EME/BME 225 : Spatial Kinematics and Robotics (4 Units)
Winter 2018

CATALOG Data: Lecture—3 hours; laboratory—3 hours. Prerequisite: Graduate Standing and Consent of Instructor. Fundamentals of Spatial Kinematics with Applications in Robotics, Biomedical Engineering, and Multibody Systems. Analysis and Measurements of Movements in Three Dimensions; Representation of the Six Dimensional Spatial Configurations Using Matrices, Screw Theory and Exponential Maps; Applications to Robot Manipulators and Robot Motion Planning; Formulation and Solution of Kinematic Equations for Robotics and Biomechanical Systems. Evaluation of Analysis of Force Systems, & Wrenches; Analysis of Equilibrium Postures; Robot Motion Planning and Programming.

PREREQUISITES: Graduate Standing in Engineering; Knowledge of Elementary Statics and Dynamics; Some Level of Programming (MatLab is ok).

TEXTBOOK: Recommended: Matrix Methods in the Design and Analysis of Mechanisms and Multibody Systems.

INSTRUCTOR: B. Ravani

OBJECTIVES: The objective is to strengthen the ability of students to handle problems associated with movements and positioning in the three dimensional space as well as performing analysis and programming of robotic devices.

Professor Ravani

EME 250A: Advanced Methods in Mechanical Design I
Fall 2011

TOPICS:

1. Three Dimensional Kinematics (2-3 Weeks)

    A. Representation of points, lines, rigid bodies

    B. Line Coordinates and Plücker Vectors.

    C. Representation of Orientation, Position, Posture and Displacement

    D. Euler and Chasles' Theorems, Euler-Rodriques Parameters; Quaternion Representation

    E. Coordinate Transformations and Matrix Exponential Formulation.

2. Modeling Robot Manipulators and Human Musculoskeletal Systems (2 Weeks)

    A. Joint and Auxiliary Coordinate Systems

    B. Dimensional Characteristics of a Body

    C. Joint Transformation Equations

3. Posture Analysis by Kinematic Equations (2 Weeks)

    A. Direct and Inverse Kinematic Solutions for Spatial Motions

    B. Solutions Using Marker Coordinates

    C. Kinematic Registration and Reuleaux's Method

    D. Denavit-Hartenberg Transformation and Solvable Configurations; Decoupling Methods of Solution

4. Differential Kinematics (1-2 weeks)

    A. Numerical Solution of Posture Equations

B. Incremental Trajectory Generation

C. Generalized Coordinate Partitioning

B. Instantaneous Screw Axis, Twists, and Ball Vectors

D. Velocity Analysis

5. Force Analysis (1 weeks)

A. Molding of External Forces and Torques, Poinsot's Theorem

B. Wrenches and Reciprocal Screws

C. Equilibrium Configurations

6. Other Topics of Interest to Students (1 Week)