The LNMIIT, Jaipur Department of Mechanical & Mechatronics Engineering Modeling and Design of Robots	LNMIIT The LNM Institute of Information Technology

Subject Code:	Course Title: Modeling And Design of Robots	Total Contact Hours: **40**	**L: 3**	**T: 0**	**P: 2**	**C: 4**
Pre-requisite: Basic Electronics, Introduction to automation		Year: **2**	Semester: **Even**			
Type of Course**: Hons./Minor Program**						

***** L – Lectures, T – Tutorials, P – Practical C – Credit***

Learning Objective:

This is a Hons./Minor programme course offered to 2nd year engineering students. It covers the study of kinematics and dynamics of both manipulators and mobile robots. This course presents an introduction to the fundamentals of manipulators and mobile robotics, spanning the mechanical, motor, sensory, perceptual and cognitive layers that comprise this field of study. One unit is also covering the robot vision, image processing and navigation techniques to make them completely autonomous. Practical knowledge on study of kinematics and dynamics of robot on MATLAB, LABVIEW, ATMEL and other such software will be given so that students can do synergistic integration of mechanics, electronics, control theory, and computer science within a robotics system, in order to improve and/or optimize its functionality.

Course outcomes (COs):

On completion of this course, the students will have the ability to:		**Bloom's Level**
CO1	Understand the basics of manipulator, mobile robots, end-effectors	**2**
CO2	Model forward and inverse kinematics of robots	**3**
CO3	Decide robot perception and navigation algorithms	**5**
CO4	Build and program robots using sensors	**6**

Course Topics:

S. No.	Contents	Hours	CO
1	**Manipulators and End Effectors:** Types of Manipulators, Manipulator Drive Systems, Manipulator Control Systems, Types of end effectors, Grippers, Gripper joints, Gripper force.	**2**	**CO1**
2	**Kinematics and Dynamics:** Links & Linkage design, 3D stress & strain analysis of links and linkage mechanism. Basics of theory of machines, Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, Direct and Inverse Kinematics for industrial robots for Position and orientation. Motion generation, Manipulator dynamics, Jacobean in terms of D-H matrices. Differential Kinematics and Static-Dynamics-Lagrangian Formulation.	**21**	**CO2**

	Mobile Robot: Introduction, wheeled mobile robots and their kinematics, humanoid robots.		
3	**Trajectory Planning:** Terminology, Joint Space Techniques, Cartesian Space Techniques, Comparison	**4**	**CO4**
4	**Control Architecture:** position, path velocity and force control systems, computed torque control, adaptive control, and Servo system for robot control	**3**	**CO4**
5	**Perception, Navigation and Simulation:** Introduction to robot perception, Feature extraction, Image acquisition, representation and processing. Introduction to localization, obstacle avoidance and navigation, Simulation.	**8**	**CO3**
6	**Application of Robots:** Application of robot in welding, machine tools, material handling, and assembly operations parts sorting and parts inspection.	**1**	**CO1**

S. No.	Name of Lab Experiment	Hours	CO
1	Introductory Lab	**2**	**CO1**
2	Study and analysis of inverted pendulum	**2**	**CO2**
3	Study of kinematics of manipulators	**2**	**CO2**
4	Design and Analysis of Manipulators on CAD	**2**	**CO2**
5	Programming of 5-DoF Robotic Arm	**2**	**CO4**
6	Fabrication and programming of basic RC mobile robots	**2**	**CO4**
7	Study of kinematics of sbRIO Mobile Robot (Turning & Rotating)	**2**	**CO2**
8	Design a suitable algorithm on LabVIEW for obstacle avoidance using sbRIO mobile Robot	**2**	**CO3**
9	Embedded C programming of firebird V robots	**2**	**CO4**
10	Study of open and closed loop motor control of Mobile Robot	**2**	**CO3**
11	Programming of a humanoid robot for different applications	**2**	**CO4**
12	Project	**4**	**CO1, CO2, CO3, CO4**

Textbook References:
Text Book:

1. John Craig, *Introduction to Robotics: Mechanics and Control*, Pearson/Prentice Hall Education, 3rd Edition, 2005
2. R. Siegwart, *et.al Introduction to Autonomous Mobile Robots*, Prentice Hall of India, 3rd Edition, 2005.
3. Mittal, R. K., and I. J. Nagrath. *Robotics and control*. Tata McGraw-Hill, 2003.

Reference books:

1. Richard D. Klafter, *Robotics Engineering, An Integrated approach*, Prentice Hall of India, 3rd Edition, 2003.
2. Fu K S, Gomalez R C and Lee C S G, *Robotics: Control, Sensing, Vision and Intelligence*, McGraw Hill Book Company, 1st Edition, 1987.
3. Groover, Mikell P., et al. *Industrial robotics: technology, programming, and applications.* McGraw-Hill, 2012.

Additional Resources:

NPTEL, MIT Video Lectures, Web Resources etc.

Evaluation Method		
Item	**Weightage**	**CO**
Quiz 1	5%	CO1, CO2
Quiz 2	5%	CO3, CO4
Assignment	5%	CO1, CO2, CO3
Project Evaluation	5%	CO1, CO2, CO3, CO4
Lab Report	5%	CO1, CO2, CO3, CO4
Lab Exam	15%	CO1, CO2, CO3, CO4
Mid term	20%	CO1, CO2
End term	40%	CO1, CO2, CO3, CO4

CO and PO Correlation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	-	-	-	-	-	-	-	-	1
CO2	3	3	1	-	-	-	-	-	-	-	-	1
CO3	3	2	3	-	-	-	-	-	-	-	-	1
CO4	3	3	3	-	-	2	-	-	-	-	-	1

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