COURSE: EECS 461. **TITLE:** Embedded Control Systems. **PREREQUISITES:** EECS 306 or 373 or Graduate standing. **ELECTIVE.**

TEXTBOOK: No single textbook. Uses D. E. Simon, *An Embedded Software Primer*, Addison-Wesley, 1999 for real-time operating systems.
COURSE MATERIALS: Handouts from various articles and textbooks. Lecture notes are available on-line at the EECS 461 course web site.

CATALOG DESCRIPTION: Basic interdisciplinary concepts needed to implement a microprocessor-based control system. Sensors & actuators. Quadrature decoding. Pulse width modulation. DC motors. Force feedback algorithms for human computer interaction. Real time operating systems. Networking. Use of MATLAB to model hybrid dynamical systems. Autocode generation for rapid prototyping. Lecture and laboratory.

COURSE OBJECTIVES:

1. To teach students how to use a microprocessor as a component of an embedded control system.
2. To teach students how to use prototyping tools to generate C code directly from a Simulink model.
3. To teach students how to develop an embedded control system using software, hardware, and haptic (force feedback) interfaces in a laboratory setting, while working in groups interacting over a network.

COURSE OUTCOMES [Program Outcomes Addressed]

1. Ability to design an embedded control system for a haptic (force feedback wheel) interface. [1,3,5,13]
2. Ability to take into account real-world effects such as networking delay and virtual artifacts. [1,5,13]
3. Ability to use Simulink and real-time operating systems, despite varying student backgrounds. [1,11]
4. Ability to use rapid prototyping software to generate C code directly from a Simulink model. [1,11]
5. Ability to work in groups, interacting over a network, to develop an adaptive cruise control system using hardware, software, and haptic interfaces in a laboratory setting (which is 4342 EECS) [1,3,4,5]

TOPICS COVERED

1. Systems theory (modeling) using Matlab and Simulink
2. Quadrature decoding
3. The MPC-555 microcontroller
4. Pulse-width modulation
5. Haptics & humans-in-the-loop
6. Feedback and logic control; finite-state machines; integration
7. Real-world operating systems
8. Networking: CAN vs. Ethernet
9. Autocode generation; prototyping

ASSESSMENT (Course outcomes)

1. 8 homework/lab assignments[1-4]
2. 1 midterm and 1 final exam[3]
3. Final (cruise control) project [2-5]

PROGRAM OUTCOMES ADDRESSED: 1,3,4,5,11
PROFESSIONAL COMPONENT ADDRESSED: 13
PREPARED BY: Andrew E. Yagle on May 10, 2005

CLASS/LABORATORY SCHEDULE:
LECTURES: 2 per week @ 90 minutes.
LABORATORY: 1 per week @ 3 hours.

COURSE DESCRIPTION: University of Michigan, College of Engineering, ELECTRICAL ENGINEERING PROGRAM