ME 375
SYSTEMS, MEASUREMENTS and CONTROL II

Course Outcomes [Related ME Program Outcomes in brackets]

1. Reinforce system-level concepts introduced in semester I. [1, 2]
2. Provide necessary mathematical tools for analyzing and predicting the performance of an engineered system based on its dynamic response. [1, 2]
3. Provide an introductory treatment of designing feedback controllers to achieve closed-loop stability and specified system performance. [1, 2, 5, 7]
4. Provide hands-on experiences with take-home projects and in-lab experiments. [1, 2, 7]
5. Sharpen technical communication skills. [3, 5, 7]

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 zeros
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 375

COURSE TITLE: System, Measurements and Control II

REQUIRED COURSE OR ELECTIVE COURSE: Required

TERMS OFFERED: Fall, Spring and Summer

TEXTBOOK/REQUIRED MATERIAL:

Provided notes and online videos

PRE-REQUISITIES:

ME 365 Systems, Measurements and Control I

MA 303 Differential Eqns and Partial Differential Eqns for Engineering and the Sciences

COORDINATING FACULTY: G.B. King

COURSE DESCRIPTION: This course continues modeling of electrical, mechanical, fluid, and thermal systems first introduced in ME 365 (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.

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3. Provide an introductory treatment of designing feedback controllers to achieve closed-loop stability and specified system performance. [1, 2, 5, 7]
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ASSESSMENTS TOOLS:

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

NATURE OF DESIGN CONTENT: Many of the homework and home 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.

RELATED ME PROGRAM OUTCOMES:

1. Engineering fundamentals
2. Engineering design
3. Communication skills
4. Ethical/Prof. responsibilities
5. Teamwork skills
6. Experimental skills
7. Knowledge acquisition

PROFESSIONAL COMPONENT:

1. Engineering Topics: Engineering Science – 2.5 credits (83.3%)
   Engineering Design – 0.5 credit (16.7%)

COMPUTER USAGE: Students are expected to use portable microcontroller boxes (such as 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 online.

COURSE STRUCTURE/SCHEDULE:

Lecture – 2 times per week & 3 times per week on alternate weeks, 50 min. each.
Laboratory – on alternate weeks at 150 minutes.

PREPARED BY: G. B. King

REVISION DATE: February 06, 2019