ME 37500
SYSTEMS, MEASUREMENTS AND CONTROL II

Course Outcomes  [Related ME Program Outcomes in brackets]
1. Reinforce system-level concepts introduced in semester I.  [A2, A3]
2. Provide necessary mathematical tools for analyzing and predicting the performance of an engineered system based on its dynamic response.  [A2, A3]
3. Provide an introductory treatment of designing feedback controllers to achieve closed-loop stability and specified system performance.  [A2, A3]
4. Provide hands-on experiences with take-home projects and in-lab experiments.  [A3, A4]
5. Sharpen technical communication skills.  [B3]

System Response (3 wks)
1. System Concepts including Feedback
2. Review of Standard Forms of Models
   - State Variable Model
   - Input/Output Model
3. System response (dominant 2nd order system models)
4. Impact of Poles and Zeros on Response
5. Stability (Routh-Hurwitz)
6. Steady-State Errors
7. Sensitivity

Controller Design Concepts (3 wks)
1. Design using Direct Pole Placement
   - Unconstrained systems
   - Constrained systems Integration
   - Pole zero cancellation
2. Root Locus
   - Root Locus sketching
3. Root Locus Design
   - PD, Lead, Lag, PI, PID

System Design (5 wks)
1. Common Sensors
2. Sensor Interfacing Techniques
3. Signal Conditioning
4. Logic Elements and FPGA Concepts
5. Distributed Control and Measurement Systems
6. Frequency and Time Delay

State Feedback Design (4 wks)
1. State-Space Modeling Review
2. State-Feedback Design
3. State-Feedback with Integration Design

Complementary Hands-on Home Projects and Laboratory Experiments
Project 1: System response modeling
Project 2: Pole placement design
Project 3: Sensor interfacing
Project 4: Signal conditioning
Project 5: Logic circuit design
Comprehensive design project

Laboratory 1: System response with additional poles and zero
Laboratory 2: Servo-table position control
Laboratory 3: Project hardware construction
Laboratory 4: Mass flow control
Laboratory 5: FPGA programming
Comprehensive design project
**COURSE NUMBER:** ME 37500  
**COURSE TITLE:** Systems, Measurements and Control II

**REQUIRED COURSE OR ELECTIVE COURSE:** Required  
**TERMS OFFERED:** Fall, Spring, Summer

**TEXTBOOK/REQUIRED MATERIAL:** Provided notes and on-line videos  
**PRE-REQUISITIES:**  
- ME 36500  Systems, Measurements and Control I  
- MA 30300 Differential Eqns and Partial Differential Eqns for Engineering and the Sciences

**COORDINATING FACULTY:** Galen B. King  
**REVISION DATE:** February 20, 2015

**COURSE DESCRIPTION:** This course continues modeling of electrical, mechanical, fluid, and thermal systems first introduced in ME 36500 (Systems, Measurements and Control I), with emphasis on sensors and actuators used in feedback control systems. Systems studied in this course require active controller design to achieve performance requirements. Closed-loop system analysis and design will include both classical and modern approaches. Topics associated with digital implementation of controllers will also be discussed. Hands-on projects and laboratories are utilized to reinforce fundamental measurement and control system concepts.

**ASSESSMENTS TOOLS:**  
1. Weekly homework assignments and hands-on home projects.  
2. Laboratory assignments.  
3. On-line quizzes for each lecture.  
4. Two 1-hour midterm exams.  
5. One comprehensive final exam.

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5. Sharpen technical communication skills. [B3]

**RELATED ME PROGRAM OUTCOMES:**  
- A2. Engineering fundamentals  
- A3. Analytical skills  
- A4. Experimental skills  
- B3. Communication

**PROFESSIONAL COMPONENT:**  
1. Engineering Topics:  
   - Engineering Science – 2.5 credits (83.3%)  
   - Engineering Design – 0.5 credits (16.7%)

**NATURE OF DESIGN CONTENT:** Many of the homework and home project assignments ask students to use analysis tools to assess the impact of different design parameters on overall performance of the system, then pick appropriate values for these parameters to achieve desired performance. In lab, the availability of several methods of achieving experimental goals, troubleshooting faulty equipment and the fact that any method employed will be in error due to assumptions and approximations when modeling system behavior, means that there is not a single correct answer to the problem and not a single correct way of solving it.

**COMPUTER USAGE:** Students are expected to use portable microcontroller boxes (such as the NI myRIO) for some of the homework assignments (home projects). LabVIEW programming is used in both Laboratory and Home Projects. Students use “ready-made” analysis modules in MATLAB and LABVIEW, in addition to writing their own special purpose programs (virtual instruments in LABVIEW) to simulate, acquire and analyze data. Programming assistance is provided in the Laboratory and on-line.

**COURSE STRUCTURE/SCHEDULE:**  
1. Lecture – 2 times per week and 3 times per week on alternate weeks, 50 min. each.  
2. Laboratory – on alternate weeks at 150 minutes.