



# **First Year Curriculum**

**Admission Year 2026-27**

**First Year Curriculum for the Admission Year 2026-27**

## **M.Tech in Mechatronics Engineering**

**Faculty of Engineering & Technology**

**Parul University**

**Vadodara, Gujarat, India**

## Semester 1

- a. **Course Name:** Fundamentals of Mechatronics Engineering
- b. **Course Code:** 03023001PC01
- c. **Prerequisite:** Fundamentals of Mechatronics Engineering typically include a foundation in basic mathematics, physics, and electronics. Familiarity with mechanics, control systems, and programming languages.
- d. **Rationale:** The rationale of pursuing an M.Tech in Robotics Engineering lies in addressing complex societal and industrial challenges through the integration of advanced robotics technologies for automation, efficiency, and innovation.

### e. Course Learning Objective:

<b>CLOBJ 1</b>	Analyze and design basic analog and digital electronic circuits for control.
<b>CLOBJ 2</b>	Select and model appropriate actuators (electrical/fluid) for a given mechanical task.
<b>CLOBJ 3</b>	Integrate sensors and signal conditioning circuits with microcontrollers.
<b>CLOBJ 4</b>	Apply mathematical modeling to describe the dynamics of mechatronic systems.
<b>CLOBJ 5</b>	Design a complete mechatronic solution that replaces traditional mechanical complexity with "smart" control.

### f. Course Learning Outcomes:

<b>CLO 1</b>	Analyze DC Circuits using Kirchhoff's laws, Ohm's law, and time-domain analysis of RL and RC circuits.
<b>CLO 2</b>	Evaluate AC Circuits with phasor representation, power calculations, and three-phase circuit analysis.
<b>CLO 3</b>	Understand Electrical Installations including wiring, switchgear, earthing, batteries, and energy consumption
<b>CLO 4</b>	Explain Analog Devices such as diodes, transistors, and their applications in amplification and switching.
<b>CLO 5</b>	Apply Boolean Algebra and Logic Gates for number system conversions and digital circuit design.

**g. Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	2	4	20	20	20	60	30	150

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

**h. Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	<b>Introduction to Mechatronics</b> Definition of Mechatronics, Key elements of a mechatronic system, Electronics, Digital control, Information technology, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach	20	10
2	<b>Fundamentals of Electronics</b> Introduction, number systems, Karnaugh maps and logic design, Combinational logic modules, Sequential logic components, Applications of digital systems, Amplifiers, the ideal operational amplifier model, the inverting and non-inverting amplifier, summing amplifier, difference amplifier, instrumentation amplifier, integrator amplifier, differentiator amplifier, comparator, sample and hold amplifier, filters.	25	11
3	<b>Electrical and Mechanical Actuator System:</b> Introduction, moving-iron transducers, solenoids, relays, electric motors, direct current motors, dynamic model and control of D.C. motors, the servo motor, the stepper motor, mechanical elements, kinematic chains, cam mechanisms, gears, hydraulic and pneumatic actuators.	30	12
4	<b>Data Conversion Device</b> Sensors, micro sensors, transducers, signal processing devices, introduction to microprocessors, microcontrollers and PLC.	15	8
5	<b>Case Studies</b> A PC based computer numerically controlled drilling machine, A robotic arm	10	4
	<b>Total</b>	<b>100</b>	<b>45</b>

**i. Text Book and Reference Book:**

1. Mechatronics Principles and Applications By Godfrey Onwubolu, Professor of Engineering

2. Mechatronic Systems: Fundamentals By R. Iserman | Springer | 1st Edition, Pub. Year 2005
3. Computer automation in manufacturing - an Introduction By T.O. Boucher | Chapman and Hall, Pub. Year 1996
4. Machine design for mobile and industrial applications By G.W. Kurtz, J.K. Schueller, P.W. Claar. II | SAE, Pub. Year 1994

(2)

- a. **Course Name:** Fundamentals of Mechatronics Engineering Laboratory
- b. **Course Code:** 03023001PC02
- c. **Prerequisite:** Fundamentals of Mechatronics Engineering typically include a foundation in basic mathematics, physics, and electronics. Familiarity with mechanics, control systems, and programming languages.
- d. **Rationale:** The rationale of pursuing an M.Tech in Robotics Engineering lies in addressing complex societal and industrial challenges through the integration of advanced robotics technologies for automation, efficiency, and innovation.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To develop and execute efficient low-level programs for the <b>8085 and 8051</b> architectures.
<b>CLOBJ 2</b>	To design and implement control strategies for <b>electrical drive systems</b> .
<b>CLOBJ 3</b>	To evaluate and calibrate various <b>transducers</b> for real-world data acquisition
<b>CLOBJ 4</b>	To design, model, and analyze <b>Hydraulic and Pneumatic circuits</b> .
<b>CLOBJ 5</b>	To program and deploy <b>Programmable Logic Controllers</b> for automated workflows.
<b>CLOBJ 6</b>	To apply basic <b>Image Processing</b> techniques for automated inspection and robotics.

- f. **Course Learning Outcomes:**

<b>CLO 1</b>	Gain knowledge of basic mechanical designing, electrical wiring, robotic sensors and actuators, PCB design and communication protocols.
<b>CLO 2</b>	Gain an understanding of the theoretical background necessary to understand advanced robotic technologies and their specific applications.
<b>CLO 3</b>	Demonstrate proficiency in design, construction, and operation of robotic systems.
<b>CLO 4</b>	Develop problem-solving skills by applying principles of robotics engineering to real-world problems.
<b>CLO 5</b>	Communicate effectively about robotics engineering technologies, their workings and potential applications.

### g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				Th	CE	P	Theory	P	
0	0	2	1	0	0	20	0	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

### h. List of Experiments:

Sr. No.	Content
1	To study about Mechatronics Engineering
2	To study and perform assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion
3	To study and perform assembly language programming of 8051 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion
4	To interface stepper motor
5	To study and control the speed of a DC motor.
6	To study various types of transducers.
7	To study hydraulic, pneumatic and electro-pneumatic circuits.
8	Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using software.
9	To study and perform basic PLC programming and its applications.
10	To study image processing.

### i. Text Book and Reference Book:

1. Machine design for mobile and industrial applications By G.W. Kurtz, J.K. Schueller, P.W. Claar. II | SAE, Pub. Year 1994
2. Computer automation in manufacturing - an Introduction By T.O. Boucher | Chapman and Hall, Pub. Year 1996
3. Mechatronic Systems: Fundamentals By R. Iserman | Springer | 1st Edition, Pub. Year 2005
4. Mechatronics Principles and Applications By Godfrey Onwubolu, Professor of Engineering

(3)

- a. **Course Name:** Manufacturing Automation
- b. **Course Code:** 03023001PC03
- c. **Prerequisite:** Basic knowledge of Manufacturing.
- d. **Rationale:** Manufacturing Automation course provides a link between engineering and automation techniques. Manufacturing Automation in general enables the effective and economical operation of both production equipment and processes.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To evaluate the economic and operational feasibility of various automation strategies.
<b>CLOBJ 2</b>	To synthesize the roles of CAD/CAM and Computer Integrated Manufacturing (CIM) within the product life cycle.
<b>CLOBJ 3</b>	To implement Computer Aided Quality Control (CAQC) using advanced inspection technologies
<b>CLOBJ 4</b>	To design and optimize Flexible Manufacturing Systems (FMS) and automated logistics.
<b>CLOBJ 5</b>	To analyze and optimize automated flow lines and assembly systems for mass production.
<b>CLOBJ 6</b>	To engineer complex control architectures using PLC, SCADA, and DCS.

- f. **Course Learning Outcomes:**

<b>CLO 1</b>	To understand the importance of product development through CIM. Get knowledge of shop floor control.
<b>CLO 2</b>	Adopt appropriate material handling and storage in automated manufacturing environment techniques.
<b>CLO 3</b>	To incorporate methods of utilization of appropriate features in CAD application enhancing productivity in design.
<b>CLO 4</b>	To learn the different types of FMS layouts, material handling and retrieval systems.

