

Course Code	Course Name	Credits
CSDLO7033	Robotics	4

Course objectives:

- 1 To know basics of a typical robot and its characteristics.
- 2 To analyse mathematically kinematic modelling of a typical robot manipulator.
- 3 To identify actuators, sensors and control of a robot for different applications.
- 4 To apply task planning and vision algorithms.

Course outcomes: On successful completion of course learner will be able to:

1. Describe typical robot and its characteristics.
2. Analyse kinematics parameters of robotic manipulator.
3. Identify actuators, sensors and control of a robot for different applications.
4. Design task plan and motion for a robot.
5. Apply Robotics to solve day to day problems using vision algorithms.
6. Use robot programming languages and acquire skills to program robots.

Prerequisite: Mathematical concepts of Geometry, Matrices Algebra, knowledge of Basic Electronics.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction and Fundamentals of Robotics	08
	1.1	Types of automation, Introduction, definition of a Robot, Classification of Robots, Robotics, History of Robotics, Advantages and Disadvantages of Robots, Robot Applications	
	1.2	Tasks involved in Robotics, Robot Components, Robot characteristics and classification, Degrees of Freedom, Robot joints, Robot Coordinates, Robot Reference frames, Programming Modes, Robot Workspace, Work Envelop.	
2.0		Direct and Inverse Kinematics	08
	2.1	Direct (Forward) Kinematics: Homogeneous coordinates, Link coordinates, Coordinate frame, coordinate transform, Arm equations, An example – Four Axis SCARA.	
	2.2	Inverse Kinematics: Inverse kinematics problem, Tool Configuration, An example – Four Axis SCARA.	
		Sensors, Actuators and Drive Systems	08

3.0	3.1	Sensors: Characteristics, Utilization, Types - Position, Velocity, Acceleration, Force and Pressure, Torque, Visible Light and Infrared, Touch and Tactile, Proximity, Range Finders sensors.	
	3.2	Actuators and Drive System: Characteristics, Hydraulic Actuators, Pneumatic Devices, Electric Motors	
4.0		Robot Task and Motion Planning	10
	4.1	Reactive Paradigms: Overview, Attributes of reactive paradigm	
	4.2	Task level programming, Uncertainty, Configuration Space, Gross motion planning, Fine-motion planning, Simulation of Planner motion, Source and goal scene, Task planner Simulation.	
	4.3	Robot Motion Planning: Concept of motion planning, BUG 1, BUG 2 and Tangent Bug Algorithms	
5.0		Robot Vision	10
	5.1	Image Representation, Template Matching, Polyhedral Objects	
	5.2	Shape Analysis, Iterative Processing	
	5.3	Perspective Transformations, Structured Illumination , Camera Calibration	
6.0		Expert Systems, Robot Language and Fuzzy Logic	12
	6.1	Introduction to Expert Systems, Expert system Characteristics, Robot as a Expert System, Robot Languages: Classification of Robot Languages, Computer Control and Robot Software, VAL System, and Language.	
	6.2	Introduction, Fuzzy set, Fuzzification, Fuzzy Inference Rule Base, Defuzzification, Applications of Fuzzy Logic in Robotics.	
		Total	52

Text Books:

1. Introduction Robotics - Analysis, Control, Applications by Saeed B. Niku, Second Edition, Wiley India.
 2. Fundamentals of Robotics – Analysis and Control by Robert J. Schilling, Pearson
 3. Introduction to AI robotics by Robin Murphy, PHI.
- University of Mumbai, B. E. (Computer Engineering), Rev. 2016

4. Robotics Technology and Flexible Automation by S. R. Deb, TMH.
5. Artificial Intelligence by Rich, Knight and Nair, TMH.
6. Introduction to Fuzzy Sets by M Ganesh PHI

Reference Books:

1. Robotics – Control, Sensing, Vision, and Intelligence by K. S. Fu, R. C. Gonzalez, C. S. G. Lee, Tata McGraw Hill
2. Principles of Robot Motion – Theory, Algorithms and Implementation by Howie Choset, Lynch, PHI
3. Introduction to Fuzzy Logic using Matlab, By: S.N.Sivanandam, S.N. Deepa, P Sumathi, Springer Publications

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Term Work :

The distribution of marks for term work shall be as follows:

• Programming Exercises:	(10) Marks.
• Mini project:	(10) Marks.
• Attendance (Theory & Practical)	(05) Marks.
TOTAL:	(25) Marks.

Suggested List of Experiments:

- 1 Representation of Various Robots and their all Specification (Study Experiment)
- 2 Co-ordinate Transform of a Robot
- 3 Fundamental Rotation
- 4 Composite Rotation
- 5 BFS and DFS
- 6 Homogeneous Rotation
- 7 Run Length Encoding
- 8 Shrink and swell Operator
- 9 BUG1 Algorithm

- 10 Bug2 Algorithm
- 11 Tangent Bug Algorithm
- 12 Edge detection algorithm
- 13 Case Study of CNC Machine
- 14 Designing a Robot Manipulator for Pre defined Task

Students can perform experiments based on Theory Syllabus or any 12 experiments from above list of experiments or experiments framed by teachers.

The Experiments for this course are required to be performed and to be evaluated in CSL704: Computational Lab-1.