

Southern Polytechnic State University  
**MTRE 4200: Robotics Analysis and Synthesis**  
Course Syllabus

**Course Description**

This class will mainly introduce the mathematical models, trajectory planning and control of robotic manipulators for engineering students. The following topics will be covered in the course: Rigid Motions and Homogeneous Transformations, Forward and Inverse Kinematics, Velocity Kinematics and Jacobian, Path and Trajectory Planning, Independent Joint Control, and Dynamics of Industrial Robots.

**Instructor:**

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**Course URL at GaVIEW Vista 8**

<https://spsu.view.usg.edu>

**Textbook (Required):**

Robot Modeling and Control, M.W. Spong, S. Hutchinson and M. Vidyasagar, 2006, Published by Wiley.  
ISBN-13: 978-0-471-64990-8

**Prerequisite:**

MTRE3710, EE4201, MATH2255, ENGR3122

**Learning Outcomes:**

Upon completion of the course, the students should be able to:

- 1- Understand rotation matrix and homogeneous transformations.
- 2- Calculate the position/orientation of the end effector using the joint variables (Forward Kinematics).
- 3- Derive the joint variables based on the position/orientation of the end effector (Inverse Kinematics).
- 4- Derive the relationship between velocities of the end effector and the velocities of the joints (Velocity Kinematics or Jacobian).
- 5- Calculate the static forces/torques of the end effector using the forces/torques on the joints.
- 6- Understand the concept of singularity.

- 7- Plan the path and trajectory of a robot.
- 8- Control the motion of a robot using independent joint control.
- 9- Derive the dynamic equations of a robot.

### **Course Outcome Measures and Assessment:**

Measures and assessment of the outcomes will be made by:

- 1- Periodic homework assignments and quizzes.
- 2- Two one hour tests during the semester.
- 3- One 2-hour final exam.
- 4- Course project.
- 5- Course and instructor evaluation at the end of the semester to provide student feedback on the quality of the course and effectiveness of the instructor.

### **Topics Covered**

- 1) Introduction
- 2) Rotation matrix and homogeneous transformations  
**Test 1**
- 3) Forward kinematics and Denavit-Hartenberg Convention
- 4) Inverse kinematics
- 5) Jacobian and velocity kinematics
- 6) Singularity, inverse velocity and acceleration
- 7) Static force/torque relationships  
**Test 2**
- 8) Path and trajectory planning
- 9) Independent joint control
- 10) Dynamics of robotic manipulators  
**Final Exam** (Cover all above topics)

### **Grading:**

1. Two Tests	30.0 %
2. Homework and Quiz	15.0 %
3. Attendance (Lectures and Labs)	10.0 %
4. Course project and reports	15.0 %
5. Final exam (during finals week)	30.0 %

### **Homework / Lab Reports Preparation Guideline:**

- **Only hard-copy homework/reports will be accepted. No email submission.**
- Printed homework is preferred but not necessary.
- The course project report must be printed.
- Submit your homework/report directly to the instructor or insert them into the door of Q342.
- **Late homework and reports will NOT be accepted for credit.**

- Homework/reports must be bounded or stapled
- Show all your work for full credit! Write your name on every page. Present your work neatly!

**Class/Lab Attendance Policy:**

“ ... The instructor may reduce the course grade of any student who fails to meet the attendance requirements as set forth in the instructor’s attendance policy. Students should understand they are responsible for all course material covered and that they are responsible for the academic consequences of their absences.” (SPSU Student’s handbook)

Class attendance policy

# of Absence	0 – 3	More than 3
Point Deduction	0	1.5 points per absence

**Disruptive Behavior and Academic Dishonesty**

SPSU has an Honor Code and a new procedure relating to when academic misconduct is alleged. All students should be aware of them. Information about the Honor Code and the misconduct procedure may be found at <http://spsu.edu/honorcode>

A faculty member reserves the right to remove any student from his or her course if the student’s behavior is of a disruptive nature or where there is evidence of academic dishonesty. In instances of disruptive behavior and/or academic dishonesty, the faculty member will discuss the circumstances with the student(s) before taking final action. In the event the student cannot be reached, he/she will be given the grade of "Incomplete" until such time as he/she can be reached. The student shall have the right of appeal of the faculty member’s decision first to the faculty member’s department head and then to the appropriate college or school dean and, if necessary, to the Vice President for Academic Affairs. Removal of a student from a course under this provision will result in the faculty member’s issuing a grade of "F". A grade of "F" issued under these circumstances shall not be superseded by a voluntary withdrawal and will be included in the student’s cumulative grade point average calculated for graduation purposes. (SPSU Student’s Handbook)