatman,“DesignwithMicrocontrollers”,McGrawHillInternational,USA, 2005.

CourseOutcomes:Attheendof thecourse,studentwillbeable to

- CO1** Explain8051architecture,instructionformats,addressingmodes,andmemory organization.
- CO2** Writeprogramsinassembly/Cfor8051andinterfaceserial/I2C/SPI/CAN,Bluetooth, and Wi-Fi modules.
- CO3** Interface8051withmemory,displays,motors,sensors,andwriteclosed-loopcontrol programs.
- CO4** DescribeARM7 architectureand writebasicprograms usingARM instruction sets.
- CO5** ApplyGPIOprogrammingandinterfaceperipheralsusingPythononsingle-board computers.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

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

- Introduce fundamental stress-strain relations and variational methods.
- Teach weighted residual methods and energy principles for solving 1D problems.
- Introduce element formulation and discretization techniques in FEM.
- Teach 2D finite element modeling using CST and rectangular elements.
- Introduce higher order and iso-parametric elements with natural coordinates 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 problems.
- UNIT– 3 1D-ELEMENTS:** Bar element formulation, Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, bandwidth, 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 of four noded rectangular element.
- UNIT– 5 HIGHER ORDER AND ISO-PARAMETRIC ELEMENTS:** One dimensional, quadratic and cubic elements in natural coordinates, two dimensional four node iso-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/YM Desai, Eldho & Shah /Pearson publishers
2. An introduction to Finite Element Method/JN Reddy/McGraw Hill
3. The Finite Element Method for Engineers–Kenneth H. Huebner, Donald L. Dewhirst,



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

Douglas E. Smith and Ted G. Byrom/John Wiley & Sons (ASIA) Pte Ltd.

4. Finite Element Analysis: Theory and Application with Ansys, Saeed Moaveni, 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 principle to 1D FEM problems.
- CO3** Formulate bar element stiffness matrix and perform mesh generation with appropriate boundary conditions.
- CO4** Model 2D stress problems using CST and four-noded rectangular elements with boundary conditions.
- CO5** Apply quadratic, cubic, and iso-parametric elements using numerical integration in FEM.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IVYearISemester	INTRODUCTIONTOMECHATRONICS (OpenElective-III)	L	T	P	C
		3	0	0	3

CourseObjectives:The studentwill acquirethe knowledge

- Introduce mechatronicssystems,theircomponents,andvariousensorsusedformeasurement.
- Explainsolid-statedevices and analogsignalconditioningusingop-amps.
- Explorefluidpowerandmechanicalactuatingsystems withtheircontrol mechanisms.
- Teachdigitalelectronics, microcontrollers,andPLC-basedcontrolsystems.
- Introducedataacquisition,digitalsignalprocessing,andmechatronicssystemdesign.

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	SOLIDSTATEELECTRONICDEVICES: PNjunctiondiode,BJT,FET, DIAC,TRIACandLEDs.Analogsignalconditioning,operationalamplifiers, noise reduction, filtering
UNIT– 3	HYDRAULICANDPNEUMATICACTUATINGSYSTEMS: Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanicalactuatingsystemsandelectricalactuatingsystems –basicprinciples 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	SYSTEMANDINTERFACINGANDDATAACQUISITION: 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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

TextBooks:

1. MECHATRONICS Integrated Mechanical Electronics Systems/ KPRamachandran, GK Vijaya Raghavan & MS Balasundaram/WILEY 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. 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 mechatronic 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 incorporating data acquisition and interfacing techniques.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	PRODUCT DESIGN AND DEVELOPMENT (Open Elective-III)	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 students with 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.
- Emphasize quality 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 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- 2 MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS:

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing processes 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- 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 Survey on



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

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 – Karl T. Ulrich, Maria C. 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 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** 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/RPT tools, and apply RE & CE to enhance product development.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IVYearISemester	ADVANCED MATERIALS (OpenElective-III)	L	T	P	C
		3	0	0	3

CourseObjectives:The studentswill acquiretheknowledge:

- Introduce various metallic materials, their applications in extreme environments, and innovative forms like metallic foams.
- Provideknowledgeofnaturalandsyntheticpolymers,ceramics,theirstructures, 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 nanomaterials compared to their bulk counterparts.

