Asian Institute of Technology
School of Engineering and Technology

AT74.01 Kinematics, Dynamics and Control of Robots 3(2-3) Semester: August

Course Objective:
Currently robots are extensively used in many industrial applications. Further the robotics has extended the horizons to bio medical, entertainment and elderly care applications in the recent past. Main objective of this course it to impart knowledge and experiences of robot design and analysis, to students. This course integrates the knowledge on control systems, kinematics and dynamics which students have studied in their undergraduate level to be applied for robot design, control and analysis.

Learning Outcomes:
Upon completion of this course, the students would be able to:

- Select an appropriate robot for a given application based on the specifications.
- Analyze a given robot design in terms of kinematics and dynamics.
- Design and develop a robot to accomplish a specified task.
- Apply the classical control theory for controlling and programming a robot.

Prerequisites: None

Course Outline:

I. Introduction to robotics and mechanisms

1. History and evolution of robots
2. Specifications of robots
3. Configurations of robots

II. Robot Kinematics

1. Rotation kinematics
2. Orientation kinematics
3. Rigid body kinematics
4. Rotation, translation and homogenous transformation
5. Forward and inverse kinematics – Denavit-Hartenberg (DH) Method
6. Velocity kinematics and Jacobian

III. Robot Dynamics

1. Importance of dynamics
2. Force and moment
3. Acceleration kinematics
4. Lagrangian dynamics

IV. Robot Control

1. Path planning and trajectory control
2. Sensors and actuator integration
3. PID control
4. Industrial robot control and programming
5. Force control and position control

Laboratory Sessions:

- Introduction to robot simulation software
- Drafting of rigid bodies and link mechanisms using Solidworks
- Matlab as a tool for Robot analysis and relevant tool boxes
- Forward Kinematics
- DH Parameters
- Velocity Kinematics
- Inverse Kinematics
- Dynamics
- Robot programming using Kuka Robot Language (KRL)

Learning Resources

Textbooks: No designated text book, but class notes and handouts will be provided

Reference Books:

1. R.N. Jazar, Theory of applied robotics: kinematics, dynamics, and control, Springer Science & Business Media, 2010.

2. M.W. Spong, and M. Vidyasagar, Robot dynamics and control, John Wiley & Sons, 2008

3. B. Siciliano, O. Khatib, Springer Handbook of Robotics,Springer, 2008

Journals and Magazines:

1. Transactions on Robotics and Automation, IEEE
2. Transactions on Mechatronics, IEEE/ASME
3. Spectrum, IEEE

Teaching and Learning Methods: Methods used are lectures, laboratory work and assignments which include presentations and conducting computer simulations.

Time Distribution and Study Load:
Lectures: 30 hours
Laboratory sessions: 45 hours
Self study and assignments: 90 hours

Evaluation Scheme: Mid semester examination(20%), final examination (40%) (both are closed book), laboratory sessions (20%) and assignments (20%).

In the evaluation, an "A" will be awarded if a student demonstrates an excellent level of understanding of the principles and demonstrates excellent capabilities in robotics related applications. "B" will be awarded if a student demonstrates an average level of understanding of the principles and demonstrates average capabilities in robotics related applications. "C" will be given if a student demonstrates below average level of understanding of the principles and demonstrates below average level of capabilities in robotics related applications.

Instructor(s): Dr. A.M. Harsha S. Abeykoon