Department of Mechanical Engineering
Tezpur University

Course-Plan

School : Engineering
Department : Mechanical Engineering
Course Code : ME 521
Course Name : Robotics
Instructor : Vivek Kumar Mehta, Assistant Professor, Department of Mechanical Engineering, Tezpur University, Email: vkmehta@tezu.ernet.in,

1. Abstract:

Robotics is one of the very important and interesting subjects in engineering. The interest in this subject is 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

- to introduce mathematical representation of robots
- to introduce forward and inverse kinematics of manipulators
- to familiarize students with the concepts like Jacobian, workspace, singularity etc.
- to introduce forward and inverse dynamics of manipulators
- to discuss various schemes of trajectory planning
- to introduce feedback control, PID control, stability analysis
- 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 Lesson 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; Fundamentals of linear algebra	8+4
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).

5. Evaluation Plan:

Test/Examinations	**Marks**
Sessional Test I	10
Sessional Test II	10
Mid-Semester Examination	30
End-Semester Examination	50
Total Marks	100

All the tests will be held as per the schedule notified by the Controller of Examinations, Tezpur University.

6. Pedagogy:

The main concepts and principles of the course will be discussed in the class with the classical pedagogical method of "Chalk and Talk". However, wherever necessary the classroom discussion will be supported by audio-visual medium and computer simulations.

7. Expected outcome: It is expected that after going through this course, the students

(a) would be able to appreciate and apply the framework (of mainly mechanics and linear algebra) acquired during this course to solve the basic problems related to robot motion and control;

(b) would be able to decode the jargons in the field of robotic

(c) would get motivated to take up advanced course in the field of robotics.