GOVT. POLYTECHNIC BALANGIR

Department of Mechanical Engineering

LESSON PLAN: 2024-25
Name of the Faculty: Ashirbad Babu
Subject: **MECHATRONICS (Th. 4)** Program: Diploma in Mechanical Engineering Semester: 5th Total Contact Hours: 60 Total Marks: 100 Assessment: Progressive –20, End Term – 80 Credits: 4

COURSE OBJECTIVES:

At the end of the course the students will be able to

1. To study the definition and elements of mechatronics system.
2. To learn how to apply the principle of mechatronics for the development of productive systems.
3. To learn the CNC technology and applications of mechatronics in manufacturing automation.
4. Define different type of system and Sensors and solve the simple problems.
5. Explain the concept of Mechanical actuation, Electrical actuation and solve the simple problems.
6. Find out the various types of System Models & Input /Output parts and solve the problems.
7. Describe the programmable Logic Controller and develop programme in PLC. 8. To learn the Industrial robotics

Unit 1: Introduction to Mechatronics (Total Classes: 5)				
Class No.	**Topic**	**Subtopic (Elaborated)**	**Teaching Aids / Activities**	**Course Objective**
1	Meaning and Definition of Mechatronics	Explain Mechatronics as a multidisciplinary field integrating mechanical, electrical, electronics, and computer systems for automation. Discuss how systems interact.	PPT with definition, block diagram of mechatronic system, examples (ABS, ATMs)	CO1
2	Advantages and Disadvantages	Discuss benefits like improved performance, reliability, accuracy, and compactness. Cover limitations such as high cost, complexity in repair, and training requirements.	Whiteboard discussion, comparative table (Traditional vs. Mechatronic systems)	CO1
3	Applications in Daily Life	Cover real-world uses: automotive systems (airbags, ABS), medical (MRI machines), consumer electronics (washing machines), and defense (guided missiles, drones).	Video demonstration, object-based learning using home appliances	CO1
4	Scope in Industrial Sector	Describe the role of mechatronics in smart manufacturing, Industry 4.0, robotics, CNC machines, and automated inspection systems.	Case study of automation in car manufacturing; factory automation videos	CO1
5	Components and Role in Automation	Discuss basic components: sensors, actuators, controllers, software. Explain their coordination in automatic systems and the importance of feedback loops in automation.	Block diagram drawing activity; class interaction on "what automates a system?"	CO1

Unit 2 – Sensors and Transducers (Total Classes: 10)				
Class No.	**Topic**	**Subtopic with Elaboration**	**Teaching Aids / Activities**	**Course Objective**
6	Introduction to Transducers	Define transducers as devices that convert one form of energy into another. Differentiate between sensors (input) and actuators (output). Discuss real-life examples.	PPT, real object demo (e.g., microphone, thermometer), sensor-actuator analogy chart	CO2
7	Classification of Transducers	Discuss types: active vs. passive, analog vs. digital, contact vs. non-contact. Explain the basis of classification using examples like thermocouple, LVDT, and proximity sensor.	Chart activity showing types, group discussion on advantages of each class, classification flowchart	CO2
8	Electromechanical Transducers	Explain how electromechanical transducers convert electrical energy into mechanical or vice versa. Use examples like LVDT, strain gauge, and piezoelectric sensors.	Animated diagram of LVDT working, YouTube demo video of strain gauge in use	CO2
9	Actuating Mechanisms	Cover types of actuators: hydraulic, pneumatic, electrical. Discuss how actuators work in automation and the concept of control signals and mechanical motion.	Physical demo of solenoid, video on pneumatic actuator, classroom sketching of actuation loop	CO2
10	Displacement Sensors	Discuss sensors used for linear and angular displacement: LVDT, potentiometer, optical encoder. Explain their construction, working, and output characteristics.	Potentiometer with multimeter activity, simulation of encoder in software or video	CO2
11	Position Sensors	Differentiate displacement vs. position sensing. Explain use of proximity sensors (inductive, capacitive, optical) in automation.	Real-life demonstration of IR sensor, object-detection experiment with Arduino (if available)	CO2
12	Velocity and Motion Sensors	Explain tachometers, encoder-based velocity sensors. Include velocity measurement in rotating and linear systems. Discuss real-time applications.	Speed sensor demo in bike/vehicle, animation on encoder speed sensing	CO2
13	Force Sensors	Introduce strain gauge, load cell working. Explain Wheatstone bridge concept and how force gets converted into an electrical signal.	Lab setup video or digital load cell demonstration, circuit diagram explanation	CO2
14	Pressure Sensors	Explain diaphragm-based, piezoelectric, and capacitive pressure sensors. Show how pressure is sensed and converted into signal for display/control.	Real-world examples (tyre pressure sensor), PPT slides with cross-sectional view of pressure sensors	CO2
15	Temperature and Light Sensors	Discuss thermocouples, RTD, thermistors, and LDRs. Explain working principles and their use in industry and homes (e.g., HVAC, smart lighting).	Live demo: LDR & torch, temperature sensor with hot object, digital thermometer display	CO2

