Mechatronics Program
Autonomous Robots Course
Suggested Syllabus

Part 1: Course Information

Course Overview

Basic Information

College:
Department:
Semester:
Instructor:
Office:
Office Hours:
Office Telephone:
Email:

Description

Autonomous Robots is a laboratory-based course that introduces the basic concepts of robotics, focusing on the construction and programming of autonomous mobile robots. This course consists of 15 lessons along with corresponding labs and/or class activities. Topics covered include the basic principles of mechanical construction, electronics, sensors, motors, and robot programming; troubleshooting techniques and strategies to identify, localize, and correct malfunctions; and safety and systematic preventative maintenance. In addition, students will work in groups to build and test increasingly more complex mobile robots.

Prerequisites

No Mechatronics courses are required as prerequisites.

To succeed in this course, students should be proficient in English and basic Algebra.

Course Materials

Recommended Textbook(s)

Mataric, M. (2007). *The Robotics Primer*. Cambridge, MA: The MIT Press. ISBN: 9780262633543.

Course Structure

This course is designed to provide a hybrid experience, including both face-to-face and online activities. Activities to be completed online and face-to-face will be updated weekly and provided as a supplement to the course syllabus.

Contact time will be divided in the following way:

80% face-to-face
20% online

Face-to-face sessions

Laboratory exercises and in-class work will emphasize skill attainment and content mastery.

Online Sessions

Online sessions will include content and activities from Platform +, Wisc-Online, Tooling U, simulated lab activities, and other resources. To access online activities, students will need access to the Internet and a supported Web browser. Technical assistance can be obtained from local technical support.

Technical Requirements

- Internet connection.
- Access to college learning management system and Platform+.
- Access to college email account.
- Microsoft PowerPoint.
- Microsoft Word.

Part 2: Learning Outcomes

Following successful completion of the Electrical Systems course, the student will be able to:

Applied Mathematics

- Use basic algebraic equations to solve problems involving pressure, area, torque, work, power, efficiency, and power equations.

Critical Thinking/Problem Solving

- Design and build agile robots and robotic arms to complete various tasks.
- Use robotic sensors to give autonomous robots more intelligence.

- Create programs in RobotC to complete complex autonomous tasks.
- Use a robot simulator for offline programming of industrial robots.

Equipment

- Correctly and safely use robotic devices, such as sensors and end effectors.

Foundational Principles

- Explain the basic parts of a robotic system and the fundamental principles of robot mechanicals.
- Explain the basic principles of robot motors, including DC (brush), servo, and stepper motors.
- Explain the basic principles of microcontrollers and the operation of typical robotic sensors.
- Explain basic robotic programming concepts and techniques, including functions in RobotC programming.
- Explain the different ways to program an industrial robot.

Troubleshooting

- Troubleshoot basic robot programming issues.

Part 3: Course Calendar

This course calendar provides a schedule of lessons and an outline of topics covered. Activities, assignments, and assessments will be explained in detail throughout the course. Please contact the instructor with questions.

Lesson 1: Introduction to Robotics Date

1. Class Syllabus, Course Policies, and Procedures
2. Introduction to Robots
    a. What Is a Robot?
    b. Different Types of Robots
    c. Demonstration of an Industrial and Agile Robot
    d. Range of Industries Using Robots
    e. Difference Between a Robot and a Remote-Controlled Vehicle
3. The Development of Robots
    a. Advent of Computers

b. Definition of an Industrial Robot
c. Early Industrial Robots
d. The Unimate Robot
e. Robot Inventors
f. Do Robots Pose a Threat?

4. Lab Activity: Introduction to the Robotic Design Platform
   a. Identifying Robotic Components in the Robotic Kit
   b. Description of Each Part in the Robotic Kit

Lesson 2: Robot Mechanicals I Date

1. Mechanical Chassis/Structure of a Robot
   a. Overview of Different Systems in a Robot
   b. Mechanical Chassis, Electrical System, Sensors, Microcontroller
   c. Function of Chassis
   d. Examples of Robot Chassis
   e. Aluminum and Steel
   f. Mechanical Hardware: Fasteners, Nuts, Bolts
   g. Overview of Roller Bearings and Reducing Friction
   h. Shafts, Collars, Spacers
2. Lab Activity: Building Your First Agile Robot

Lesson 3: Robot Mechanicals II Date

1. Mechanical Gears
   a. Definition of Torque
   b. Quick Introduction to DC Motors: High Speed, but Low Torque
   c. How to Increase Torque
   d. Types of Gears: Spur, Bevel, Worm, Rack, and Pinions
2. Lab Activity: Robot Design Project #1 - DORA (Door-Opening-Robot-Assistant)

Lesson 4: Robot Motors Date

1. Robot Motors: DC, Servo and Stepper Motors
   a. Introduction to Motors
   b. How a DC Motor Works

c. Differences between DC, Servo, and Stepper Motors
d. Choosing a Motor/Motor Characteristics
e. Motor Parameters: Speed and Torque
f. How a Stepper Motor Works
g. Basics of Pulse Width Modulation

