

LESSON PLAN

Sub Code: ME521

School : Engineering
Department : Mechanical Engineering
Course Code : ME 521
Course Name : Robotics
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1. Abstract:

Robotics is one of the very important and interesting subjects. The interest in this subject widespread and growing. Robotics being an interdisciplinary subject draws from various fields of engineering and science; however, the main focus of this course would be related to the mechanical engineering aspects of robotics.

2. Objectives:

One of the main objective of the course is to introduce the mathematical terminologies that are used to describe a robot manipulator. In this course, the student would get an opportunity to apply the knowledge and skills acquired during the course related to mechanisms, kinematics, dynamics and linear algebra in the context of robot manipulators. Apart from a brief introduction to the robot control and other important elements of a robot system, various schemes of trajectory planning and generation would also be discussed.

In particular the objectives of this course are:

1. to introduce the concept of robotics
2. to introduce mathematical representation of robots
3. to introduce forward and inverse kinematics of manipulators
4. to familiarize students with the concepts like Jacobian, workspace, singularity etc.
5. to introduce forward and inverse dynamics of manipulators
6. to discuss various schemes of trajectory planning
7. to introduce feedback control, PID control, stability analysis
8. to discuss various elements of a robotic system: Actuators, Transmission & Sensors

3. **Prerequisites of the course:** None (However, students should brush up the fundamentals of engineering mechanics and linear algebra.).

4. Course outline and Time plan

S. No.	Topics	Content	L+T
1	Introduction	A brief History and a general introduction	2
2	Mathematical Representation of Robots	Position & orientation of a rigid body; Transformation between coordinate systems; Homogeneous transformation; Properties of homogeneous transformation; Denavit-Hartenberg parameters;	8+4

		Some fundamentals of linear algebra	
3	Kinematics of Manipulators	Degrees of freedom of a manipulator; Direct kinematics problem; Inverse kinematics problem	6
4	Velocity Analysis & Statics of Manipulators	Kinematic modeling of instantaneous motions - Jacobian; Singularity, Infinitesimal rotations; Redundancy; Force & moment analysis; Relationship between joints torque and end-effector force	7
5	Dynamics of Manipulators	Forward and inverse dynamics of manipulators; Newton-Euler and Lagrangian formulations.	7
6	Trajectory Planning and Generation	General considerations in path description and generation; Joint space schemes; Cartesian space schemes.	6
7	Position and Force Control of Manipulators	Feedback control of a single-link manipulator; PID control of a multi-link manipulator; Non-linear control of manipulators; Partitioning a task for force and position control; Hybrid position/force controller; Stability analysis.	8
8	Elements of a robot	Actuators, Transmission & Sensors.	3
Total			51

Textbooks:

1. Ghosal, A., *Robotics - Fundamental concepts & Analysis*, Oxford university press (2006).
2. Craig, J. J., *Introduction to Robotics - Mechanics & Control*, Addison - Wesley Publishing Company, New York (1986).

Reference books:

1. Asada, H., Slotine, J. E., *Robot Analysis & Control*, John Wiley & Sons, New York (1986).
2. Nakamura, Y., *Advanced robotics - Redundancy & Optimization*, Addison - Wesley Publishing Company, New York (1991).
3. Merlet, J.P., *Parallel Robots*, Kluwer Academic Publishers, Netherlands (2000).