Subject Code: 01ME0511
Subject Name: Mechatronics
B. Tech. Year - III (Semester - 5)

Type of course : Core

Prerequisite : Basics of Mechanical and Electronic Concepts.

Rationale : The key objective of this course is to provide students with fundamental to moderate-level concepts of mechatronics. In addition, it emphasizes system modeling, System transfer functions, and recent developments in industrial robotics.

Course Outcome :
After completion of this course, student will be able to

1. Understand the fundamentals of mechatronics.
2. Apply the knowledge gain for system modeling.
3. Understanding different sensors and actuation systems.
4. Understand transfer function representation of a control system and apply block diagram reduction procedure.
5. Understand the time response of a control system and modern-day industrial requirements of mechatronic devices.

Teaching and Examination Scheme :

Teaching Scheme			Credits	Examination Marks					
				Theory Marks			Practical Marks		Total Marks
THEORY	TUTORIAL	PRACTICAL	C	ESE(E)	IA	CSE	Viva (V)	Term Work (TW)	
3	0	2	4	50	30	20	25	25	150

Content :

Sr. No.	Content	Total Hrs.
1	**Introduction** Describing Mechatronics, Systems, Measurement Systems, Example of Control Action, Control Systems: Open- and Closed-loop Systems, Basic Elements of a Closed-loop System, Sequential Controllers; Microprocessor-based Controllers: The Automatic Camera, The Engine Management System; Response of a System, The mechatronics Approach, Summary, Problems	**04**
2	**Sensor and Transducers** Introduction, Performance Terminology: Range and Span, Error, Accuracy, Sensitivity, Hysteresis Error, Non-Linearity Error, Repeatability, Stability, Dead Band/Time, Resolution, Static and Dynamic Characteristics: Response Time,	**10**

	Time Constant, Rise Time, Settling Time; Displacement, Position and Proximity Sensors: Potentiometer, Strain Gauge, Capacitive Element, Differential Transformers, Eddy Current Proximity Sensor, Optical Encoders, Pneumatic Sensors, Proximity Switches, Hall Effect Sensors; Velocity and Motion: Incremental Encoder, Tachogenerator, Pyroelectric Sensors; Force: Strain Gauge Load Cell, Fluid Pressure: Diaphragm Pressure Gauge, LVDT with Bellows, Tube Pressure, Piezoelectric Sensors, Tactile Sensors; Liquid Flow Sensors: Orifice Plate, Turbine Meter, Floats, Differential Pressure; Temperature: Bimetallic Strips, Resistance Temperature Detectors (RTDs), Thermistors, Thermodiodes and Transistors, Thermocouples; Light Sensors, Selection of Sensors, Exercise Problems.	
3	**Pneumatic, Hydraulic and Electrical Actuation Systems** Mathematical Models, Mechanical System Building Blocks: Rotational Systems, Building up a Mechanical System; Actuation Systems, Pneumatic and Hydraulic Systems, Directional Control Valves: Valve Symbols, Pilot Operated Valves, Directional Valves; Pressure Control Valves: Pressure Limiting Valve, Pressure Sequence Valve, Cylinders: Control of a Single-acting Cylinder, Control of a Double- acting Cylinder; Rotary Actuators; Electrical Systems, D.C. Motors, A.C. Motors, Stepper Motors, Problems.	**08**
4	**Transfer Function and Block Diagrams** Use of Laplace Transformation in Control systems, Laplace Transform: Derivation of Laplace Transform, Basic Laplace Transform Theorems, Examples, Transfer Function, Poles and Zeros of a Transfer Function, Relationship with Impulse Response, Procedure for Determining Transfer Function of a Control System, Practice Problems, Representation of a Control System by BlockDiagram, Block Diagram Reduction and Procedure, Take off Point, Blocks in Cascade, Summing Point, Blocks in Parallel, Shifting of a Take-off Point Before and After a Block, Shifting of a Summing point Before and After a block, Shifting of a Take-off point Before and After a Summing Point, Practice Problems	**14**
5	**Time Response Analysis of Control Systems** Transient and Steady State Response, Input Test Signals: Step Function, Ramp Function, Parabolic, Impulse Function, Time Response of a First Order Control System: Unit Step Input Function, Demarcation between Transient and Steady State Part of Time Response, Unit Ramp Input, Unit Impulse Input Function, Time Response of a Second Order Control System using Unit Step Input, Exercise Problems	**08**

Distribution of Theory Marks

R Level	**U** Level	**A** Level	**N** Level	**E`** Level	**C** Level
10	**20**	**25**	**25**	**10**	**10**

Legends: R: Remember**; U:** Understand**; A:** Apply**; N:** Analyze**; E:** Evaluate**; C**: Create

List of Experiments :

1. Introduction to Mechatronics.
2. To study open- and closed-loop control systems with suitable illustrations.
3. To study various types of the sensors and transducers with neat and clean diagrams.

4. To study variety of hydraulic and pneumatic actuation systems.
5. To study control of the single- and double-acting cylinders.
6. To study various electrical actuation systems.
7. To study block diagram reduction procedure with application.
8. To study the control of a D.C. motor.
9. To study the control of a Stepper motor.
10. To study the various types of the input test signals.
11. To study response of the first order system using different types of the input test signals.
12. Build up a mathematical model for a simple fluid system.

Important Equipment/Software Used :

1. Pneumatic and Hydraulic valves kit/interface.
2. Single- and double-acting cylinders.
3. D.C. motor control kit
4. Stepper motor control kit

Design-based Problems (DP) / Open-Ended Problems :

1. Build up a mathematical model for a thermal system.

Reference books :

1. W. Bolton. Mechatronics. Pearson Education India; 2008.
2. B. S. Manke. Linear Control Systems: With Matlab Applications. Khanna Publishers; 2005.

List of Open Base Software / learning website :

1. www.nptel.ac.in
2. https://swayam.gov.in/explorer