Department of Mechanical Engineering
NIT Srinagar
Spring 2020

Course: Robotics: Mechanics and Control
LTP: 2-0-2 (3 Credits)
Course Instructor: Majid Hameed Koul
Level: M. Tech. Second Semester **Type:** Elective

Google Classroom Code: rqteu6f

For discussions and doubts, log in to the Google classroom with your email ID's. Useful resources will be shared via classroom interface.

Course Objectives:

After completion of the course, a student should be able to:

CO1 Select appropriate sensors and actuators for a particular robot task.
CO2 Evaluate inverse and forward kinematics of robot manipulators.
CO3 Derive the equations of motion for robot manipulators and perform dynamic analyses.
CO4 Write basic programs for controlling robot manipulators using embedded systems.

Course Outline:

Robot Classification, Serial and Parallel Manipulators, Robot Selection and Application, Sensors and Actuators, Motion and Force Sensing, Actuation Schemes, Electric, Hydraulic, and Pneumatic.

Robot Kinematics, Degrees of freedom and mobility, Rotation representation, Coordinate transformations, DH parameters, Matrix methods for forward and inverse kinematics analyses, Jacobian and Singularity.

Robot Dynamics and Control, Euler-Lagrange and Newton-Euler equations of motion for robot manipulators, Inverse and forward dynamic analyses, linear control of robot manipulators, microcontroller programming.

Lab Exercises:

1. Kinematic and dynamic analyses of robot manipulators using MATLAB.
2. Simulation of controller schemes for robot manipulators using SIMULINK.
3. Introduction to microcontroller programming.
4. Robot control using microcontrollers.

Recommended Texts:

1. Craig, J. J., Introduction to Robotics: Mechanics and Control, Pearson, 3rd Edition, 2004.

Other References and Texts:

1. Siciliano, Bruno, Khatib, Oussama, Springer Handbook of Robotics, Springer, 2016.
2. Alciatore David G & Histand Michael B, Introduction to Mechatronics and Measurement Systems, 4th Edition, Tata McGraw Hill, 2006.
3. Saha, Subir Kumar. Introduction to Robotics. Tata McGraw-Hill Education, 2014.
4. Ghosal, Ashitava. Robotics: Fundamental Concepts and Analysis, Oxford, 2006.
5. Spong, Mark W., Seth Hutchinson, and Mathukumalli Vidyasagar. Robot Modelling and Control. Vol. 3. New York: Wiley, 2006.

Web Resources:

NPTEL: https://nptel.ac.in/courses/112/108/112108093/

NPTEL: https://nptel.ac.in/courses/112/107/112107289/

Coursera: https://www.coursera.org/specializations/modernrobotics

Stanford: https://see.stanford.edu/Course/CS223A

MIT: https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/index.htm

Lecture #	2-0-2	Date	CO
1	**Introduction: Robots, Robotics, Robot Classification**		
2	Contemporary Applications (Research Articles/News/Fiction)		
3	Role of Mechatronics in Robotics		
4	Serial, Parallel, Tree-type Manipulators (Classifications)		
5	Robot Selection and Application (Task/Medical/Industry)		
6	Sensors: Motion Sensing (Optical Encoders/Hall Effect)		
7	Sensors: Force Sensing (F/T Sensor)		
8	Actuators: Electrical (AC/DC/Servo/Stepper)		
9	Actuators: Hydraulic and Pneumatic, Applications.		
10	**Robot Kinematics**		
11	Degrees of freedom and mobility		
12	Rotation representation, Coordinate transformations, DH parameters		
13	Coordinate transformations, DH parameters Examples		
14	Matrix methods for forward and inverse kinematics analyses		
15	Jacobian and Singularity		
16	Robot Statics: Design		
17	**Robot Dynamics and Control**		
18	Equations of Motion based on Euler-Lagrange Methods		
19	Equations of Motion based on Euler-Lagrange Methods**:** Examples		
20	Newton-Euler equations of motion for robot manipulators		

21	Newton-Euler equations of motion for robot manipulators: Examples		
22	Inverse and forward dynamic analyses: Examples		
23	Linear control of robot manipulators		
24	Linear control of robot manipulators: Examples		

	Laboratory		
1	Introduction to MATLAB: Arrays/Loops/Conditional		
2	Basic exercises on MATLAB: Modelling Dynamic Systems		
3	Introduction to Microcontrollers: Architecture/Types/Circuits		
4	Programming Microcontrollers: PIC/ATMEL		
5	Kinematic analyses of serial manipulators using MATLAB		
6	Kinematic analyses of parallel manipulators using MATLAB		
7	Introduction to Simulink		
8	Dynamic analyses in MATLAB		
9	Dynamic analysis in SIMULINK		
10	Robot Control examples in SIMULINK		
11	Robot Control using Microcontrollers		
12	Robot Control using Microcontrollers: Examples		
13	Control using MATLAB/SIMULINK/Microcontroller		