- g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	0	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	<b>INTRODUCTION TO AUTOMATION:</b> Automation production system, Mechanization and automation, Types of automation, Automation strategies, Mechanical, electrical, hydraulic and Pneumatic automation devices and controls, Economics of automation.	9	4
2	<b>AUTOMATION AND COMPUTER INTEGRATED MANUFACTURING (CIM):</b> Computers in Industrial manufacturing, Product cycle & Production development cycle, Introduction of CAD/CAM & CIM, sequential and concurrent engineering, Computerized Manufacturing planning systems, shop floor control & automatic identification techniques. Computer Network for manufacturing and the future automated factor.	16	7
3	<b>COMPUTER AIDED QUALITY CONTROL (CAQC):</b> The computer in Q.C, automated inspection principles and methods, Contact inspection methods, non-contact inspection methods, machine vision system, optical inspection method, sensors, coordinate measuring machine, Computer Aided testing, Integration of CAQC with CAD/CAM, Features of Computer controlled machine tools, NC, DNC, CNC, VNC, automatic tool changers, group technology, cell design and layout, Computer aided process planning (CAPP).	13	6
4	<b>FLEXIBLE MANUFACTURING SYSTEMS (FMS):</b> Major elements of FMS and their functioning: Tool handling system, Material handling system, Automated guided vehicles (AGV), Automated storage and retrieval system (AS/RS), FMS layout - concept, types and applications: Data required developing an FMS layout, Signal flow diagram and line balancing in FMS	13	6
5	<b>HIGH VOLUME MANUFACTURING AUTOMATION:</b> Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multi model and mixed model production lines. <b>ASSEMBLY AUTOMATION:</b> Assembly systems, Automatic transfer, feeding and orienting devices, Flexible assembly	31	14

	systems, Performance evaluation and economics of assembly systems.		
<b>6</b>	<b>Programmable controllers and Advanced Control Strategy in Automation:</b> PLC Architecture, Modes of operation, Programming methods, Instructions, Instruction addressing, latches, timers and counters, SCADA, DCS, Integration of PLC, SCADA and DCS with manufacturing systems, Man-machine interfaces, Introduction to PLM, Case studies.	18	8
	<b>Total</b>	<b>100</b>	<b>45</b>

i. **Text Book and Reference Book:**

1. Automation, Production Systems & Computer Aided manufacturing, By M. P. Grover | Prentice Hall
2. Industrial Automation and Robotics By A.K Gupta, S.K. Arora | Laxmi Publication (P) Ltd
3. Principles of Automation & Automated Production Process By Malov and Ivanov | Mir Publication.
4. CAD/CAM/CIM By Radhakrishnan, P.,Subramanyan, S., Raju,V | New AgeInternational Publishers(P) Ltd.

(4)

- a. **Course Name:** Manufacturing Automation Laboratory
- b. **Course Code:** 03023001PC04
- c. **Prerequisite:** Basic knowledge of Manufacturing.
- d. **Rationale:** Manufacturing Automation course provides a link between engineering and automation techniques. Manufacturing Automation in general enables the effective and economical operation of both production equipment and processes.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To develop and verify G-code and M-code programs for complex CNC milling operations.
<b>CLOBJ 2</b>	To evaluate and design operational layouts for Flexible Manufacturing Systems (FMS) and automated assembly lines.
<b>CLOBJ 3</b>	To engineer automated control solutions using Programmable Logic Controllers (PLC).
<b>CLOBJ 4</b>	To simulate and monitor industrial processes using SCADA systems.
<b>CLOBJ 5</b>	To design and interface user-centric control panels (HMI) with PLC-driven systems.

- f. **Course Learning Outcomes:**

<b>CLO 1</b>	To understand the importance of product development through CIM. Get knowledge of shop floor control.
<b>CLO 2</b>	Adopt appropriate material handling and storage in automated manufacturing environment techniques.
<b>CLO 3</b>	To incorporate methods of utilization of appropriate features in CAD application enhancing productivity in design.
<b>CLO 4</b>	To learn the different types of FMS layouts, material handling and retrieval systems.

- g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

**j. Text Book and Reference Book:**

1. Automation, Production Systems & Computer Aided manufacturing, By M. P. Grover | Prentice Hall
2. Industrial Automation and Robotics By A.K Gupta, S.K. Arora | Laxmi Publication (P) Ltd
3. Principles of Automation & Automated Production Process By Malov and Ivanov | Mir Publication.
4. CAD/CAM/CIM By Radhakrishnan, P.,Subramanyan, S., Raju,V | New AgeInternational Publishers(P) Ltd.

**k. Experiment List:**

Sr. NO.	Experiment List
1	Part Programming on CNC Milling Machine
2	Problems on CNC Programming.
3	Case study on FMS Layout.
4	Case study on Assembly Automation.
5	Automation using PLC such as bottle filling, elevator control.
6	Process automation simulation using SCADA
7	Interface HMI with PLC.

(5)

- a. **Course Name:** Optimization Techniques
- b. **Course Code:** 03023001PE01
- c. **Prerequisite:** Basic knowledge of linear algebra, vector calculus and ordinary differential equations.
- d. **Rationale:** This course deals with optimization techniques used in engineering.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To translate real-world engineering challenges into formal mathematical optimization models.
<b>CLOBJ 2</b>	To apply calculus-based methods to solve continuous optimization problems.
<b>CLOBJ 3</b>	To solve linear programming (LP) problems using algebraic and graphical methods.
<b>CLOBJ 4</b>	To execute one-dimensional and unconstrained multi-variable search algorithms.
<b>CLOBJ 5</b>	To solve complex optimization problems with physical and operational limitations.
<b>CLOBJ 6</b>	To apply modern evolutionary computing to "black-box" or non-differentiable problems.

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Understand basic theoretical principles for formulation of optimization models and its solution.
<b>CLO 2</b>	Learn the unified and exact mathematical basis as well as the general principles of various soft computing.
<b>CLO 3</b>	To apply detailed theoretical and practical aspects of intelligent modelling, optimization and control of linear and non-linear systems.
<b>CLO 4</b>	Solve engineering design and manufacturing-related optimization problems using software tools.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	0	60	0	100

**L-** Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

<b>Sr. No.</b>	<b>Content</b>	<b>Weightage</b>	<b>Teaching Hours</b>
<b>1</b>	<b>Introduction to Optimization:</b> Historical Development, Engineering applications of Optimization, Design vector and constraints, Constraint surface, Objective function, Classification of Optimization Problems	<b>9</b>	<b>4</b>
<b>2</b>	<b>Classical Optimization Techniques:</b> Single variable optimization, Constrained and unconstrained multi-variable optimization, Direct substitution method, Lagrange's method of multipliers, Karush-Kuhn-Tucker conditions	<b>16</b>	<b>7</b>
<b>3</b>	<b>Linear Programming:</b> Statement of an LP problem, Graphical Solution of an LP problem, Simplex method, Dual simplex method	<b>13</b>	<b>6</b>
<b>4</b>	<b>Non-linear Programming: One-dimensional minimization method:</b> Unimodal function, Unrestricted search, Exhaustive search, Dichotomous search, Interval halving method, Fibonacci method, Golden section method, Direct root methods	<b>13</b>	<b>6</b>
<b>5</b>	<b>Non-linear Programming: Unconstrained Optimization Techniques:</b> Direct Search Methods: Random search methods, Grid search method, Univariate method, Hookes and Jeeves' method, Powell's method, Indirect Search Methods: Steepest descent method, Fletcher-Reeves method, Newton's method	<b>18</b>	<b>8</b>
<b>6</b>	<b>Non-linear Programming: Constrained Optimization Techniques:</b> Direct Methods: Random search method, Sequential linear programming, Indirect methods: Transformation techniques, Exterior penalty function method, Interior penalty function method	<b>18</b>	<b>8</b>

<b>7</b>	<b>Evolutionary Algorithms:</b> An overview of evolutionary algorithms, Simulated annealing algorithm, Genetic algorithm, Particle swarm optimization	<b>13</b>	<b>6</b>
	<b>Total</b>	<b>100</b>	<b>45</b>

**i. Text Book and Reference Book:**

1. Engineering Optimization Theory and Practice, S.S.Rao; New Age International (P) Ltd, Publishers Basic Mechanical Engineering
2. Introduction to Optimum Design, J. S. Arora; McGraw Hill, New York
3. Multi-objective optimization using evolutionary algorithms, K Deb; John Wiley Publications
4. Optimization Techniques, Chandrashekhar Mohan & Kusumdeep; New Age Science Publications

(6)

- a. **Course Name:** Optimization Techniques Laboratory
- b. **Course Code:** 03023001PE02
- c. **Prerequisite:** Basic knowledge of linear algebra, vector calculus and ordinary differential equations.
- d. **Rationale:** This course deals with optimization techniques used in engineering.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To translate mathematical optimization logic into functional code scripts.
<b>CLOBJ 2</b>	To implement and compare the efficiency of interval-reduction algorithms.
<b>CLOBJ 3</b>	To program gradient-driven search methods for rapid convergence.
<b>CLOBJ 4</b>	To execute and analyze multi-variable optimization through univariate and indirect search paths.

