

ENAE 692 Introduction to Space Robotics

Introductory course to the kinematics, dynamics, and control of robot manipulators. Serial and parallel mechanisms are examined, and examples are drawn from space, medical, industrial, and virtual reality applications. Computer tools such as Mathematica™ and Matlab™ are introduced for kinematic and dynamic analysis of complex configurations. A term project will be issued to allow students to design their own robots and apply the principles and tools learned in class. A course in rigid body dynamics is required, and an introductory controls course is recommended. Experience in computer simulation is also helpful but not required.

Prerequisites

ENAE 301 or ENES 221 or equivalent course in dynamics

ENAE 432 or ENEE 460 or equivalent course in control (suggested)

Texts

Required: Introduction to Robotics: Mechanics and Control, 3rd Ed., John J. Craig, Addison-Wesley ©2003

Optional: Modeling and Control of Robot Manipulators, 2nd Ed., Lorenzo Sciavicco and Bruno Siciliano, Springer-Verlag, New York, ©2000

Topics Covered

KINEMATICS (4 weeks)

- Cartesian Representations
- Mappings and Operators
- Link Description/Transformations
- Cartesian Velocities
- Link Velocity Propagation
- Jacobians

DYNAMICS (2 weeks)

- Newton-Euler Dynamics
- Lagrangian Method
- Properties of Dynamics

INVERSE KINEMATICS (2 weeks)

- Inverse Kinematics Approaches
- Pieper's Solution
- Iterative Solution Methods
- Kinematic Redundancy
- Singularities

CONTROL (2 weeks)

- Single Joint Linear Control
- Control Law Partitioning
- Independent/Decoupling Joint Control
- Cartesian-Based Control
- Force Control
- Hybrid Position/Force Control

Stiffness Control
MECHANISMS (2 weeks)
Parallel Mechanisms and Closed Chains
Four-Bar Linkages
Kinematic Configuration
Workspace
Single Joint Modeling
HARDWARE (1 week)
Actuators and Drive Systems
Sensors and Actuators
APPLICATIONS (1 week)
Parallel End-Effector Mechanism
Force Feedback Devices

Grading*

Approximately 8-10 problems sets, three in-class exams, and one design project/lab will be issued during the semester. Each quiz will count for 20% of the grade, the problem sets for 20%, and the term project 20%.

(*these are approximate)