UNIT	CONTENTS
UNIT– 1	ADVANCED METALS & ALLOYS: Metallic materials- super alloys, titanium and Nickel based alloys and intermetallics, Materials for cryogenic application, Materials for space environment, Evaluation of materials for extreme environment, Introduction to metallic foams.
UNIT– 2	CERAMICS: Applications-characteristics-classification-Processingofceramics- Powder preparations- consolidation- hot compaction-drying-sintering-finishingofceramics, Al_2O_3 ,siliconnitride Si_3N_4 andCermets,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: Fibres- glass, silica, kevlar, carbon, boron, silicon carbide, and born carbide fibres.
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-propertiesatnanoscales-advantages& disadvantages applicationsincomparisonwith bulkmaterials(nano–structure, wires,tubes,composites).stateofartnanoadvanced-topicdeliveredby student.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

TextBooks:

1. Nanomaterial/A.K.Bandyopadhyay/NewagePublishers
2. Materials 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, New York, 1975.
2. Analysis of Laminated Composite Structures/L.R.Calcote/VanNostrandRainfold, NY 1969
3. Analysis and performance of fibre 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 FGMs in modern materials engineering.
- CO5** Analyze nano-scale material behavior, assess their benefits and limitations, and present advanced nano topics through seminars.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	INTRODUCTION TO SMART MANUFACTURING (Open Elective-III)	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 5C architecture 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 infrastructure 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 Industry 4.0, and their benefits
UNIT- 2	SMART MACHINES AND SMART SENSORS: Concept and Functions of a Smart Machine, 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 a IIoT Sensing Device, Sensors in IIoT Applications, Smart Machine Interfaces
UNIT- 3	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- 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 IIoT predictive maintenance; Rule-based



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

(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. 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 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 IIoT-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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	OPTIMIZATION TECHNIQUES (Open Elective-IV)	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- 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 BOOK:

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



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

REFERENCES:

1. Engineering Optimization/Kalyanmanai Deb/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 unconstrained problems using methods like pattern search, Rosenbrock's, simplex, and steepest descent.
- CO3** Apply penalty methods, feasible direction methods, and solve convex programming problems.
- CO4** Solve G.P. and C.G.P 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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IV Year I Semester	ADVANCED MANUFACTURING PROCESSES (Open Elective-IV)	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 nanomaterials, 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, Elastomers, 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 NANOMANUFACTURING:** Nanotubes, Nanoparticles, nanowires, Lithography, Electrospinning, 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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

TEXT BOOKS:

1. Manufacturing Engineering and Technology Kalpakjian/ Addison Wesley, 1995.
2. Process and Materials of Manufacturing/R. A. Lindburg/ 1st edition, PHI 1990.

REFERENCES:

1. Microelectronic packaging handbook/Rao. R. Thummala and Eugene, J. Rymaszewski /Van Nostrand Reinhold,
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 A. Schey/ McGraw 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 nanomanufacturing techniques and evaluate their applications, advantages, and working principles.
- CO5** Explain the working principles and limitations of rapid prototyping technologies such as stereolithography and laser sintering.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IVYearISemester	TOTALQUALITY MANAGEMENT (OpenElective-IV)	L	T	P	C
		3	0	0	3