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Understand basic theoretical principles for formulation of optimization models and its solution. 2.
<b>CLO 2</b>	Learn the unified and exact mathematical basis as well as the general principles of various soft computing.
<b>CLO 3</b>	To apply detailed theoretical and practical aspects of intelligent modelling, optimization and control of linear and non-linear systems.
<b>CLO 4</b>	Solve engineering design and manufacturing-related optimization problems using software tools.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

**h. Experiment List:**

Sr. NO.	Experiment List
1	Computer programme (using Matlab / Scilab) for Unrestricted Search methods.
2	Computer programme (using Matlab / Scilab) for Golden Section Method.
3	Computer programme (using Matlab / Scilab) for Fibonacci Method.
4	Computer programme (using Matlab / Scilab) for Newton Methods.
5	Computer programme (using Matlab / Scilab) for Quasi Newton and Secant methods.
6	Computer programme (using Matlab / Scilab) for Univariate methods.
7	Computer programme (using Matlab / Scilab) for Indirect search methods.

**i. Text Book and Reference Book:**

1. Engineering Optimization Theory and Practice, S.S.Rao; New Age International (P) Ltd, Publishers Basic Mechanical Engineering
2. Introduction to Optimum Design, J. S. Arora; McGraw Hill, New York
3. Multi-objective optimization using evolutionary algorithms, K Deb; John Wiley Publications
4. Optimization Techniques, Chandrashekhar Mohan & Kusumdeep; New Age Science Publications

(7)

- a. **Course Name:** Advanced Electrical Drives
- b. **Course Code:** 03023001PE03
- c. **Prerequisite:** Power Electronics, Machines, Basic Electronics
- d. **Rationale :** To equip students with a deep understanding of both fundamental and cutting-edge concepts, enabling them to design, analyze, and optimize high-performance electric drive systems for various applications.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To model and analyze the fundamental dynamics of electrical drive systems.
<b>CLOBJ 2</b>	To design and implement closed-loop control architectures for precise motion.
<b>CLOBJ 3</b>	To evaluate and control DC motor performance using power converters.
<b>CLOBJ 4</b>	To implement sophisticated speed control for Induction Motors.
<b>CLOBJ 5</b>	To manage the operation and variable frequency control of Synchronous Motors.
<b>CLOBJ 6</b>	To integrate and control Brushless DC (BLDC), Stepper, and Switched Reluctance Motors.

- f. **Course Learning Outcomes:**

<b>CLO 1</b>	Remember and understand the fundamental concepts of drives.
<b>CLO 2</b>	Apply the knowledge in designing the power electronic converters.
<b>CLO 3</b>	Analyze and evaluate vector control of machines.
<b>CLO 4</b>	Create innovative solutions by integrating emerging technologies.
<b>CLO 5</b>	Apply modelling and simulation tools to analyze electric drive systems.

- g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

**h. Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	<p><b>Introduction to Electrical Drives:</b>            Electrical Drives, Parts of Electrical Drives, Dynamics of Electrical Drives, Components of Load Torques, Classification of Load Torques, Time and Energy-Loss in Transient Operations, Steady State Stability, Load Equalization.</p>	15	6
2	<p><b>Control of Electrical Drives:</b>            Modes of Operation, Speed Control and Drive Classifications, Closed-Loop Control of Drives, Current-limit control, Closed-loop torque control, Closed-loop speed control, Closed-loop speed control of multi-motor drives, Speed sensing, Current sensing, Phase-locked-loop (PLL) control, Closed loop position control.</p>	15	6
3	<p>DC Motor Drives:            DC Motors and Their Performance, dc servo motors, Starting &amp; Braking, Regenerative braking, Dynamic braking, Plugging, Transient Analysis, Speed Control, Transformer and Uncontrolled Rectifier Control, Controlled Rectifier Fed dc Drives, Single-phase fully-controlled and half-controlled, Three-phase fully-controlled and half-controlled rectifier control of dc motor, Dual-converter control of dc motor.</p>	20	9
4	<p><b>Induction Motor Drives:</b>            Three-Phase Induction Motors, Analysis and performance, Starting, Soft start using saturable reactor starter, Braking, Transient Analysis, Starting and plugging, Speed Control, Rotor Resistance Control, Static rotor resistance control, Slip Power Recovery, Static Scher-bus drive, Static Kramer drive, Variable Speed Constant Frequency Generation, Squirrel-cage induction machine and Cycloconverter scheme, Wound-rotor induction motor and Cycloconverter scheme, Single-Phase Induction Motors: Starting, Breaking, Speed Control, Linear Induction Motor and it's Control, PWM voltage source inverter (VSI) induction motor drives, Load commutated inverter fed synchronous motor drives, CSI squirrel-cage induction motor drive, PWM VSI squirrel--cage induction</p>	20	10

	motor drive, Load commutated inverter (LCI) fed Induction motor drive.		
<b>5</b>	<b>Synchronous Motor:</b> Synchronous Motors, Starting, Braking, Synchronous Motor Variable Speed Drives, Variable frequency control, Modes of variable frequency control, Variable frequency control of multiple synchronous motors, Self-controlled synchronous motor drive employing load commutated thyristor inverter, Self-controlled synchronous motor drive employing a Cycloconverter, Starting Large Synchronous Machines.	<b>15</b>	<b>7</b>
<b>6</b>	<b>Brushless dc Motor, Stepper Motor &amp; Switched Reluctance Motor Drives:</b> Brushless dc Motors Unipolar brushless dc motor, Bipolar brushless dc motor, Speed control of brushless dc motors, Important features and applications, Stepper (or Stepping) Motors, Variable reluctance, Permanent magnet important features of stepper motors, Torque versus stepping rate characteristics, Drive circuits for stepper motors, Switched Reluctance Motor.	<b>15</b>	<b>7</b>
	<b>Total</b>	<b>100</b>	<b>45</b>

i. **Text Book and Reference Book:**

1. Electric Motors and Drives: Fundamentals, Types and Applications Austin Hughes and Bill Drury ; Elsevier ; 5<sup>th</sup>
2. Electrical Drives: Principles, Planning, Applications, Solutions Dieter Gerling ; Springer
3. Modern Power Electronics by-P. C. Sen, ; TATA MCGRAW HILL
4. Power Electronics: Converters, Applications, And Design Ned Mohan ; Wiley India Pvt Ltd

(8)

- a. **Course Name:** Advanced Electrical Drives Laboratory
- b. **Course Code:** 03023001PE04
- c. **Prerequisite:** Power Electronics, Machines, Basic Electronics.
- d. **Rationale:** To equip students with a deep understanding of both fundamental and cutting-edge concepts, enabling them to design, analyze, and optimize high-performance electric drive systems for various applications.

e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To design and analyze sophisticated power converter architectures for high-performance drives.
<b>CLOBJ 2</b>	To implement and optimize complex control algorithms for dynamic motor response.
<b>CLOBJ 3</b>	To create high-fidelity digital twins and perform real-time testing of drive systems.
<b>CLOBJ 4</b>	To enhance system robustness through fault analysis and parametric optimization.

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Remember and understand the fundamental concepts of drives.
<b>CLO 2</b>	Apply the knowledge in designing the power electronic converters.
<b>CLO 3</b>	Analyze and evaluate vector control of machines.
<b>CLO 4</b>	Create innovative solutions by integrating emerging technologies.
<b>CLO 5</b>	Apply modeling and simulation tools to analyze electric drive systems.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	0	0	20	0	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. **Experiment List:**

Sr. NO.	Experiment List
1	Design and simulate a power electronic converter for an electric drive system
2	Implement a vector control algorithm for an AC motor drive.
3	Explore and implement sensor less control techniques for motor drives.
4	Design, simulate, and analyze the performance of a multilevel inverter for an electric drive system.
5	Develop a simulation model for an entire electric drive system, including the motor, power electronic converter, and control algorithms.
6	Integrate wireless power transfer technology into an electric drive system.
7	Explore energy harvesting techniques, such as regenerative braking or piezoelectric energy harvesting.
8	Implement a real-time control system for an electric drive using hardware-in-the-loop (HIL) simulation.
9	Introduce faults in the electric drive system, such as motor winding faults or converter failures. Implement fault diagnosis algorithms and explore methods for fault tolerance to ensure system reliability.
10	Optimize the performance of an electric drive system by adjusting various parameters such as control gains, switching frequencies, and modulation techniques.

