EE 543: Models of Robot Manipulation
Blake Hannaford

PREREQUISITES
EE 543 is an introductory graduate course.
- Knowledge of basic Matrix multiply, inverse operations etc.
- Definitions of Eigenvalues, Eigenvectors, pseudoinverse (will be reviewed).
- Ability to program in Python strongly recommended.

- Spatial Serial Chain Mechanisms
- Using robot arms to position and orient objects
- Mathematical Analysis
- Emphasis on computational issues (not theoretical)
- Innovative and Time Efficient Course Structure
Understand and Program Solutions to Fundamental Problems

**Positioning:** Q: How do we specify the position and orientation of robot arms and objects?  
A: Frames, Homogeneous Transformations, and joint-space teaching.

**Forward Kinematics:** Find a linear transformation from end effector ($P_{EE}$) to base frame ($P_0$):

$$P_0 = T_6^0(\theta_1...\theta_6)P_{EE}$$

...  
Inverse Kinematics, Incremental Kinematics (velocity and force), Inverse Dynamics, Position Control, Force Control, Trajectory Generation, Motion Planning, Sensor Based Control, Telemanipulation, etc.

ELECTRICAL ENGINEERING  
UNIVERSITY OF WASHINGTON
Innovative Course Structure:

60-90 minutes lecture on Pre-recorded Video (watch at home/work prior to class)

In-Class-Active-Learning:

- **6:00PM - 8:00PM:**
  - Work in teams or individually on In-Class-Problems (ICPs)
  - Continuous in-person assistance from Prof. and TA’s.

Symbolic Math Toolkit

- We will have access to a symbolic math toolkit in Python using the sympy package (all problems of 5 DOF or greater, but do hand computations for < 5 DOF).
- We will have simple programming assignments to create a library of numerical functions in Scilab or Matlab.

Homework and Final Project   NO FINAL