2. Lab Activity: Robot Design Project #1 - Completing DORA

Lesson 5: Microcontrollers and Sensors Date

1. Microcontrollers
   a. Introduction to Microcontrollers and Sensors
   b. CPU, RAM, ROM, Interface
   c. Purpose of Microcontrollers
   d. RobotC Firmware
   e. Digital and Analog Signals
2. Robot Sensors
   a. Purpose of Sensors
   b. Digital Sensors: Pushbutton, Limit-Switch
   c. Ultrasonic Sensor
   d. Optical Shaft Encoder
   e. Analog Sensors: Potentiometer
   f. Line-Following Sensor: LED/Photodiode
3. Lab Activity: Robot Design Project #2 - Autonomous Maze Robot
   a. Project Overview
   b. Downloading Firmware to the Microcontroller
   c. Downloading Basic Code to the Microcontroller
   d. Using Pushbutton Sensors

Lesson 6: Robot Programming Date

1. Robotic Programming 1
   a. RobotC Programming Basics
   b. PseudoCode
   c. Statements
   d. RobotC rules
   e. Compiling

f. Statement Order
g. Coding Punctuation Pairs
h. Control Structure
i. Adding Comments to Programs
j. Setting Up Motors and Sensors in RobotC
k. Motor and Wait Commands

2. Lab Activity: Robot Design Project #2 – Completing Autonomous Maze Robot

Lesson 7: Robot Arm Programming I Date

1. Industrial Robot Arms
   a. Definition of an Industrial Robotic Arm
   b. Various Applications: Palletizing, Loading and Unloading, Welding, Spray Paint
   c. Robot Anatomy: Joints, Links, Degrees of Freedom
   d. Translational and Rotational Motion
   e. Cartesian Robots and Applications
   f. Jointed Arm and Scara Robots
   g. End Effectors and Examples
   h. Two-Finger, Three-Finger, and Vacuum Grippers
   i. Overview of Programming an Industrial Robot.
2. Lab Activity: Robot Design Project #3 - Industrial Robotic Arm with Conveyor Belt
   a. Building a Conveyor Belt Using Vex Parts
   b. Detecting the Parts When They Reach the End of the Conveyor
   c. Building the Robotic Arm First, Then Adding the Potentiometers
   d. Measuring the Potentiometer Readings at Each Robot Position
   e. Programming the Robot to Move to Each Position

Lesson 8: Robot Arm Programming II Date

1. Lab Activity: Robot Design Project #3 – Completing Robotic Arm with Conveyor Belt

Lesson 9: Line-Following Robot I Date

1. More Robot Programming and Line Tracking Robots
   a. Defining a Line-Tracking Sensor
   b. Reading Robot Sensor Values in Real Time
   c. Using IF/ELSE Statements in RobotC

   d. Creating a Programming Counter
   e. How Ambient Light Affects the Sensor and What to Do About It
2. Lab Activity: Robot Design Project #4 – Line-Tracking Robot
   a. Types of Robot Chassis Design
   b. Calculating a Good Threshold Value to Use the Sensors.
   c. Using an IF/ELSE Statement to Control the Robot.
   d. Programming Issues Occurring with this Project

Lesson 10: Line-Following Robot II Date

1. Functions and Variables
   a. Purpose of Functions
   b. Defining Variables
   c. Using Variables in RobotC
   d. Using Functions in RobotC
   e. Creating a Programming Counter
2. Lab Activity: Robot Design Project #4 – Completing the Line-Tracking Robot

Lesson 11: Industrial Robot Programming Date

1. Industrial Robot Programming
   a. Parts of Industrial Robot: Arm, Controller, Teach Pendant, End-Effector
   b. Applications for Industrial Robots
   c. Operation of a Six-Axis Industrial Robot
   d. Defining Offline Robot Programming
2. Lab Activity: Offline Robot Programming
   a. Jogging a Robot
   b. Setting the Robot Co-ordinate System
   c. Creating Virtual Objects, such as End Effectors and Training Objects
   d. Creating Targets or Robot Positions
   e. Creating Paths Using Robot Targets
   f. Generating the Robot Coding from the Robot Simulator
   g. Simulating the Robotic Path
   h. Saving the Program and Transferring It to the Actual Robot

Lesson 12: Industrial Robot Programming Date

1. Lab Activity: Continuation of Offline Robot Programming

Lesson 13: Final Robot Design Project Date

1. Lab Activity: Final Robotic Project - Recycling Robot

Lesson 14: Final Robot Design Project Date

1. Lab Activity: Final Robotic Project – Recycling Robot

Lesson 15: Final Robot Design Project Date

1. Lab Activity: Final Robotic Project – Recycling Robot

Part 4: Grading Information

Graded Activities

Robot Projects

There will be four robot projects, two worth 10% and two worth 15% of the final grade.

Final Robotic Design Project

There will be a final robot design project worth 40% of the final grade.

Laboratory Exercises

Laboratory exercises measure skills and abilities relating to knowledge learned in class and will be worth 5% of the final grade.

Class Participation

Class participation is important and will be worth 5% of the final grade.

Grading Breakdown

Robot Projects = 50%

Final Robot Project = 40%

Laboratory Exercises = 5%

Class Participation = 5%

Grading Scale

A = 90-100
B = 80-89
C = 70-79
D = 60-69
F = 59 and below

Late Work

Late work will not be accepted unless it is pre-approved by the instructor. All graded work will be posted in the college learning management system within 48 hours of due date.

Part 5: College Policies and Resources

Policies

Attendance

Academic Integrity

Campus Civility

Resources

Counseling

Veterans

Students with Disabilities

About These Materials

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The National STEM (Science, Technology, Engineering, and Mathematics) Consortium (NSC), a collaborative of ten colleges in nine states, was funded by a Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant from the U.S. Department of Labor to develop new workforce training programs in technical fields. For more information about NSC, visit the NSC website: http://www.nationalstem.org.

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