(9)

- a. **Course Name:** Micro Electro-Mechanical Systems
- b. **Course Code:** 03023001PE07
- c. **Prerequisite:** Gain knowledge of micro system and fabrication process
- d. **Rationale:** This subject deals with fundamentals of Micro-electromechanical Systems and its applications, which are useful for Mechatronics engineers.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To understand the fundamental principles of miniaturized sensors and actuators.
<b>CLOBJ 2</b>	To evaluate the unique properties of materials used in micro-fabrication.
<b>CLOBJ 3</b>	To master the cleanroom processes required to build microscopic structures.
<b>CLOBJ 4</b>	To apply elasticity theory and finite element modeling (FEM) to smart materials.

- f. **Course Learning Outcomes:**

<b>CLO 1</b>	Attain a broad range of the knowledge required to flourish in the rapidly developing field of MEMS and Nanotechnology.
<b>CLO 2</b>	Facilitate the application of basic physical laws, chemical laws, dynamic behaviour as well as steady state performance to design and synthesize MEMS and Microsystems.
<b>CLO 3</b>	Acquaint him / her with applications of mems fabrication techniques to solve the problems encountered at a macro level.
<b>CLO 4</b>	Gain Proficiency in modelling, simulating and evaluating MEMS and Microsystems.

- g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	0	60	0	100

**L-** Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

j. **Course Content:**

<b>Sr. No.</b>	<b>Content</b>	<b>Weightage</b>	<b>Teaching Hours</b>
<b>1</b>	<b>Introduction to MEMS and Micro Systems:</b> Microsystems and Microelectronics – Miniaturization – Micro sensors: Chemical Sensors- Optical Sensors- Pressure Sensors- Thermal Sensors – Micro actuators and Micro motors.	<b>20</b>	<b>10</b>
<b>2</b>	<b>Microsystem Materials:</b> Molecular Theory and Intermolecular Forces – Silicon Piezo Resistors– Electrochemistry – Substrates and Wafers – Silicon Compounds – Polymers – Packaging Materials	<b>25</b>	<b>12</b>
<b>3</b>	<b>Microsystem Fabrication Process:</b> Photolithography – Ion Implantation – Diffusion – Oxidation – Chemical Vapor Deposition – Etching – Applications of MEMS in Automatic-Telecom and Other Industries.	<b>30</b>	<b>11</b>
<b>4</b>	<b>Introductory concepts in modeling:</b> Theory of elasticity, Solution Procedures in linear theory of elasticity, Theory of laminated composites, Micromechanical analysis of a laminae, wave propagation in structures	<b>15</b>	<b>8</b>
<b>5</b>	<b>Modeling of Smart sensors and Actuators:</b> Introduction, Constitutive modelling, Finite Element modelling, Modelling of magneto strictive sensors and actuators, Modelling of Micro Electro Mechanical systems, Active Control Techniques	<b>10</b>	<b>4</b>
	<b>Total</b>	<b>100</b>	<b>45</b>

k. **Text Book and Reference Book:**

1. MEMS & Microsystems Design & Manufacture Tai, Ran Hsu; Tata Mc Graw Hill, 2002
2. Smart Materials Systems and MEMS: Design and Development Methodologies, Vijay K Varadan, K.J. Vinoy and S. Gopalakrishnan; John Wiley and sons
3. The MEMS Hand book, Mohamed Gad-el-Hak; CRC Press, New York, London

(10)

- a. **Course Name:** Micro Electro-Mechanical Systems Lab
- b. **Course Code:** 03023001PE08
- c. **Prerequisite:** Gain knowledge of micro system and fabrication process
- d. **Rationale:** This subject deals with fundamentals of Micro-electromechanical Systems and its applications, which are useful for Mechatronics engineers.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To perform rigorous static and contact analysis on mechanical components.
<b>CLOBJ 2</b>	To evaluate the dynamic characteristics of structures through Modal Analysis.
<b>CLOBJ 3</b>	To model complex interactions between thermal, electrical, and mechanical domains.
<b>CLOBJ 4</b>	To design and analyze specialized micro-sensors based on fabrication constraints.

- f. **Course Learning Outcomes:**

<b>CLO 1</b>	Attain a broad range of the knowledge required to flourish in the rapidly developing field of MEMS and Nanotechnology.
<b>CLO 2</b>	Facilitate the application of basic physical laws, chemical laws, dynamic behaviour as well as steady state performance to design and synthesize MEMS and Microsystems.
<b>CLO 3</b>	Acquaint him / her with applications of mems fabrication techniques to solve the problems encountered at a macro level.
<b>CLO 4</b>	Gain Proficiency in modelling, simulating and evaluating MEMS and Microsystems.

- g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	0	0	20	0	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

- i. **Experiment List:**

Sr. NO.	Experiment List
1	To Perform Static Analysis of a Corner Bracket.
2	To Perform Interference Fit and Pin Pull-Out Contact Analysis.
3	To Perform Modal Analysis of a Model Airplane Wing.
4	To Perform Multiphysics Analysis of a Thermal Actuator -I.
5	To Perform Multiphysics Analysis of a Thermal Actuator -II.
6	Tutorial – 6 Introduction to MEMS & Microsystems.
7	Tutorial – 7 Mechanics of MEMS.
8	Tutorial – 8 Dynamics of MEMS.
9	Tutorial – 9 Fabrications processes for MEMS.
10	Design and Analysis of MEMS Pressure Sensor-I

(11)

- a. **Course Name:** Robotics Engineering
- b. **Course Code:** 03023201PE11
- c. **Prerequisite:** Have Knowledge of kinematics, dynamics, motion planning, perception, and robot learning.
- d. **Rationale:** Robotics engineering integrates multiple disciplines to create efficient manipulator.

e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To distinguish between robotic configurations and identify the fundamental constraints of a robot's physical design.
<b>CLOBJ 2</b>	To mathematically represent the position and orientation of a robot in 3D space.
<b>CLOBJ 3</b>	To analyze the velocity and static force distribution of a robotic manipulator.
<b>CLOBJ 4</b>	To synthesize sensors, actuators, and grippers into a functional robotic solution for diverse environments.

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Gain knowledge of basic mechanical designing, electrical wiring, robotic sensors and actuators, PCB design and communication protocols.
<b>CLO 2</b>	Gain an understanding of the theoretical background necessary to understand advanced robotic technologies and their specific applications.
<b>CLO 3</b>	Demonstrate proficiency in design, construction, and operation of robotic systems.
<b>CLO 4</b>	Develop problem-solving skills by applying principles of robotics engineering to real-world problems.
<b>CLO 5</b>	Communicate effectively about robotics engineering technologies, their workings and potential applications.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	0	60	0	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

**l. Course Content:**

<b>Sr. No.</b>	<b>Content</b>	<b>Weightage</b>	<b>Teaching Hours</b>
<b>1</b>	<b>Basic of Robotics:</b> Definition of Robots, History of Robots, Classification of Robots, Robotic Joints and Links, Robot Workspaces, CNC Vs Robots, Present Research in Robotics, 3H of Robotics, Laws of Robotics.	<b>25</b>	<b>12</b>
<b>2</b>	<b>General considerations of Robotic Manipulator:</b> Robot anatomy: Links, Joint and joint notations scheme, Degrees of freedom; Arm and wrist configurations, End effectors; Coordinate frames, Mapping between: Rotated frames, translated frames, rotated and translated frames; Description of robotic pose in a space; Homogeneous transformation and inverting a homogeneous transformation; Orientation with RPY and Euler angles.	<b>20</b>	<b>11</b>
<b>3</b>	<b>Differential Motion and Statics:</b> Linear and Angular Velocity of a rigid body; Relation between transformation matrix and angular velocity; Mapping velocity vectors; Linear and Angular velocity of a link; Manipulator Jacobian; Jacobian Singularities; Static analysis of robots.	<b>25</b>	<b>10</b>
<b>4</b>	<b>Robotics Sensors, Actuators, Grippers:</b> Acoustic, Optic, Pneumatic, Force/ Torque sensors; Properties of Sensors, Robotics actuators, Robotic grippers and their design criteria.	<b>20</b>	<b>8</b>
<b>5</b>	<b>Robot Applications:</b> Case studies on various robotic applications in Industrial, Material Handling, Processing, Assembly, Compliance, Inspection, Surgical, Space and Military applications.	<b>10</b>	<b>4</b>
	<b>Total</b>	<b>100</b>	<b>45</b>

**m. Text Book and Reference Book:**

1. Introduction to Robotics S. K. Saha; Mc Graw Hill publication
2. Introduction to Robotics – Mechanics and Control, J. J. Graig; Pearson Education, Inc; 2nd edition
3. Robotics and Control, R. K. Mittal, I. J. Nagrath; Tata McGraw-Hill Publishing

Company Ltd

4. ROBOTICS – Control, Sensing, Vision, and Intelligence, K. S. Fu, R. C. Gonzalez, and C. S. G. Lee ; McGraw-Hill Book Company

(12)

1. **Course Name:** Micro Electro-Mechanical Systems Lab
2. **Course Code:** 03023001PE08
3. **Prerequisite:** Gain knowledge of micro system and fabrication process
4. **Rationale:** This subject deals with fundamentals of Micro-electromechanical Systems and its applications, which are useful for Mechatronics engineers.

