**San Jose State University Department of Mechanical Engineering**

# ME 192 Robotics and Manufacturing Systems
# Fall 2021

**Lecture Instructor** Dr. Winncy Du, 408-924-3866; winncy.du@sjsu.edu; Office: E310F

**Online Office Hours** MW: 12:50-13:20 PM (E310F); MW: 17:45 – 18:15 PM

**Instructor** Lin Jiang, Email: lin.jiang@sjsu.edu
**Office Hours** M: 4:00-5:00 PM; W: 12:00-1:00 PM or by email appointment (Location: E192 or Zoom)

**Course Code & Schedule**

ME192 Section 4 (Seminar, by Dr. Winncy Du) 50109

- Describe the dynamic equation of a robot in a state-space form
- Control an industrial robot both manually and automatically (through a computer program)
- Design a robot's trajectory with the desired velocity, acceleration, and via points.
- Write a code using Matlab, ACE, and V+ programming tools to control and simulate an industry robot.
- Know how to use a virtual lab to control robots.

Late Policy: Unless otherwise specified for a particular assignment, work that is submitted late will be accepted with reduced credit accordingly:

Homework

- 12 hours late -10%
- 24 hours late -25%
- 36 hours late: -50%
- 37~48 hours late: -100%

Midterm & Final Exam

- 1 ~ 5 minutes late: -10%
- 6 ~ 10 minutes late: -25%
- 11~15 minutes late: -50%
- Over 15 minutes late: -100%

Exceptions:

## Tentative Schedule for Seminar Section

| WEEK # | TOPICS |
|---|---|
| Week #1 | |

Lab quizzes (2) - 5% weight
- Robot arm kinematics and manipulation.
- Gripper offset and camera offset. Robot vision processing.

Term project (1) - 15% weight
- 4-week duration following 2 week planning period.
- Team initiated projects with instructor assistance
- 3-person teams. The students form teams.

Demonstration of robotic tools and applications
- To introduce various robotic equipment and application software, not covered in the lab exercises.
- To provide tips for term project ideas and use of special tools.

**Lab Exercise – General Description**

Lab 1: Introduction to Robots

| Online: | **Onsite**: |
|---|---|
| • Industrial Robot types and configurations<br>• Robot applications<br>• Software interface to control Robots: MATLAB, V+, etc. | • Robot coordinate systems (World-, Joint-, and tool-coordinates)<br>• Robot's controller, driver, amplifiers<br>• Robot control using a teaching pedant |

Lab 2: Robot's Forward Kinematics and Programming using ACE

| Online: | **Onsite**: |
|---|---|
| • Robot Programming Software and Emulation<br>• Adept ACE programming environment<br>• V+ learning<br>• Writing a simple program to move a robot on emulation.<br>• Understand the different coordination systems in the emulation program. | • Setting up a coordinate system to each joint of a robot<br>• Measure a robot's parameters (link length, twist angle, offset, or joint angle)<br>• Establish a Denavit-Hartenberg table for the given robot<br>• Derive a 4x4 transformation matrix for each joint<br>• Find the robot's forward kinematics using excel kinematics model or MATLAB model |

Lab 3: Robot Motion Control Using a computer

| Online | **Onsite** |
|---|---|
| • Write a robot's pick-and-place program with the position indexing and the gripper offset<br>• Calculate the transformation needed in order to place a robot's end-effecter in a desired position and orientation<br>• Input the transformation into the programming code | • Write and run the V+ program on ACE, and transfer program file to robots.<br>• Debug and Troubleshoot the V+ program<br>• Run the pick and place motion with the robots. |

| | |
|---|---|
| • Demonstrate (using emulation) the robot is placed and orientated in the desired position and direction with the transformation code | |

Lab 4: Robotic Control with Digital I/O (**onsite**)

- Use the robot's controller's digital output ports to turn on indications
- Design a circuit (or use a pre-designed circuit) integrated with the robot controller
- Control the robots with external sensors via digital input & output ports
  Such as:
  - Read three different inputs from toggle switches.
  - Direct the robot to a distinct location depending on button pressed.
  - Indicate location by turning on appropriate indicator lamp. R4.Design2.3 T6.nl .30.6 (9 (gi.7 13 (g.4 (i).7 x Desigx

# ME 192 Lab Schedule

| *Wk* | *Dates* | **ME192-02 Monday** | | **ME192-05 Wednesday** | | *Contents* |
|---|---|---|---|---|---|---|
| | | ***Group A*** | ***Group B*** | ***Group A*** | ***Group B*** | |
| 1 | 8/23 | Lab introduction | | | | Tour the lab, introduce lab policy, syllabus and etc. |
| 2 | 8/30 | Lab 1 online | Lab 1 **onsite** | Lab 1 online | Lab 1 **onsite** | Download ACE & Excel model. Understand Joint framing, Power up procedure. ManjETQ 629.28 Tm( )Tj |