ME 365
SYSTEMS, MEASUREMENTS AND CONTROL I

Course Outcomes [Related ME Program Outcomes in brackets]

1. Provide a *fundamental knowledge* of systems, measurements and control. [1, 2]
2. Provide an introduction to the concept of *feedback control*. [1, 2]
3. Gain knowledge of the practice and art of modeling, measurements and control through laboratory experiments. [1, 2, 4, 7]
4. Provide hands-on experiences with take-home projects and in-lab experiments [3, 5, 6]
5. Sharpen technical communication skills. [3, 5]

Static System Characteristics (1 wk)

1. Calibration
2. Digital-to-Analog Conversion
3. Sampling and Aliasing

Intro to Feedback Control Systems (1 wk)

1. Concept of feedback
2. Block diagrams

Dynamical System Characteristics (5 wks)

1. Laplace Transform – Solution of ODEs
2. Transient and Steady-state Response
3. Transfer Functions
4. Stability Concept
5. Frequency Response
6. Bode Plots
7. System Identification

Dynamic Modeling (4 wks)

1. Introduction to General Modeling Procedure
2. Standard Forms of Models
   - State variable model
   - Input/Output model
3. Mechanical Systems
   - Translational
   - Rotational
4. Electrical Systems
5. Electro-mechanical Systems
6. Hydraulic (Fluid) Systems
7. Thermal (Heat Transfer) Systems

Signal Analysis (3 wks)

Statistics and Error Analysis
1. Sample Statistics
2. Confidence Intervals
3. Propagation of Error
4. Linear Regression

Signal Analysis
1. Fourier Analysis
2. Spectrum Analysis

Signal Conditioning
1. Loading (Impedance Matching)
2. Modulation and Demodulation

Noise (1 wk)

1. Noise Spectra and Signal to Noise Ratio
2. Noise Sources
3. Noise Reduction

Complementary Hands-on Home Projects and Laboratory Experiments

Project 1: Digital signals
Project 2: Transfer functions
Project 3: First and second order systems
Project 4: Signal spectrum analysis

Laboratory 1: Practical lab skills
Laboratory 2: Balancing beam
Laboratory 3: System identification
Laboratory 4: Electromechanical system
Laboratory 5: Flow measurements
Laboratory 6: Noise reduction

COURSE NUMBER: ME 365 **COURSE TITLE:** Systems, Measurement, and Control I

REQUIRED COURSE OR ELECTIVE COURSE: Required

TERMS OFFERED: Fall, Spring, and Summer

TEXTBOOK/REQUIRED MATERIAL: Provided notes and online videos

PRE-REQUISITIES: ME 274 Basic Mechanics II
MA 262 Linear Algebra and Differential Equations
EE 201 Linear Circuit Analysis
EE 207 Electric Measurement Techniques

COORDINATING FACULTY: G. B. King

COURSE DESCRIPTION: The fundamentals of dynamic systems are reviewed, including modeling of mechanical, electrical, fluid, and thermal systems containing elements such as sensors and actuators used in feedback control systems. Analytical and experimental techniques of general importance in systems engineering are presented. Engineering measurement fundamentals, including digital and frequency domain techniques, noise, and error analysis are covered. Simple proportional controllers are used to convey the benefits of feedback control. Hands-on projects and laboratories are utilized to reinforce fundamental measurement and control system concepts.

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2. Provide an introduction to the concept of *feedback control*. [1, 2]
3. Gain knowledge of the practice and art of modeling, measurements and control through laboratory experiments. [1, 2, 4, 7]
4. Provide hands-on experiences with take-home projects and in-lab experiments [3, 5, 6]
5. Sharpen technical communication skills. [3, 5]

ASSESSMENTS TOOLS:

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

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 no single *correct* answer to the problem and not a single *correct* way of doing 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 credits (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 Laboratory and online.

COURSE STRUCTURE/SCHEDULE:

Lecture - 2 days per week and 3 times per week on alternative weeks, 50 minutes each.
Laboratory – Alternative weeks at 150 minutes.

PREPARED BY: G.B. King **REVISION DATE:** February 06, 2019