COURSE TITLE	**MECHATRONICS**
COURSE CODE	**01ME0511**
COURSE CREDITS	**4**

Objective:

1 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 Outcomes: After completion of this course, student will be able to:

1 Apply the fundamentals of mechanical and electrical engineering to model mechatronic systems.

2 Analyze and integrate sensors, actuators, and control method for efficient and reliable automated solutions.

3 Utilize the programming and simulation skills on microcontrollers and PLCs to control and automate mechatronic applications.

4 Utilize system modeling tools to calculate the performance, stability, and dynamics of mechatronic systems.

5 Apply sustainable mechatronic solutions for maintianing ethical, safety, and environmental condition.

Pre-requisite of course: Basics of Mechanical and Electronic Concepts.

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
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	4

Contents : Unit	Topics	Contact Hours
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, 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.	10
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.	8
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, Numerical based on Poles and Zeros of a Transfer Function., Numerical based on Transfer function., Relationship with Impulse Response;, Procedure for Determining Transfer Function of a Control System;, Practice Problems on Transfer function;, Representation of a Control System by Block Diagram, 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

Contents : Unit	Topics	Contact Hours
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	8
Total Hours		**44**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Introduction to Mechatronics.** Introduction to Mechatronics.	2
2	**To study open- and closed-loop control systems with suitable illustrations.** To study open- and closed-loop control systems with suitable illustrations.	2
3	**To study various types of the sensors and transducers with neat and clean diagrams.** To study various types of the sensors and transducers with neat and clean diagrams.	2
4	**To study variety of hydraulic and pneumatic actuation systems.** To study variety of hydraulic and pneumatic actuation systems.	2
5	**To study control of the single- and double-acting cylinders.** To study control of the single- and double-acting cylinders.	2
6	**To study various electrical actuation systems.** To study various electrical actuation systems.	2
7	**To study block diagram reduction procedure with application.** To study block diagram reduction procedure with application.	2
8	**To study the control of a D.C. motor.** To study the control of a D.C. motor.	2
9	**To study the control of a Stepper motor.** To study the control of a Stepper motor.	2
10	**To study the various types of the input test signals.** To study the various types of the input test signals.	2
11	**To study response of the first order system using different types of the input test signals.** To study response of the first order system using different types of the input test signals.	2
12	**Build up a mathematical model for a simple fluid system.** Build up a mathematical model for a simple fluid system.	2
Total Hours		**24**

Textbook :

1 A Textbook of Mechatronics, R.K. Rajput, S. Chand Publishing, 2007

2 Introduction to Mechatronics: An Integrated Approach, Biswanath Samanta, Springer, 2023

References:

1 Mechatronics 7th Edition, Mechatronics 7th Edition, W Boltan, Pearson Education India, 2024

2 Mechatronics: fundamentals and applications., Mechatronics: fundamentals and applications., De Silva CW, Khoshnoud F, Li M, Halgamuge SK, editors, CRC Press, 2015

3 Mechatronics: a foundation course. , Mechatronics: a foundation course. , De Silva CW., CRC press, 2010

4 Introduction to mechatronics and measurement systems. , Introduction to mechatronics and measurement systems. , Alciatore DG and Histand MB., New York: McGraw-Hill., 2007

5 Mechatronics with experiments. , Mechatronics with experiments. , Cetinkunt S., John Wiley & Sons., 2015

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
10.00	20.00	20.00	30.00	10.00	10.00

Instructional Method:

1 White Board work, PPT, Animations, Videos.

Supplementary Resources:

1 https://www.youtube.com/watch?v=zVVITxiec7g&list=PLLy_2iUCG87BNHXRb6L2pWEpMcLoFaY_U

2 https://www.youtube.com/watch?v=LX2oxCz8cU4&list=PLOzRYVm0a65dAI5mqWdoXKExqzWn0pK-j