# 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
3. What Is a Robot?
4. Different Types of Robots
5. Demonstration of an Industrial and Agile Robot
6. Range of Industries Using Robots
7. Difference Between a Robot and a Remote-Controlled Vehicle
8. The Development of Robots
9. Advent of Computers
10. Definition of an Industrial Robot
11. Early Industrial Robots
12. The Unimate Robot
13. Robot Inventors
14. Do Robots Pose a Threat?
15. Lab Activity: Introduction to the Robotic Design Platform
16. Identifying Robotic Components in the Robotic Kit
17. Description of Each Part in the Robotic Kit

## Lesson 2: Robot Mechanicals I Date

1. Mechanical Chassis/Structure of a Robot
2. Overview of Different Systems in a Robot
3. Mechanical Chassis, Electrical System, Sensors, Microcontroller
4. Function of Chassis
5. Examples of Robot Chassis
6. Aluminum and Steel
7. Mechanical Hardware: Fasteners, Nuts, Bolts
8. Overview of Roller Bearings and Reducing Friction
9. Shafts, Collars, Spacers
10. Lab Activity: Building Your First Agile Robot

## Lesson 3: Robot Mechanicals II Date

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

## Lesson 4: Robot Motors Date

1. Robot Motors: DC, Servo and Stepper Motors
2. Introduction to Motors
3. How a DC Motor Works
4. Differences between DC, Servo, and Stepper Motors
5. Choosing a Motor/Motor Characteristics
6. Motor Parameters: Speed and Torque
7. How a Stepper Motor Works
8. Basics of Pulse Width Modulation
9. Lab Activity: Robot Design Project #1 - Completing DORA

## Lesson 5: Microcontrollers and Sensors Date

1. Microcontrollers
2. Introduction to Microcontrollers and Sensors
3. CPU, RAM, ROM, Interface
4. Purpose of Microcontrollers
5. RobotC Firmware
6. Digital and Analog Signals
7. Robot Sensors
8. Purpose of Sensors
9. Digital Sensors: Pushbutton, Limit-Switch
10. Ultrasonic Sensor
11. Optical Shaft Encoder
12. Analog Sensors: Potentiometer
13. Line-Following Sensor: LED/Photodiode
14. Lab Activity: Robot Design Project #2 - Autonomous Maze Robot
15. Project Overview
16. Downloading Firmware to the Microcontroller
17. Downloading Basic Code to the Microcontroller
18. Using Pushbutton Sensors

## Lesson 6: Robot Programming Date

1. Robotic Programming 1
2. RobotC Programming Basics
3. PseudoCode
4. Statements
5. RobotC rules
6. Compiling
7. Statement Order
8. Coding Punctuation Pairs
9. Control Structure
10. Adding Comments to Programs
11. Setting Up Motors and Sensors in RobotC
12. Motor and Wait Commands
13. Lab Activity: Robot Design Project #2 – Completing Autonomous Maze Robot

## Lesson 7: Robot Arm Programming I Date

1. Industrial Robot Arms
2. Definition of an Industrial Robotic Arm
3. Various Applications: Palletizing, Loading and Unloading, Welding, Spray Paint
4. Robot Anatomy: Joints, Links, Degrees of Freedom
5. Translational and Rotational Motion
6. Cartesian Robots and Applications
7. Jointed Arm and Scara Robots
8. End Effectors and Examples
9. Two-Finger, Three-Finger, and Vacuum Grippers
10. Overview of Programming an Industrial Robot.
11. Lab Activity: Robot Design Project #3 - Industrial Robotic Arm with Conveyor Belt
12. Building a Conveyor Belt Using Vex Parts
13. Detecting the Parts When They Reach the End of the Conveyor
14. Building the Robotic Arm First, Then Adding the Potentiometers
15. Measuring the Potentiometer Readings at Each Robot Position
16. 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
2. Defining a Line-Tracking Sensor
3. Reading Robot Sensor Values in Real Time
4. Using IF/ELSE Statements in RobotC
5. Creating a Programming Counter
6. How Ambient Light Affects the Sensor and What to Do About It
7. Lab Activity: Robot Design Project #4 – Line-Tracking Robot
8. Types of Robot Chassis Design
9. Calculating a Good Threshold Value to Use the Sensors.
10. Using an IF/ELSE Statement to Control the Robot.
11. Programming Issues Occurring with this Project

## Lesson 10: Line-Following Robot II Date

1. Functions and Variables
2. Purpose of Functions
3. Defining Variables
4. Using Variables in RobotC
5. Using Functions in RobotC
6. Creating a Programming Counter
7. Lab Activity: Robot Design Project #4 – Completing the Line-Tracking Robot

## Lesson 11: Industrial Robot Programming Date

1. Industrial Robot Programming
2. Parts of Industrial Robot: Arm, Controller, Teach Pendant, End-Effector
3. Applications for Industrial Robots
4. Operation of a Six-Axis Industrial Robot
5. Defining Offline Robot Programming
6. Lab Activity: Offline Robot Programming
7. Jogging a Robot
8. Setting the Robot Co-ordinate System
9. Creating Virtual Objects, such as End Effectors and Training Objects
10. Creating Targets or Robot Positions
11. Creating Paths Using Robot Targets
12. Generating the Robot Coding from the Robot Simulator
13. Simulating the Robotic Path
14. 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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