CourseObjectives:The studentwill acquirethe knowledge

- Introducethefundamentals ofTQMandtherole ofprocessqualityandstatistical control in business performance.
- Emphasize customer satisfaction, loyalty, and benchmarking practices for continuous improvement.
- ExplainhowtoorganizeandtransitionacompanytowardTQMusingssystemsthinking and productivity tools.
- Teachtheconceptandclassificationofqualitycostsandtheirroleinquality management.
- ProvideknowledgeofISO9000standardsandthecertificationprocessforglobal 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, QualityControl,abriefhistory,ProductInspectionvs,ProcessControl, StatisticalQualityControl,ControlChartsandAcceptanceSampling.
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, qualityfocus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. Bench Marketing: Evolution of Bench Marketing, meaning of Benchmarking,benefitsofbenchmarking,thebenchmarkingprocess, pitfallsofbenchmarking.
UNIT– 3	ORGANIZING FOR TQM: The systems approach, Organizing for quality implementation, making the transition from a traditional to a TQM organizing, QualityCircles.Productivity,QualityandReengineering:Theleverageof Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

- UNIT– 4 3-D OBJECT REPRESENTATION:** spline representation, Hermitem
- 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-SeriesStandards,benefitsofISO9000certification, thethirdpartyaudit,DocumentationISO9000andservices,thecostof certificationimplementingthe system

TEXT BOOKS:

1. TotalQualityManagement/JoelE.Ross/TaylorandFranscisLimited
2. Total QualityManagement/P.N.Mukherjee/PHI

REFERENCES:

1. BeyondTQM/RobertL.Flood
2. StatisticalQualityControl/E.L.Grant/McGraw Hill.
3. TotalQualityManagement-APracticalApproach/H.Lal
4. QualityManagement/KanishkaBedi/OxfordUniversityPress/2011
5. TotalEngineeringQualityManagement/SunilSharma/Macmillan

CourseOutcomes:Attheendof thecourse,studentwillbeable to

- UnderstandTQMprinciplesandapplyprocesscontroltoolslikecontrolchartsand
- CO1** acceptance sampling.
- CO2** Evaluatecustomer-focusedstrategiesandimplementbenchmarkingprocessestoenhance quality.
- CO3** ImplementorganizationalchangesforTQMandassessproductivityimprovements through quality circles and reengineering.
- CO4** Analyzeandutilizequalitycostdatatodrivemanerialdecisionsandquality improvements.
- CO5** UnderstandandapplyISO9000certificationproceduresandassesstheirimpacton business quality systems.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

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

Course Objectives: The student will acquire the knowledge

- Introduce forecasting 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: PandQ 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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

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 Handbook, Kjell B. 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.

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

- CO1** Apply forecasting 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** Solve real-world problems using LPP, transportation, assignment, and travelling salesman models.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

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

COURSE OBJECTIVES

- 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, labelling, 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 - 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

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



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

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

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

REFERENCES:

1. Abbi YP, Shashank Jain., Handbook on Energy Audit and Environment Management, TERI Press, 2006.
2. Albert Thumann and Paul Mehta D, "Handbook of Energy Engineering", 7th Edition, The Fairmont Press, 2013.
3. Murphy. W.R. and McKay. G, "Energy Management", Butterworth, London 1982.
4. Paul W. O'Callaghan, Design and management for energy conservation: A handbook for energy managers, plant engineers, and designers, Pergamon Press, 1981.
5. Steve Doty, Wayne Turner C, Energy Management Handbook 7th Edition, The Fairmont 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** Perform energy performance analysis using economic tools and understand schemes like PAT and ESCO.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IVYearISemester	MECHATRONICSLAB	L	T	P	C
		0	0	4	2

CourseObjectives:The studentwill acquirethe knowledge

- Tostudythecharacteristicsandworkingprinciplesofbasictransducersandsignal conditioning elements.
- TodevelopandsimulatePLCladderlogicprogramsforreal-timeindustrialcontrol systems.
- Todesign,simulate,andanalyzehydraulicandelectro-pneumaticcircuitsusing Automation Studio.
- TointroduceMATLABandSIMULINKformodelingandsimulationofcontrol systems.

