Course Objective

The objective of this course is to provide an introduction to robotics within a wide variety of application areas. Topics include classification of robots, sensor technology, machine vision; control systems, including programmable logic controllers (PLCs); robot safety and maintenance; and economic justification of robotic systems.

Course Format

This course will primarily be conducted in the form of lectures, videos to represent real-world applications, problem-solving tasks, and hands-on laboratory activities.

Attendance:

Class attendance will be taken each session and will be used in the final evaluation of student performance.

Evaluation of Student Performance

- Homework - 20%
- Team Activities/Class Participation – 10%
- Exam 1 - 15%
- Exam 2 – 25%
- Exam 3 - 25%
- Attendance - 5%

Grading Standards:

- A: 90 – 100%
- B: 80 – 89%
- C: 70 – 79%
- D: 60 – 69%
- F: < 60%

Final Exam

The final exam for the course (Exam 4) will be administered on Wednesday, December 11th, from 12:50 – 2:50 p.m. in D131.

Course Policy

Missed examinations will not be made up unless prior consent of instructor is obtained.
Emergency Procedures
Southern Illinois University is committed to providing a safe and healthy environment for study and work. Because some health and safety circumstances are beyond our control, we ask that you become familiar with the SIUC Emergency Response Plan and Building Emergency Response Team (BERT) program. Emergency response information is available on posters in buildings on campus, available on the BERT's website at www.bert.siu.edu, Department of Public Safety's website www.dps.siu.edu (disaster drop down) and in the Emergency Response Guide pamphlet. Know how to respond to each type of emergency.

Instructors will provide guidance and direction to students in the classroom in the event of an emergency affecting your location. It is important that you follow these instructions and stay with your instructor during an evacuation or sheltering emergency. The Building Emergency Response Team will provide assistance to your instructor in evacuating the building or sheltering within the facility.

Major Topics to be Covered
- Introduction to Robotics
- Robotics Terminology
- Robot Components
- Robot Configurations
- Control Techniques
- End-of-Arm Tooling
- Safety and Maintenance of Robots
- Electromechanical Systems
- Cell Design and Control
- Sensors
- Programmable Logic Controllers
- Vision Systems
- Economic Analysis in Robotics Projects
- Innovations in Robotics

Learning Modules and Objectives
1. Introduction to Robotics
   a. Define a robot.
   b. Define robotic terms provided by OSHA.
   c. Define the various robot specifications.
   d. Identify the components of a robot.
2. Robot Classification
   a. Classify a robot based on arm geometry, power sources, applications, control techniques, and path control.
   b. Recognize and describe the motion of Cartesian, cylindrical, spherical, and articulated robots.
   c. Describe the characteristics of the hydraulic, pneumatic, and electric sources used to power robot systems.
   d. Describe the operation of servo (closed-loop) and nonservo (open-loop) robot systems.
   e. Distinguish among the operation of four types of path control: stop-to-stop, point-to-point, controlled, and continuous path.
3. Automated Work Cells and CIM Systems
   a. Describe the steps used to implement CIM.
   b. Describe and evaluate six manufacturing performance measures.
   c. Describe flexible automation, fixed automation, flexible manufacturing cells and systems.
   d. Calculate various performance measures given a specific manufacturing scenario.
   e. Apply the work-cell design checklist to the design of an automated system.

4. End-of-Arm Tooling
   a. List the five characteristics of good tooling design.
   b. Classify tooling based on following five gripper categories: standard, vacuum, magnetic, air pressure, and special purpose.
   c. Calculate the maximum payload for a gripper given gripper parameters and the acceleration.
   d. Design a vacuum gripper system using standard components for the vacuum cup and surface configuration given the degree of vacuum and device parameters.
   e. Calculate the gripping force for air pressure type grippers.

5. Compliance
   a. Define compliance.
   b. Describe active and passive compliance and force torque sensing devices.
   c. Describe the operation of remote center compliance devices.
   d. Define the various parameters of the RCC device.

6. Electromechanical Systems – DC Motors
   a. Identify the components of a DC motor.
   b. Describe the operation of a DC motor.
   c. Explain the concept of commutation.
   d. Identify the common types of DC motors: permanent magnet, series, shunt, and compound.

7. Electromechanical Systems – AC Motors/Servomotors
   a. Explain the construction of a squirrel cage AC motor.
   b. Describe the operation of a rotating magnetic field.
   c. Define synchronous speed, slip, and rotor speed.
   d. Distinguish among the types of AC motors: series, synchronous, induction.
   e. Explain the operation of a servomotor.
   f. Explain the operation of a stepper motor.
   g. Calculate the resolution of a stepper motor.

8. Sensors
   a. Define a sensor.
   b. Describe the operation of the following position sensors: potentiometers, resolvers, and encoders (absolute and incremental).
   c. Explain the basic operation of the following contact sensors: limit switch, touch sensor, and tactile sensing array.
   d. Describe the operation of the following noncontact sensors: inductive proximity, capacitive proximity, and ultrasonic.
   e. Compare shielded versus unshielded sensors.

9. Programmable Logic Controllers
   a. Define a programmable logic controller (PLC).
   b. Name the component parts of a PLC.
   c. Explain the difference between hard-wired control and PLC control.
   d. Define the function of basic PLC instructions.
e. Program ladder logic diagrams to perform basic control functions.

10. Machine Vision Introduction
   a. Describe the five tasks that vision systems perform in automated manufacturing.
   b. Name the component parts for vision systems.
   c. Describe the basic operation of the vidicon and CCD cameras.
   d. Describe image measurement, analysis, and recognition.

11. Machine Vision Lighting and Applications
   a. Describe the three lighting techniques – front, back, and structured – used for vision work.
   b. Explain the role of vision systems in robotics.
   c. Explain the following methods for analyzing an image: edge detection, region growing, and thresholding.
   d. Define the AIA ANSI standards for vision systems.

12. Robot Safety
   a. Identify the organizations that set the standards for manufacturing safety.
   b. Describe the various safety devices that can be incorporated into robotic systems.
   c. Describe the various levels of safety and strategies upon detection of a safety violation.
   d. List the procedures used to safeguard the operator, programmer, and maintenance personnel in a work cell.

13. Robot Maintenance
   a. Define the significance of proper robot maintenance.
   b. Define the OSHA guidelines for robot maintenance.

14. Economic Analysis
   a. Explain the role of economics in robotic systems.
   b. Perform economic analyses on a proposed robotic system using payback, ROI, cash flow, and time value of money methods.