Syllabus for
ECE 450: Introduction to Robotics
Section 001, Call Number 11426
(Spring 2015 Semester)

Instructor: Carl G. Schaefer, Jr., adjunct professor.

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Office Hours: Immediately after class or by appointment.

Required Texts:

Suggested Readings:

Course Prerequisites: CS112, Introduction to Computer Programming
ECE280, Electric Circuit Analysis and Lab
ECE301, Digital Electronics

Class Meets: Tuesday, 4:30 pm – 7:10 pm, Room 3208, Nguyen Engineering Building

Course Web Site: All lectures, class handouts, labs, and announcements will be posted on GMU Backboard Learn.

Course Objectives: The specific objectives of the course include, but aren’t limited to, the following:
- To consider robotics as an embedded system and to explore, in detail, mobile robot navigation and control strategies;
- To learn the Linux operating system and to understand why it is the OS of choice for many types of embedded systems, including robotic systems;
- To understand the integration and control of analog and digital electronics to sophisticated single board computers like the BeagleBone Black;
- To provide a hands-on design experience involving the interaction of hardware and software including sensors and actuators and their drive circuitry and software

Grading:
- 40% Labs
- 20% Semester Project
- 20% Midterm Exam
- 20% Final Exam
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Week 1:
Part 1: Introduction to Mobile Robotics
Part 2: Introduction to Mobile Robotics (continued)
Lab: Setting Up Your BeagleBone Black; software and hardware (WiFi)

Week 2:
Part 1: Introduction to the BeagleBone Black Single Board Computer
Part 2: Introduction to Embedded Linux
Lab: Adafruit BBIO and PyBBIO Python GPIO Libraries

Week 3:
Part 1: Python Programming for Embedded Systems
Part 2: Using Python to Control BeagleBone Black GPIO
Lab: BeagleBone Black GPIO: Interfacing Sensors and Controlling Servos

Week 4:
Part 1: Power Systems; Power Sources and Power Regulation and Conditioning
Part 2: Robotic Platforms and Mechanics
Lab: Power Regulation Circuitry

Week 5:
Part 1: Motors and Drivetrains
Part 2: Motor Controllers
Lab: Motor Control and Simple Robot Navigation

Week 6:
Part 1: Sensors and Sensor Interfaces
Part 2: Phototaxis: Braitenberg Vehicles
Lab: Phototaxis Lab: Mothbot and Roachbot

Week 7:
Part 1: Midterm Exam and Semester Project Assignment
Part 2: Bang-Bang Control and Line Following
Lab: Line Following Robot

Week 8:
Part 1: Robot Localization and Navigation
Part 2: Navigation Using Dead Reckoning
Lab: Wheel Encoders and Dead Reckoning Navigation

Week 9:
Part 1: PID Closed-Loop Control
Part 2: PID Gain Tuning Using Ziegler-Nichols Approach
Lab: Wall Follower

Week 10:
Part 1: Behavior-based Control
Part 2: Goal-Directed Navigation Using Subsumption
Lab: Goal-Directed Navigation with Obstacle Avoidance

Week 11:
Part 1: The Global Positioning System (GPS)
Part 2: Mobile Robot Kinematics
Lab: Navigating a Maze Using Multiple Sensor Modalities

Week 12:
Part 1: Contemporary Topic: Introduction to Computer Vision
Part 2: Contemporary Topic: Introduction to Swarm Robotics
Lab: Putting it all Together – Follow the Leader

Week 13:
Part 1: Contemporary Topic: Introduction to the Mars Curiosity Rover
Part 2: Semester Project Demonstration

Week 14:
Part 1: Final Exam

Exam and Honor Code Policy: Make-up exams will only be given to students with excused absences. Make-up exams must be arranged in advance of the exam date. All exams will be closed book, closed notes. The GMU Honor Code will be strictly enforced.

General: The use of cellular phones or other personal communications devices while class is in progress, or during tests, will not be tolerated. If you must have them, please turn audible ringers off and take conversations outside of class. The class is asked to respect the rights of other students and the instructor and to avoid conversations during class.