CONTENTS

List ofExperiments

1. DYNA1750 TransducersKit :-

- a. CharacteristicsofLVDT
- b. Principle&CharacteristicsofStrainGauge
- c. CharacteristicsofSummingAmplifier
- d. CharacteristicsofReflectiveOptoTransducer

2. PLCPROGRAMMING&SimulationofAllenBradley,SiemensorIECLadderUsing Automation Studio

- a. LadderprogrammingonLogicgates,Timers(TON,TOFF)&counters(UP,DOWN)
- b. LadderProgrammingfordigital&Analogysensors
- c. Ladder programming & Simulations of Virtual System such as Traffic Light control, Washingmachine,GarageDoor,Waterlevelcontrol,Liftcontrol,ConveyorBeltetc.
- d. Ladder programming to control circuits such as single solenoid spring return latch circuit,doublesolenoidHydraulic/Pneumaticcircuits,Self-ReciprocatingHydraulic / Pneumatic Circuit.

3. AUTOMATIONSTUDIOSOFTWARE(Design,Simulate&Analyze)

- a. IntroductiontoAutomationstudio&itscontrol.
- b. Draw & Simulate Hydraulic circuits for series ¶llel cylinders connection, Accumulatorcircuit,Pressureintensifiercircuit,SimpleElectro-HydraulicElectro-Pneumatic circuits (Plot Waveforms for different parameters).
- c. Design&SimulateMeter-in,Meter-out,Regenerativedcircuit,sequencingcircuit, traverse and feedhydraulic circuit, hydraulic press and clamping.
- d. PositionControlofProportionalServo ValveCircuitusingPIDFeedbackcontroller.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

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** Analyze and interpret the response of LVDT, strain gauges, opto transducers, 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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IVYearI Semester	CONSTITUTION OF INDIA	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-State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, 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: Organisation, Structure and Functions.

Learning outcomes: After completion of this unit student will

- Understand the structure of state government
- Analyze the role of 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 Panchayati Raj: Functions PRI: Zilla 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.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

Learningoutcomes:-Aftercompletionofthisunitstudentwill

- UnderstandthelocalAdministration
- Compareandcontrastdistrictadministrationroleandimportance
- AnalyzetheroleofMyer and electedrepresentativesofMunicipalities
- EvaluateZillaPanchayatblocklevelorganization

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

Learningoutcomes:-Aftercompletionofthisunitstudentwill

- KnowtheroleofElectionCommissionapplyknowledge
- ContrastandcomparetheroleofChiefElectioncommissionerandCommissionerate
- Analyzeroleofstateelectioncommission
- EvaluatevariouscommissionsofvizSC/ST/OBCandwomen

References:

- 1) Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd..New Delhi
- 2) SubashKashyap,IndianConstitution,NationalBookTrust
- 3) J.A.Siwach,DynamicsofIndianGovernment&Politics
- 4) D.C.Gupta,IndianGovernmentandPolitics
- 5) H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
- 6) J.C.Johari,IndianGovernmentandPoliticsHans
- 7) J.RajIndianGovernmentandPolitics
- 8) M.V.Pylee,Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice
- 9) –HallofIndiaPvt.Ltd..NewDelhi
- 10) Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to CivilRight),Challengesto CivilRightsGuaranteesinIndia, Oxford UniversityPress 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



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY
An Autonomous Institute
DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year:2026-27
(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

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

CO1	Understand historical background of the constitution making and its importance for building a democratic India
CO2	Understand the functioning of the three wings of the government i.e., executive, legislative and judiciary.
CO3	Understand the value of the fundamental rights and duties for becoming a good citizen of India.
CO4	Analyze the decentralization of power between central, state and local self-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 Panchayati Raj.
CO9	Be aware of basic concepts and developments of Human Rights.
CO10	Gain knowledge on roles and functioning of Election Commission.



SRI VASAVI INSTITUTE OF ENGINEERING & TECHNOLOGY

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year:2026-27

(R23 – IV-YEAR COURSE STRUCTURE & SYLLABUS)

IVYearISemester	EVALUATIONANDINDUSTRY INTERNSHIP	L	T	P	C
		-	-	-	2