

Branch Name:	Mechanical Engineering
Program Code:	ET101
Course Name:	Mechatronics, Robotics and Control
Course Code:	2ET1010502T
Pre-requisite Course:	Kinematics and Dynamics of Machines, Electrical Technology

Course Objectives:

1. To model and analyze mechatronic systems for an engineering application.
2. To identify sensors, transducers and actuators to monitor and control a process or product.
3. To develop PLC programs for an engineering application.
4. To evaluate the performance of mechatronic systems.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								
					Theory (Marks)				Practical (Marks)				Total (Marks)
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
3	3	-	-	3	24	60	16	40	-	-	-	-	100

Course Contents:

Sr. No	Topic	Total Hours	Weightage (%)
1	Module-I Introduction: Electro-mechanical systems; Typical applications; Examples – automobiles, home appliances, medical instruments, etc.	04	10
2	Module II: Sensors: Transduction principles; Sensitivity, accuracy, range, resolution, noise sources; Sensors for common engineering measurements – proximity, force, velocity, temperature, etc.; Signal processing and conditioning; Selection of sensors.	04	10
3	Module III: Actuators: Pneumatic and hydraulic actuators; Electric motors including DC, AC, BLDC, servo and stepper motors; Solenoids and relays; Active materials – piezoelectric and shape memory alloys.	04	10
4	Module IV: Motion Control of Robotic manipulators: Robotic open and closed loop control systems, Second order systems, Non – linear closed loop equation of motion, Different friction models, Control of Single axis robotic arm, Generalized motion control laws for robotic manipulators, Common control system for industrial robots, Error controlled Robotic dynamics, Independent joint PID control, Independent joint PID control with effective joint inertia, Force control of robotic manipulator, Tracking error analysis, Coordinated movement.	06	15

5	Module V: Robotics: Robot configurations: serial and parallel; Denavit–Hartenberg parameters; Manipulators kinematics; Rotation matrix, Homogenous transformation matrix; Direct and inverse Kinematics for robot position and orientation; Workspace estimation and path planning; Robot vision; Motion tracking; Robot programming and control; Industrial robots - Pick and place robots, sorting, assembly, welding, inspection, etc.	08	20
6	Module VI: Control Theory and Systems: Basic control concepts; Feedback; Open and closed loop control; Concept of block diagrams; P, PI and PID controllers; Tuning the gain of controllers; System models, transfer functions, system response, frequency response; Root Locus method and Bode plots.	06	20
7	Module VII: Computational Tools: Demonstration and projects using simulation software (e.g., Matlab, Scilab, ROBODK) for control systems and robotics.	04	15

Reference Books:

1. Robotics control, sensing, vision and intelligence, K S Fu, R C Gonzalez, CSG Lee, Tata McGraw Hill, 2008.
2. Introduction to Robotics: Analysis, Control, Applications by Saeed Niku, John Wiley & Sons., 2018
3. Introduction to Robotics by S K Saha, Tata McGraw-Hill, 2018
4. Robotics and control by R K Mittal, I J Nagrath, Tata McGraw Hill 2003.
5. Robotics Fundamental Concepts & Analysis by Ashitava Ghoshal, Oxford University Press, 2017
6. Ganesh S Hegde, Industrial Robotics, Laxmi Publications (P) Ltd, 2015
7. Mikell P. Groover, Mitchell Weiss, 'Industrial Robotics (Technology, Programming and Applications)', 2nd Edition, McGraw-Hill Education, 2016

E-Resources:

1. <https://nptel.ac.in/courses/112105249>

Course Learning Outcomes (CLO):

CLO	Description	Bloom's Taxonomy Level
CLO1	Ability to recognize and analyze electro-mechanical systems in daily lives.	1 Remembering 2 Understanding
CLO2	Understand the role of sensors, actuators, and controls in mechatronic systems.	3 Applying 4 Analyze
CLO3	Understand the basic theory of robot kinematics.	2 Understanding 4 Analyze
CLO4	Familiarity with control theory and controller design.	2 Understanding 4 Analyze
CLO5	Ability to apply D-H parameters for given configuration of robot manipulator.	3 Applying 5 Evaluating Analyze
CLO6	Understand the measurement of various quantities using instruments, their accuracy & range, and the techniques for controlling devices automatically.	4 Analyze

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CLO1	M		M			M						L	M	M
CLO2		H	M			M	M					L	M	L
CLO3	M	H	M	M		M	M					L	M	L
CLO4	H	M	M	M	M								M	
CLO5	H	L	M										L	
CLO6	M			M	H	M					L		H	

H: High, M: Medium, L: Low