5. **Course Learning Objective:**

<b>CLOBJ 1</b>	To evaluate and deploy diverse actuation and sensing technologies for remote robotic control.
<b>CLOBJ 2</b>	To design and execute real-time motion paths for stationary manipulators via remote triggering.
<b>CLOBJ 3</b>	To implement remote feedback control systems for complex manipulation tasks.
<b>CLOBJ 4</b>	To program and analyze navigation algorithms for mobile robots in dynamic environments.

6. **Course Learning Outcomes:**

<b>CLO 1</b>	Gain knowledge of basic mechanical designing, electrical wiring, robotic sensors and actuators, PCB design and communication protocols.
<b>CLO 2</b>	Gain an understanding of the theoretical background necessary to understand advanced robotic technologies and their specific applications.
<b>CLO 3</b>	Demonstrate proficiency in design, construction, and operation of robotic systems.
<b>CLO 4</b>	Develop problem-solving skills by applying principles of robotics engineering to real-world problems.
<b>CLO 5</b>	Communicate effectively about robotics engineering technologies, their workings and potential applications.

7. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	0	0	20	0	30	50

**L-** Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

**j. Experiment List:**

Sr. NO.	Experiment List
1	To study different remote triggered actuators (electric, hydraulic and pneumatic types) and sensors used in developing robots
2	To study online trajectory planning by remotely triggering stationary base robot
3	To study the remotely triggered feedback control of robot for pick and place operation.
4	To study the remotely triggered trajectory planning of mobile robot without obstacles.
5	To study the remotely triggered trajectory planning of mobile robot with obstacles.
6	Open Ended Case studies in robotics applications.
7	Open Ended Case studies in Industrial robotics applications.

## Semester 2

(1)

- a. **Course Name:** Smart Materials and Micro-Systems
- b. **Course Code:** 03023002PC01
- c. **Prerequisite:** The course has no mandatory prerequisite, however basic knowledge of engineering materials, sensors/actuators, and control systems will be helpful. Students should be familiar with fundamental electronics/instrumentation used in mechatronic systems. Basic exposure to modelling or simulation tools (FEA concepts) will also support better understanding of design and selection of smart materials.
- d. **Rationale:** This course introduces smart materials and microsystems that respond intelligently to external stimuli and are widely used in modern mechatronic applications. It develops the ability to select, design, and integrate smart materials into sensors and actuators with proper system control. The subject supports advanced applications in automotive, aerospace, biomedical, and robotics, and prepares students for emerging trends like nano-smart materials and IoT/AI integration.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To analyze the fundamental physical mechanisms and phase transformations of smart materials.
<b>CLOBJ 2</b>	To develop selection criteria and design methodologies for integrating smart materials into mechanical systems.
<b>CLOBJ 3</b>	To engineer advanced control strategies for non-linear smart material responses.
<b>CLOBJ 4</b>	To synthesize smart material solutions across the automotive, aerospace, and biomedical sectors.
<b>CLOBJ 5</b>	To evaluate the impact of Nanotechnology, 3D printing, and AI on the next generation of smart systems.

- f. **Course Learning Outcomes:**

<b>CLO 1</b>	Explore different smart materials and their applications in mechatronics systems.
<b>CLO 2</b>	Apply criteria for selecting appropriate smart materials for specific applications.
<b>CLO 3</b>	Design and implement control algorithms for smart actuators with sensor integration for real-time feedback.
<b>CLO 4</b>	Design prototypes incorporating smart materials for specific applications and evaluate the performance in real-world applications.
<b>CLO 5</b>	Identify future trends and challenges in smart material systems.

**g. Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	0	60	0	100

**L-** Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

**n. Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	<p>Introduction to Smart Materials:</p> <p>Overview of Smart Materials: Definition and characteristics of smart materials, Historical development and applications, Types of Smart Materials: Piezoelectric materials, Shape memory alloys, Magnetostrictive materials, Electroactive polymers, Smart fluids (magnetorheological and electrorheological fluids), Properties and Behaviour: Material properties (mechanical, electrical, thermal, etc.) Phase transformations and hysteresis, Applications in Mechatronics: Use cases in sensors, actuators, and transducers</p>	20	8
2	<p>Design and Selection of Smart Materials:</p> <p>Material Selection Criteria: Mechanical, electrical, and thermal properties, Environmental considerations, Cost and availability, Design Considerations: Design methodologies for incorporating smart materials (to the mechanism as sensor / actuator), Integration with traditional materials, Case studies of smart material integration, Simulation and Modelling: Finite element analysis (FEA), Computational tools for material behaviour prediction and control.</p>	20	8

<b>3</b>	Control of Smart Material Systems:  Control Principles: Basics of control theory relevant to smart materials, Feedback and feedforward control systems, Actuation Mechanisms: Control of piezoelectric actuators, Shape memory alloy actuation, Magnetostrictive and electroactive polymer control, Sensors and Feedback: Integration of smart sensors, Real-time monitoring and control, Signal processing techniques, Control Algorithms: PID control, Adaptive control, Intelligent control strategies (fuzzy logic, neural networks)	<b>20</b>	<b>10</b>
<b>4</b>	Application of Smart Materials in Mechatronics:  Automotive Applications: Adaptive suspension systems, Vibration control and noise reduction, Aerospace Applications: Morphing wings and control surfaces, Health monitoring systems, Biomedical Applications: Smart prosthetics and orthotics, Biomedical sensors and actuators, Robotics and Automation: Soft robotics, Adaptive grippers and manipulators	<b>20</b>	<b>10</b>
<b>5</b>	Future trends and advancement in smart material application:  Emerging Smart Materials: Nano-smart materials, Bio-inspired smart materials, Advanced Fabrication Techniques: 3D printing of smart materials, Nanofabrication methods, Integration with IoT and AI: Smart materials in IoT systems, AI-driven smart material systems, Challenges and Opportunities: Technical and economic challenges, Future research directions	<b>20</b>	<b>9</b>
	<b>Total</b>	<b>100</b>	<b>45</b>

**o. Text Book and Reference Book:**

1. Fundamentals of Microfabrication and Nanotechnology, Marc J. Madou
2. Smart Materials and Structures, Gandhi, M.V. and Thompson, B.S.
3. Engineering Optimization: Theory and Practice, Rao, S.S.
4. Piezoelectric Actuators and Ultrasonic Motors, Kenji Uchino
5. Shape Memory Alloys: Modelling and Engineering Applications, D.C. Lagoudas (Ed.)

(2)

- a. **Course Name:** Smart Materials and Micro-Systems Laboratory
- b. **Course Code:** 03023002PC02
- c. **Prerequisite:** The course has no mandatory prerequisite, however basic knowledge of engineering materials, sensors/actuators, and control systems will be helpful. Students should be familiar with fundamental electronics/instrumentation used in mechatronic systems. Basic exposure to modelling or simulation tools (FEA concepts) will also support better understanding of design and selection of smart materials.
- d. **Rationale:** This course introduces smart materials and microsystems that respond intelligently to external stimuli and are widely used in modern mechatronic applications. It develops the ability to select, design, and integrate smart materials into sensors and actuators with proper system control. The subject supports advanced applications in automotive, aerospace, biomedical, and robotics, and prepares students for emerging trends like nano-smart materials and IoT/AI integration.

a. **Course Learning Objective:**

<b>CLOBJ 1</b>	To quantify the transduction properties of active materials through empirical testing.
<b>CLOBJ 2</b>	To identify and map non-linear material behaviors such as hysteresis and thermal lag.
<b>CLOBJ 3</b>	To design and tune feedback control loops for non-linear smart actuators.
<b>CLOBJ 4</b>	To evaluate the performance of "soft" smart systems like EAPs and MR Fluids.
<b>CLOBJ 5</b>	To synthesize experimental data with computational models for system design.