Unit 3: Actuators – Mechanical, Electrical (Total Classes: 10)				
Class No.	**Topic**	**Subtopic (with elaboration)**	**Teaching Aids/Activities**	**Course Objective**
16	Mechanical Actuators	Introduction to machine elements; definition of machine, kinematic link and pair with examples	Diagrammatic explanation using board and mechanical components	CO5
17	Mechanical Actuators	Mechanism: slider-crank mechanism and its application in engines and actuators	3D model or animation of slider-crank mechanism	CO5
18	Mechanical Actuators	Gear drives: working of spur, bevel, helical, and worm gears; torque and speed relations	Physical gear models or animated gear simulation	CO5
19	Mechanical Actuators	Belt and belt drive types: flat, V-belt, timing belt; advantages and applications	Belt drive kits and videos showing real-world usage	CO5
20	Mechanical Actuators	Bearings: types like ball, roller, and sleeve; function and usage in rotating systems	Real bearing samples and exploded mechanical diagrams	CO5
21	Electrical Actuators	Switches and relays: construction, operation, and industrial use	Actual components, relay logic demos, switch circuit	CO5
22	Electrical Actuators	Solenoids: working principle, construction, and application in automation	Animated video and practical solenoid demo	CO5
23	Electrical Actuators	DC and AC motors: types, construction, and working with industrial examples	Chart comparison, motor cut section, videos	CO5
24	Electrical Actuators	Stepper motors: principle, construction, step angle, and applications	Stepper motor kits, video showing motion control	CO5
25	Electrical Actuators	Servo motors (DC & AC): working principle, feedback control, and applications	Control setup demonstration using Arduino/PLC	CO5

Unit 4: Programmable Logic Controllers (PLC) –(15 Classes)				
Class No.	**Topic**	**Subtopics with Elaboration**	**Teaching Aids/Activities**	**Course Objective**
26	Introduction	What is a PLC, its history, need in automation, basic role	Video on PLC evolution and real-time use cases	CO6
27	Advantages of PLC	Over conventional relay-based systems: flexibility, speed, diagnostics	Comparative diagram of relay vs PLC systems	CO6
28	Selection of PLC	Criteria: I/O needs, memory, processor, environment, cost	Case-based classroom activity: Choose a PLC for a mini project	CO6
29	Applications of PLC	Common uses: manufacturing, conveyor, elevator, bottling plant	Case studies with YouTube examples of PLC in action	CO6
30	Architecture of PLC	Basic block diagram, internal structure: CPU, memory, power supply	Use cutaway models or animated block diagrams	CO6
31	Internal working	Scan cycle: input scan, logic execution, output scan, housekeeping	Flowchart explanation, live simulation video	CO6
32	Input Processing	Digital vs analog input types, isolation, wiring diagrams	PLC input module demonstration	CO6

