NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	M.Tech. in Electronics & Instrumentation Engineering (Robotics and Artificial Intelligence)
Semester:	I
Course Code:	6ME801CC25
Course Title:	Robot Manipulators
Course Type:	Core
Year of introduction:	2025 - 26

L	T	Practical component				C
		LPW	PW	W	S	
2	-	2	-	-	-	3

Course Learning Outcomes (CLOs):

After successful completion of the course, student will be able to –

1. develop the kinematic model of planar mechanisms (BL3)
2. analyse relative motions using the concepts of coordinate transformation (BL4)
3. select the trajectory and perform dynamic analysis of manipulators (BL5)
4. formulate the mathematical relations for kinematic analysis of robotic manipulator (BL6)
5. design end effectors for robotic manipulator. (BL6)

Unit	Contents	Teaching Hours (Total 30)
Unit I	**Introduction to Robotics** Introduction, definition, history, classification, robot arm anatomy, degree of freedom, application, robotic arm specifications, basic components, control system, economical and societal aspects related to robotics.	04
Unit II	**Co-ordinate Transformation** Concept of transformation, transformation matrices, homogeneous transformation matrix and its applications to robotics, Co-ordinate transformation, transform arithmetic, inverse of transformation matrix, Denavit-Hartenber (DH) parameters.	05
Unit III	**Forward and Inverse kinematics** Forward kinematics, solutions for joint variables, development of end effector transformation matrix for various types of manipulators. Inverse kinematics solutions for robot arm and its methodology. Derivation of joint and link parameters for various configuration of robots	08
Unit IV	**Trajectory planning and Dynamics equation of motion** Robot motion consideration, trajectory generation, joint space technique, cartesian space technique, cubic spline trajectory, joint interpolation for calculation of the position of joint, different interpolations for joint of a robot, Lagrange-Euler formulation, calculation of kinetic and potential energy, dynamic model of robotic arm.	08

Unit V	**Design of end effector** End effectors, types of end effector, classification of mechanical grippers, gripper mechanism, gripping force estimation, static force analysis of gripper mechanism, gripper design.	05

Self – Study: The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings/References:

1. John J. Uicker, Jr, Gordon R. Pennock and Joseph E. Shigley, Theory of Machines and Mechanisms, Cambridge University Press.
2. K S Fu, R C Gonzalez and C S G Lee, Robotics: Control, Sensing, Vision and Intelligence, Mc Graw Hill.
3. Klafter R. D., Thomas A Chmielewski and Michael Negin, Robotics Engineering An integrated approach, Prentice Hall
4. R K Mittal, I J Nagrath, Robotics and Control , Tata McGraw-Hill Publishing Company Ltd.
5. Craig John, Introduction to Robotics, mechanics and control, Pearson Education
6. Rattan S. S., Theory of Machines, Tata McGraw Hill Education

Suggested List of Experiments:

Sr. No.	Title	Hours
1.	To prepare a robot task, set up tools and demonstrate the manipulator	02
2.	To demonstrate the interaction of the collaborative robot with external devices	02
3.	To perform safety settings, optimization, and programme flow for a manipulator	02
4.	To develop algorithms for various features like coordinates, way points, force control, and palletizing.	02
5.	To prepare algorithm and code for forward kinematics.	02
6.	To prepare algorithm and code for inverse kinematics	02
7.	To develop a dynamic model for a robotic manipulator	02
8.	To simulate robot motion on virtual robot modules.	02
9.	To program the robotic manipulator for pick and place application	02
10.	To program the robotic manipulator for tracing the curve	02
11.	To design and simulate gripper mechanism	04
12.	To develop 2 DOF planer robotic manipulator	06

L = Lecture, T = Tutorial, P = Practical, C = Credit

w.e.f. the academic year 2025 - 26 and onwards