b. **Course Learning Outcomes:**

<b>CLO 1</b>	Explore different smart materials and their applications in mechatronics systems.
<b>CLO 2</b>	Apply criteria for selecting appropriate smart materials for specific applications.
<b>CLO 3</b>	Design and implement control algorithms for smart actuators with sensor integration for real-time feedback.
<b>CLO 4</b>	Design prototypes incorporating smart materials for specific applications and evaluate the performance in real-world applications.
<b>CLO 5</b>	Identify future trends and challenges in smart material systems.

c. **Teaching & Examination Scheme:**

<b>Teaching Scheme</b>	<b>Evaluation Scheme</b>
------------------------	--------------------------

L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	0	0	20	0	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

k. **Experiment List:**

Sr. NO.	Experiment List
1	<p><b>Characterization of Piezoelectric Sensor</b></p> <ul style="list-style-type: none"> <li><i>Aim:</i> Measure piezoelectric voltage output vs applied force/vibration.</li> <li><i>Outcome:</i> Sensitivity (mV/N), linearity, frequency response.</li> </ul>
2	<p>Piezoelectric Actuator Displacement Measurement  Aim: Study displacement vs applied voltage using a piezo-buzzer/stack actuator.</p> <p>Outcome: Hysteresis plot, displacement gain, operating limits.</p>
3	<p>Closed-Loop Control of Piezo Actuator (PID)  Aim: Implement PID control for precise positioning using feedback (LVDT/optical sensor/pot).</p> <p>Outcome: Rise time, overshoot, steady-state error comparison (open vs closed loop).</p>
4	<p>Shape Memory Alloy (SMA) Wire Actuation Test  Aim: Observe SMA contraction vs current and load.</p> <p>Outcome: Stroke-current curve, response time, safe heating range.</p>
5	<p>SMA Temperature Control (On-Off / PID)  Aim: Control SMA actuation using temperature feedback (thermistor/IR sensor).</p> <p>Outcome: Improved repeatability, reduced overheating, controlled actuation cycles.</p>
6	<p>Magnetostrictive Material Demonstration  Aim: Study strain/displacement due to magnetic field (simple coil + magnetostrictive rod/demo kit).</p> <p>Outcome: Field vs displacement trend, dynamic response observation.</p>
7	<p>Electroactive Polymer (EAP) Bending Actuator Study  Aim: Create/operate a simple ionic polymer actuator (or dielectric elastomer demo) and measure bending.</p> <p>Outcome: Deflection vs voltage, limitations (hydration, breakdown, load).</p>
8	<p>Smart Fluids: Magnetorheological (MR) / Electrorheological (ER) Fluid Viscosity Change  Aim: Observe change in damping/flow resistance under magnetic/electric field (mini damper setup).</p>

	Outcome: Field-controlled damping concept for suspension/vibration control.
9	<p>Smart Material Selection for a Mechatronic Application (Design Exercise)  Aim: Select best smart material for a given case (micro-positioner, adaptive gripper, vibration absorber) using a decision matrix.</p> <p>Outcome: Weighted scoring based on mechanical/electrical/thermal, cost, environment (as per selection criteria).</p>
10	<p>Simulation/Modeling of Smart Actuator Behavior (FEA or Lumped Model)  Aim: Model piezo/SMA actuator behavior (COMSOL/ANSYS/Matlab) and validate with experimental data.</p> <p>Outcome: Predicted vs measured response, error analysis, design improvements.</p>

(3)

- a. **Course Name:** Industrial Process Automation
- b. **Course Code:** 03023002PC03
- c. **Prerequisite:** The course has no mandatory prerequisite, however basic knowledge of manufacturing processes, production systems, and industrial engineering concepts is desirable. Students should be familiar with fundamentals of electronics, control systems, and sensors/actuators used in automation. Prior exposure to PLC basics and industrial instrumentation will help in understanding industrial control and SCADA/DCS concepts.
- d. **Rationale:** This course provides essential knowledge of industrial process automation including automation strategies, material handling systems, automated manufacturing systems, and modern industrial control technologies. It enables students to understand and apply tools such as PLCs, SCADA, DCS, and industrial communication networks used in real industries. The course prepares learners for designing, analyzing, and implementing automation solutions to improve productivity, quality, safety, and efficiency in modern manufacturing and process industries.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To evaluate the feasibility of automation using mathematical production models and economic analysis.
<b>CLOBJ 2</b>	To design and analyze automated material transport and storage systems.
<b>CLOBJ 3</b>	To synthesize Group Technology (GT) and Cellular Manufacturing into Flexible Manufacturing Systems (FMS).
<b>CLOBJ 4</b>	To engineer logical control sequences for discrete manufacturing and process industries.
<b>CLOBJ 5</b>	To design networked control architectures using SCADA, DCS, and Industrial IoT.

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Identify potential areas for automation in modern industries. 2. 3. 4. 5.
<b>CLO 2</b>	Analysis different material handling and storage systems used in Modern Industries.
<b>CLO 3</b>	Critically decide upon different manufacturing systems.
<b>CLO 4</b>	Analyze and suggest modern control technologies for industries.
<b>CLO 5</b>	Understand about application computers in industries

g. **Teaching & Examination Scheme:**

<b>Teaching Scheme</b>	<b>Evaluation Scheme</b>
------------------------	--------------------------

L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	0	60	0	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

**h. Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	<b>Introduction to Industrial Automation:</b> Automation in Production System - Principles, strategies of Automation - Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, Flow lines Different level of Flow lines - Production economics: Cost in manufacturing - Break even analysis, unit cost of production - Lead time and work in process - Production concepts and Mathematical models - Types of plant layouts - Case Study	20	9
2	<b>Material Handling and Storage:</b> Overview of Material Handling Systems, Principles of Material Handling Systems - Design Consideration of Material Handling Systems - Material Transport Systems, Introduction of Storage Systems - Different types of storage system - Automatic storage and Retrieval system - Work in process storage - Storage system performance - Material Identification Methods	20	9
3	<b>Automated Manufacturing Systems:</b> Overview of Manufacturing Systems - Classification of Manufacturing Systems - Introduction of Manufacturing Cells - Introduction of GT, Cellular Manufacturing - Case studies - Overview and classification of FMS, FMS and its Planning and Implementation - Lean and Agile manufacturing system - Design for automated assembly, types of automated assembly system - Parts feeding devices - Analysis of single station and multi-station assembly machine	20	9
4	<b>Control technologies in Automation:</b> Industrial Control Systems - Process Industries and Discrete-Manufacturing Industries - Continuous Versus	20	9

	Discrete Control - Computer Process control - Case study Sequence Control: Programmable Logic Controllers, Relay Ladder Logic, Programming - Supervisory Controllers: Functionally of Supervisory Control Level - Process Optimization - Recipe Management Material. Tracking - Man-machine interfaces - Case Study		
<b>5</b>	<b>Computer based Industrial Control:</b>  Automatic Process Control - Building Blocks of Automation Systems: LAN - Analog Digital I/O Modules , Digital I/O Modules -SCADA Systems and RTU - Case study Distributed Control System - Functional Requirements - Configurations and some popular Distributed Control Systems - Industrial Communication Systems: Characteristic features of industrial networks - Low level networks and their features, Field bus architecture - Performance aspects of Industrial Automation Systems - Case Study – Internet of Things based industrial control - Case Study	<b>20</b>	<b>9</b>
	<b>Total</b>	<b>100</b>	<b>45</b>

i. **Text Book and Reference Book:**

1. Automation production systems and computer – integrated manufacturing, Mikell P.Groover ; Prentice Hall of India
2. Modern control systems, Richard C. Dorf, Robert H Bishop ; Pearson Education International, Twelfth edition.
3. Programmable Logic Controllers, Frank D. Petruzella ; McGraw-Hill Book Company
4. Programmable Logic Controllers by John w. Webb and Ronald A. Reis ; PHI Learning

(4)

- a. **Course Name:**Industrial Process Automation Laboratory
- b. **Course Code:** 03023002PC04
- c. **Prerequisite:** The course has no mandatory prerequisite, however basic knowledge of manufacturing processes, production systems, and industrial engineering concepts is desirable. Students should be familiar with fundamentals of electronics, control systems, and sensors/actuators used in automation. Prior exposure to PLC basics and industrial instrumentation will help in understanding industrial control and SCADA/DCS concepts.
- d. **Rationale:** This course provides essential knowledge of industrial process automation including automation strategies, material handling systems, automated manufacturing systems, and modern industrial control technologies. It enables students to understand and apply tools such as PLCs, SCADA, DCS, and industrial communication networks used in real industries. The course prepares learners for designing, analyzing, and implementing automation solutions to improve productivity, quality, safety, and efficiency in modern manufacturing and process industries.

e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To deconstruct complex industrial environments into their constituent automation levels.
<b>CLOBJ 2</b>	To calculate the financial and operational efficiency of automated lines.
<b>CLOBJ 3</b>	To design and evaluate automated material movement and storage solutions.
<b>CLOBJ 4</b>	To program and wire industrial controllers for complex multi-actuator sequences.
<b>CLOBJ 5</b>	To develop SCADA interfaces for real-time process monitoring and data acquisition.
<b>CLOBJ 6</b>	To implement networked industrial control systems using modern communication protocols.

f. **Course Learning Outcomes:**

<b>CLO 1</b>	Identify potential areas for automation in modern industries.
<b>CLO 2</b>	Analysis different material handling and storage systems used in Modern Industries.
<b>CLO 3</b>	Critically decide upon different manufacturing systems.
<b>CLO 4</b>	Analyze and suggest modern control technologies for industries.
<b>CLO 5</b>	Understand about application computers in industries.

