Introduction to Robotics

Level: Under Graduate

Prerequisite: Computer architecture and microprocessors (25754), Linear control systems (25752)

Purpose: Introduction to modeling, design, planning, and control of robots.

Syllabus: _____

- **Mechanical Modeling:**
  - **Preliminaries:** Orientation representations, Orientation matrix, Quaternions, Euler angels, Pitch-role-yaw representation, Combination of rotations, Homogeneous transformations,
  - **Rigid manipulator kinematics:** Configuration variables, Forward and inverse kinematics, Velocity kinematics, Angular velocity, Jacobians, Linear algebra preliminaries, Kinematic redundancies, Kinematic singularities,
  - **Dynamics:** Newton laws of rotation, Angular momentum, Matrix of inertia, Rigid body motion, Generalized Jacobians, Link constrains, Non-minimal multi-link model, Minimal models.
  - **Identification methods:** offline and online gradient methods,
  - **Introduction to mobile robots,** velocity constraints, wheeled robot types, maneuverability, steerability, monocycles,
- **Hardware systems:** encoders, resolvers, joint torque sensors, force-moment sensors, velocity sensors, gyros, vision systems, drivers, interface systems, electric actuators, hydraulic actuators,
- **Trajectory planning:** Path planning for manipulators, path planning for mobile robots, sinusoidal steering,
- **Control:** Joint-space control, task-space control, PD control, PD+gravity compensation control, PID control, intelligent-based control,
- **Special applications:** Exoskeleton systems,

References: _____

1. Robot modeling and control, *M. Spong, S. Hutchinson and M. Vidyasagar*, John Wiley and sons, 2006
2. Theory of robot control, *C. Canudas de Wit, B. Sicilliano and G. Bastin*, Springer, 1996
3. Modeling and control of robot manipulators, *L. Sciavicol and B. Sicilliano*, McGraw Hill, 1996
4. Introduction to Robotics: Mechanics and Control, (3rd edition), *John J. Craig*, 2003