33	Output Processing	Output module types: relay, transistor, triac; examples	Output terminal board model, lab demo	CO6
34	Programming Basics	Ladder logic fundamentals: contacts, coils, rungs	Simulator software (like ZelioSoft or LogixPro) demo	CO6
35	Mnemonics	Standard instructions: LD, AND, OR, OUT, timers and counters	Mnemonic table handout and conversion exercises	CO6
36	Timer Instructions	ON-delay, OFF-delay, retentive timer – Ladder + Mnemonic	Practice timer program in simulator	CO6
37	Counter Instructions	Up/down counters, preset, reset logic	Live simulation activity using ZelioSoft	CO6
38	Master Control	Use of Master control relay (MCR) zone in ladder logic	Sample circuit building on projector with explanations	CO6
39	Jump Instruction	JMP, LBL (Label), and their use in skipping routines	Demo using simple jump logic in software	CO6
40	Revision + Assignment	Recap of full PLC module; problem-solving, debug faulty logic	In-class assignment & group activity	CO6

Unit 5: Elements of CNC Machines (15 Classes)				
Class No.	**Topic**	**Subtopic (with Elaboration)**	**Teaching Aids / Activities**	**Course Objective**
41	Introduction to NC Machines	Concept of Numerical Control, manual vs automated control, history and development	Chalkboard illustration, animation of old NC machines	CO3
42	CNC Machines	Types of CNC machines (Turning, Milling, EDM), importance in automation	Video demonstration of CNC turning center	CO3
43	CAD/CAM Overview	Introduction to CAD/CAM; integration of design and manufacturing	CAD software demo (AutoCAD/Fusion 360)	CO3
44	CAD Elements	CAD tools, coordinate systems, design-to-manufacture workflow	Live screen demonstration using AutoCAD or Creo	CO3
45	CAM Elements	Introduction to CAM – tool paths, simulation, CNC code generation	CAM toolpath simulation activity	CO3
46	CAD/CAM System Functioning	Hardware (controllers, servers), Software (CAD tools), networking	Real-life system demo or block diagram presentation	CO3
47	Features & Applications of CAD/CAM	Key features like parametric modeling, Application areas: Die making, PCB, Automobile	Real industry application case study	CO3
48	Elements of CNC Machines – Overview	Key components: structure, guideways, drives, spindle	Chart of machine layout and parts	CO6
49	Machine Structure	Bed, column, carriage, mechanical rigidity, base materials	Physical parts demo or photo visuals	CO6
50	Guideways/Slideways	Types – box, linear, dovetail; advantages, accuracy requirements	Comparison table, diagram	CO6
51	Design Factors of Guideways	Friction, load capacity, alignment, wear resistance	Short class quiz/discussion	CO6

52	Drives – Overview	Functions, types of drives: hydraulic, electrical, servo	Schematic diagram of drive system	CO6
53	Spindle Drives & Feed Drives	Motor types, torque-speed characteristics, feed mechanism	Video clip or animation of feed drive working	CO6
54	Spindle and Bearings	Spindle configuration, types of spindle bearings, alignment	Physical sample or cross-section animation	CO6
55	Summary & Application-Based Case	Recap all components with an application in a CNC lathe/mill	Real-world system walk-through, MCQ quiz	CO8

Unit 6: Robotics (Total Classes: 5)				
Class No.	**Topic**	**Subtopic (with elaboration)**	**Teaching Aids/Activities**	**Course Objective**
56	6.1 Definition, Function and Laws of Robotics	Define robot; explain basic functions (manipulation, sensing, control); Discuss the **Three Laws of Robotics** by Isaac Asimov and their relevance.	Video of industrial robots performing tasks, Chart with laws of robotics	CO8
57	6.2 Types of Industrial Robots	Classify robots based on configuration: Cartesian, SCARA, Articulated, Cylindrical, Polar etc. Explain with diagrams.	Animated PPT with robot types; real robot model video	CO8
58	6.3 Robotic Systems	Describe subsystems: controller, manipulator, end effector, sensor, power supply. Explain degrees of freedom, work envelope.	Interactive diagram; Sample robotic system layout	CO8
59	6.4 Advantages of Robots	Benefits like precision, speed, safety in hazardous conditions, cost-saving, continuous operation.	Group activity: list advantages of robots in different industries	CO8
60	6.4 Disadvantages of Robots	Limitations: High cost, limited flexibility, unemployment, programming complexity. Real-life limitations in Indian industries.	Classroom debate: "Can robots replace human labor entirely?"	CO8

A. Babu 24-8-24
Signature of the Faculty

24.08.24
Signature of the HOD