**g. Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	0	0	20	0	30	50

**L-** Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

**h. Course Content:**

Sr. No.	Experiment List
1	Automation System Study & Level Identification (Case Study)
2	Break-Even Analysis & Unit Cost for an Automated vs Manual Line
3	Lead Time & Work-in-Process (WIP) Estimation for a Flow Line
4	Material Handling System Selection using Design Principles
5	AS/RS (Automated Storage & Retrieval System) Model and Performance
6	Material Identification Methods Demonstration
7	PLC Basics: Digital I/O Wiring and Ladder Logic for Motor Control
8	Sequence Control using PLC: Two-Cylinder Electro-Pneumatic/Discrete Process
9	SCADA with PLC/RTU: Tank Level or Temperature Monitoring
10	Industrial Communication & IoT Based Industrial Control (Mini Project)

**i. Text Book and Reference Book:**

1. Automation production systems and computer – integrated manufacturing, Mikell P. Groover ; Prentice Hall of India
2. Modern control systems, Richard C. Dorf, Robert H Bishop ; Pearson Education International, Twelfth edition.
3. Programmable Logic Controllers, Frank D. Petruzella ; McGraw-Hill Book Company
4. Programmable Logic Controllers by John w. Webb and Ronald A. Reis ; PHI Learning

(5)

- a. **Course Name:** Digital Manufacturing and Smart Factories
- b. **Course Code:** 03023002PE03
- c. **Prerequisite:** Students should have basic understanding of manufacturing processes and modern production systems, along with fundamentals of automation and industrial engineering concepts. Prior knowledge of computer applications in manufacturing (CAD/CAM) and basic control systems will be helpful. Familiarity with sensors, PLC/industrial networking, and introductory concepts of data handling will support better understanding of the course..
- d. **Rationale:** This course introduces students to the emerging concepts of Digital Manufacturing and Smart Factories, focusing on intelligent and networked manufacturing environments. It enables learners to understand the role of IoT/IIoT, big data analytics, AR/VR technologies, and cloud manufacturing in transforming industrial production systems. The course builds competence in integrating digital twin, automation, cybersecurity, and smart architecture for next-generation manufacturing. This prepares students to meet Industry 4.0 requirements and implement smart factory solutions in real industrial settings.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To analyze and design digital networked manufacturing systems using virtual environments.
<b>CLOBJ 2</b>	To apply modeling theories and reverse engineering techniques to manufacturing processes.
<b>CLOBJ 3</b>	To engineer connectivity solutions using IIoT architectures and communication protocols.
<b>CLOBJ 4</b>	To leverage Big Data and AR/VR for industrial data visualization and decision-making.
<b>CLOBJ 5</b>	To integrate Cloud Computing, Digital Twins, and Cyber-Security into a Smart Factory architecture.

- f. **Course Learning Outcomes:**

<b>CLO 1</b>	Understand the concepts of digital manufacturing
<b>CLO 2</b>	Familiar in interfacing and intelligent control in digital manufacturing.
<b>CLO 3</b>	Illustrate the fundamentals of IoT architecture, communication, and networking.
<b>CLO 4</b>	Understand methods for data preparation and processing for big data analytics.

<b>CLO 5</b>	Explore challenges and industrial applications of cloud computing in manufacturing.
--------------	---

**g. Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	3	0	3	20	20	0	60	0	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

**h. Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	<b>Introduction to Digital Manufacturing</b> Introduction and concepts of digital manufacturing-digital networked manufacturing-new generation intelligent manufacturing- virtual environment for digital manufacturing- Application of virtual environment digital manufacturing system	20	8
2	Manufacturing computational model-Modeling theory of digital manufacturing-Introduction to reverse engineering-Methodologies and techniques for reverse engineering-Applications-Intelligent control concept of intelligent multi information sensing and fusion-Multi agent manufacturing system	20	8
3	<b>Industrial Internet of Things</b> Introduction to internet of things (IoT)-IoT vs IIoT-M2M architecture-IoT Architecture-Sensing and actuation-wireless sensor networks-Basics of networking protocols-Transmission control protocol (TCP)- User datagram protocol (UDP)-Message Queueing Telemetry Transport (MQTT)	20	9
4	<b>Big Data Analytics and AR, VR for Industrial Application</b> Introduction to big data analytics-Data visualization methods- Types of digital data-big data analytics-History of Hadoop-design of HDFS-Hadoop file system interface-Data flow- Hadoop I/O tools. Introduction to immersive technologies-Design and implementation of an immersive	20	10

	user experience case study for AR and VR in industrial applications		
<b>5</b>	<b>Cloud Manufacturing and Smart Factory Architecture</b> Introduction to cloud computing and manufacturing-cloud models-cloud service-architecture-cyber physical manufacturing-data security and cyber security-advanced automation and robotics: cobotsrobotics in flexible manufacturing systems-integration of digital twin with IoT platform- edge computing -fog computing.	<b>20</b>	<b>9</b>
	<b>Total</b>	<b>100</b>	<b>45</b>

i. **Text Book and Reference Book:**

1. Automation production systems and computer – integrated manufacturing, Mikell P.Groover ; Prentice Hall of India
2. Modern control systems, Richard C. Dorf, Robert H Bishop ; Pearson Education International, Twelfth edition.
3. Programmable Logic Controllers, Frank D. Petruzella ; McGraw-Hill Book Company
4. Programmable Logic Controllers by John w. Webb and Ronald A. Reis ; PHI Learning

(6)

- a. **Course Name:** Digital Manufacturing and Smart Factories Laboratory
- b. **Course Code:** 03023002PE04
- c. **Prerequisite:** Students should have basic understanding of manufacturing processes and modern production systems, along with fundamentals of automation and industrial engineering concepts. Prior knowledge of computer applications in manufacturing (CAD/CAM) and basic control systems will be helpful. Familiarity with sensors, PLC/industrial networking, and introductory concepts of data handling will support better understanding of the course.
- d. **Rationale:** This course introduces students to the emerging concepts of Digital Manufacturing and Smart Factories, focusing on intelligent and networked manufacturing environments. It enables learners to understand the role of IoT/IIoT, big data analytics, AR/VR technologies, and cloud manufacturing in transforming industrial production systems. The course builds competence in integrating digital twin, automation, cybersecurity, and smart architecture for next-generation manufacturing. This prepares students to meet Industry 4.0 requirements and implement smart factory solutions in real industrial settings.
- e. **Course Learning Objective:**

<b>CLOBJ 1</b>	To design and simulate high-fidelity virtual manufacturing environments.
<b>CLOBJ 2</b>	To reconstruct physical assets into digital formats and implement intelligent data fusion.
<b>CLOBJ 3</b>	To engineer decentralized manufacturing systems using Multi-Agent architectures.
<b>CLOBJ 4</b>	To design and benchmark IIoT communication frameworks using modern protocols.

- f. **Course Learning Outcomes:**

<b>CLO 1</b>	Understand the concepts of digital manufacturing.
<b>CLO 2</b>	Familiar in interfacing and intelligent control in digital manufacturing.
<b>CLO 3</b>	Illustrate the fundamentals of IoT architecture, communication, and networking
<b>CLO 4</b>	Understand methods for data preparation and processing for big data analytics
<b>CLO 5</b>	Explore challenges and industrial applications of cloud computing in manufacturing.

