Course (Catalogue) Description:
Implementation of computer-based, embedded, control systems using MATLAB xPC Target toolbox. Small-scale, representative projects demonstrate theoretical issues and provide hands-on expertise.
Lecture, Lab. Technical Elective.
Prerequisite: EEE 203 and 230 (or CSE 230), or MAE 318 only
Supplemental Materials: Class notes and software distributed by the instructor.
Coordinator: K. Tsakalis
Course Objectives:
1. Students are familiar with the most common elements of computer control: sensors, sampling, control algorithms, actuators.
2. Students understand the basic problems in computer control of processes: principles of feedback and feedforward control, sampling, quantization, real-time operation.
3. Students are familiar with computer software to implement embedded control systems (e.g., MATLAB, Real Time Workshop, xPC Target).
Course Outcomes:
1. Students can discuss the principles of operation of common sensors and actuators, A/D-D/A converters.
2. Students can state and apply basic definitions in measurements.
3. Students can apply standard design techniques for common control algorithms (PID, feedforward).
4. Students can discuss and analyze issues related to controller discretization and signal/parameter quantization.
5. Students can use computer software to implement embedded controllers.
Course Topics:
1. Examples of computer controlled systems
   Open-loop (feed-forward) and closed-loop (feedback) control. Position control. Velocity control. Temperature control. Pressure control. Voltage, current, power control. Light intensity control
2. Instrumentation*
3. Real-Time and Discretization Issues
4. Software and Hardware Platforms
   MATLAB/SIMULINK and other high-level development environments. Embedded Controllers and stand-alone applications; xPC Target Toolbox, Auto-code generation.

5. Actuators*

6. Control Algorithms and Procedures

Computer Usage: Exercises and demonstrations using MATLAB/SIMULINK.

Laboratory Experiments:
1. Familiarization with basic hardware connections and procedures to create real-time executables.
2. RS-232 serial port asynchronous communication.
3. Target-Host communications and MATLAB programming.
5. Modeling and implementation of a virtual heat transfer experiment; PID control.
7. Modeling and implementation of a virtual water level control experiment.
8. Modeling and implementation of a virtual inverted pendulum experiment; more complicated controller design and communication requirements.

Assessment: Through homeworks, quizzes, tests, laboratory/project and final exam.
Distribution of Weights: Homeworks: up to 15%, Quizzes: up to 15%, Tests: up to 20%, Laboratory/projects: up to 25%, Final exam: up to 25%.

Course Contribution to Engineering Science and Design:
EEE 481 emphasizes engineering design by using open-ended exercises and hardware/software implementation of theoretically derived algorithms. Emphasis is placed on integrating various components. Since there are many possible solutions to such a problem, students are able to consider design tradeoffs and issues involved in practical implementation.

Course Relationship to Program Outcomes:
Relates to outcomes a,c,e,h,k:
The operation of basic sensor and actuators, analog-to-digital and digital-to-analog conversions, and common computer communication protocols and platforms, are reviewed to enable their usage in control system implementations. This provides a broad perspective on the applications of feedback systems (h). Students learn the advantages and limitations of various hardware and software components of control systems. They are using this knowledge to provide integrated control system solutions for virtual properties (c). Students obtain models for various processes and create virtual (computer simulated) experiments, for which they then design control systems (e). The translation of physical problems into an abstract but rigorous and quantitative mathematical framework enhances the understanding of the physical phenomena (a). The creation of virtual experiments also requires a deeper understanding of model limitations. Students are exposed to modern computational techniques for designing feedback and
feedforward control systems. They are also exposed to modern CAD tools (e.g., MATLAB, RTW, xPC-Target) that have been used extensively during the last decade in industry and academia for modeling and implementation of control systems (k).

Person preparing this description and date of preparation: K. Tsakalis, April 2009.