- g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	0	0	20	30	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

**h. Course Content:**

Sr. No.	Experiment List
1	Study of Digital Manufacturing System
2	Virtual Environment Modeling for Manufacturing
3	Digital Networked Manufacturing – Data Flow Design
4	Reverse Engineering Using 3D Scanning / CAD Reconstruction
5	Intelligent Multi-Sensor Data Fusion for Manufacturing
6	Implementation of Multi-Agent Manufacturing System (MAS)
7	IIoT Architecture & Sensor Node Interfacing.
8	MQTT-Based IoT Communication
9	Networking Protocols (TCP vs UDP) Performance Test
10	Big Data Analytics / Hadoop + AR/VR Industrial Case Study

**i. Text Book and Reference Book:**

1. Automation production systems and computer – integrated manufacturing, Mikell P.Groover ; Prentice Hall of India
2. Modern control systems, Richard C. Dorf, Robert H Bishop ; Pearson Education International, Twelfth edition.
3. Programmable Logic Controllers, Frank D. Petruzella ; McGraw-Hill Book Company
4. Programmable Logic Controllers by John w. Webb and Ronald A. Reis ; PHI Learning

(7)

- a. **Course Name:** Intelligent Sensors and Actuators
- b. **Course Code:** 03023002PE05
- c. **Prerequisite:** Basic electronics, Measurements and Instruments
- d. **Rationale:** The syllabus aims to equip students with a holistic understanding of sensors and actuators, fostering their ability to design, integrate, and troubleshoot in real-world applications.

**e. Course Learning Outcomes:**

<b>CLO 1</b>	Understand the principles of various sensors and actuators and their applications.
<b>CLO 2</b>	Design and integrate sensors and actuators into control systems for automation and feedback.
<b>CLO 3</b>	Evaluate the performance parameters of sensors and actuators, considering factors like sensitivity and response time.
<b>CLO 4</b>	Apply knowledge to real-world engineering challenges, developing solutions in areas such as robotics and industrial automation.

**f. Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

**g. Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	<b>Sensors :</b> Difference between sensor, transmitter and transducer - Primary measuring elements - selection and characteristics: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy, impedance, backlash, Response time, Dead band. Signal transmission - Types of signal: Pneumatic signal; Hydraulic signal; Electronic Signal. Principle of operation, construction details, characteristics and applications of potentiometer,	20	9

	Proving Rings, Strain Gauges, Resistance thermometer, Thermistor, Hot-wire anemometer, Resistance Hygrometer, Photo-resistive sensor.		
<b>2</b>	<p><b>Inductive &amp; capacitive transducer :</b></p> <p>Inductive transducers: - Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer, variable reluctance transducer, synchros, microsyn.</p> <p>Capacitive transducers: - Principle of operation, construction details, characteristics of Capacitive transducers – different types &amp; signal conditioning- Applications:- capacitor microphone, capacitive pressure sensor, proximity sensor</p>	<b>20</b>	<b>9</b>
<b>3</b>	<p><b>Actuators :</b></p> <p>Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria. Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors - Single phase &amp; 3 Phase Induction Motor; Synchronous Motor; Stepper motors - Piezoelectric Actuator.</p>	<b>20</b>	<b>9</b>
<b>4</b>	<p><b>Micro sensors and micro actuators :</b></p> <p><b>Micro Sensors:</b> Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors.</p> <p><b>Micro Actuators:</b> Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles.</p>	<b>20</b>	<b>9</b>
<b>5</b>	<p><b>Sensor materials and processing techniques :</b></p> <p>Materials for sensors: Silicon, Plastics, metals, ceramics, glasses, nano materials Processing techniques: Vacuum deposition, sputtering, chemical vapour deposition, electro plating, photolithography, silicon micro</p>	<b>20</b>	<b>9</b>

	machining, Bulk silicon micro machining, Surface silicon micro machining, LIGA process		
	<b>Total</b>	<b>100</b>	<b>45</b>

**h. Text Book and Reference Bok:**

1. Nagraj, 1998, Jeevan Vidyaek Parichay, Divya Path Sansthan, Amarkantak.
2. A.N. Tripathy, 2003, Human Values, New Age International Publishers
3. The Story of My Experiments with Truth By M K Gandhi
4. Small is Beautiful By E. F Schumacher
5. Rediscovering India By Dharampal

(9)

- a. **Course Name:** Artificial Intelligence and Machine Learning
- b. **Course Code:** 03023202PE11
- c. **Prerequisite:** Basic Programming Skills
- d. **Rationale:** The syllabus aims to equip students with a holistic understanding of sensors and actuators, fostering their ability to design, integrate, and troubleshoot in real-world applications.
- e. **Course Learning Outcomes:**

<b>CLO 1</b>	Explain foundational AI concepts and their applications.
<b>CLO 2</b>	Apply search algorithms to solve decision making problems.
<b>CLO 3</b>	Differentiate between various machine learning techniques and use cases.
<b>CLO 4</b>	Explain and apply optimization methods like GA and PSO.
<b>CLO 5</b>	Build and train deep learning models using neural networks.
<b>CLO 6</b>	Analyze the role of AI and ML in various industrial domains.

f. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	0	60	0	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

i. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	<b>Fundamentals of Artificial Intelligence :</b> <ul style="list-style-type: none"><li>• Introduction to AI: Definitions, history, and applications</li><li>• Intelligent agents: Types, structure, and environment</li><li>• Problem solving using search algorithms: BFS, DFS, Algorithms</li></ul>	20	9

	<ul style="list-style-type: none"> <li>• Constraint satisfaction problems</li> <li>• Knowledge representation and reasoning: Propositional and predicate logic</li> </ul>		
<b>2</b>	<b>Machine Learning Basics :</b> <ul style="list-style-type: none"> <li>• Introduction to ML: Definitions and types (supervised, unsupervised, reinforcement learning)</li> <li>• Linear regression and logistic regression</li> <li>• Decision trees, random forests, and support vector machines</li> <li>• Overfitting, underfitting, and model evaluation metrics</li> </ul>	<b>20</b>	<b>9</b>
<b>3</b>	<b>Optimization Techniques :</b> <ul style="list-style-type: none"> <li>• Optimization fundamentals: Objective functions, constraints, and solution spaces</li> <li>• Genetic algorithms: Encoding, fitness function, selection, crossover, and mutation</li> <li>• Particle Swarm Optimization (PSO): Principles, inertia weights, and velocity updates</li> <li>• Applications of GA and PSO: Solving Matyas and Rosenbrock functions</li> <li>• Hybrid optimization techniques</li> </ul>	<b>20</b>	<b>9</b>
<b>4</b>	<b>Deep Learning :</b> <ul style="list-style-type: none"> <li>• Introduction to neural networks and perceptrons</li> <li>• Multilayer perceptrons and backpropagation</li> <li>• Convolutional Neural Networks (CNNs) and applications</li> <li>• Recurrent Neural Networks (RNNs) and sequence modeling</li> <li>• Hands-on implementation using TensorFlow/PyTorch</li> </ul>	<b>20</b>	<b>9</b>
<b>5</b>	<b>AI and ML Applications and Research Directions :</b>	<b>20</b>	<b>9</b>

	<ul style="list-style-type: none"> <li>• AI applications in healthcare, finance, and autonomous systems</li> <li>• Natural Language Processing (NLP): Text classification, sentiment analysis, and chatbots</li> <li>• Current trends in AI and ML research</li> <li>• Capstone project: Developing an AI/MLbased solution for a selected domain</li> </ul>		
	<b>Total</b>	<b>100</b>	<b>45</b>

**j. Text Book and Reference Bok:**

1. "Artificial Intelligence: A Modern Approach" Author: Stuart Russell and Peter Norvig |Publisher: Pearson
2. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" Author: Aurélien Géron | Publisher: O'Reilly Media
3. "Practical Workbook Artificial Intelligence and Soft Computing for beginners, Anindita Das Bhattacharjee ; Shroff Publisher-X team Publisher
4. Deep Learning for Natural Language Processing: Creating Neural Networks with Python: P. Goyal, S. Pandey and K. Jain by Apress.

**List of Experiments**

<b>Sr. No.</b>	<b>Experiment List</b>
1	Linear and Logistic Regression Models
2	Decision Trees and Random Forests
3	Support Vector Machines (SVM)
4	Neural Network Implementation
5	Image Classification Using Convolutional Neural Networks (CNNs)
6	Text Classification Using Recurrent Neural Networks (RNNs)
7	Optimization Using Genetic Algorithms (GAs)
8	Particle Swarm Optimization (PSO)
9	Mini-Project-I
10	Mini-Project-II