Official Syllabus for January 11, 2016
MAE 3340, Instrumentation and Measurements
Required Course in MAE Professional Curriculum

Course Description:

Course presents an introduction to instrumentation and measurement systems. Material covers generalized measurement systems, references and standards, basic electronics, sensing elements and transducers, basic error theory, statistical analysis of data, response of measurement systems, introduction to signals and sampling, frequency response, data acquisition and signal conditioning, applied mechanical measurements. 3 credits, Spring Semester.

Prerequisites: ENGR 2140, ENGR 2210, MAE 3420

Course Materials:

Main Textbook:

1. *Mechanical Measurements, 6th ed*., Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard, V, Prentice Hall, 2006, Inc., 2007, ISBN: 0-201-84765-5

References:

1. *"Theory and Design for Mechanical Measurements,"* Figliola, Richard, and Beasley Donald E., Wiley, 2011, ISBN: ISBN 978-0-470-54741-0, *Also available as e-book:* ISBN: 978-0-470-91208-9
2. *Companion Student Resource Website from Wiley:* http://www.wiley.com/WileyCDA/WileyTitle/productCd-EHEP001804,descCd-STUDENT.html
3. *Labview Programming Guide,* "*LabVIEW For Everyone: Graphical Programming Made Easy and Fun*," Travis, Jeffrey, and Kring, James, Prentice-Hall, ISBN-10: 0131856723, 2007.
4. *National Instruments Student Resources*
    a. *"NI Measurements Laboratory*," *http://www.ni.com/academic/measurements_curriculum.htm*
    b. *"myDAQ User Guide and Specifications," www.ni.com/pdf/manuals/373060e.pdf*
    c. *"myDaq Zone," user's community web site*, *https://decibel.ni.com/content/groups/mydaq*
    d. *"NI Student Community," https://decibel.ni.com/content/groups/loop*

Course Objectives:

Provide mechanical engineering graduates with sufficient skill to design experiments, assembly measurement apparatus, acquire and process data, and evaluate accuracy of experimental results. At the completion of this course students will have the ability to

1. Acquire the common mechanical measurement signals in the laboratory using computer based data acquisition systems,
2. Design measurement systems including transducer and sensing element selection, signal conditioning, sampling, and data logging,

3. Understand the characteristics of measurement signals; effects of data sampling, Nyquist frequency, aliasing, bandwidth, frequency resolution,
   Understand the response of measurement systems and instruments, frequency response analysis, Fourier analysis, spectral decomposition using fast Fourier transform (FFT),
4. Analyze and classify measurement data using the basic theory of error, probability theory and statistics. Apply sample mean, variance, normal and student-T probability distributions to assess measurement error, predict confidence intervals.
5. Perform basic curve fitting of measurement data, and assess goodness of fit using Chi-square analysis.

Topics Covered:

1. *Introductory materials*
   - History of measurements and measurement standards
   - Basic concepts, types of measurement methods
   - Introduction to Labview software,
2. *Basic Resistive Analog Measurements Devices*
   - Electrical circuit and electronics review
   - Strain gauges
   - Wheatstone bridge
   - Thevenin analysis and bridge balancing
   - Bridge loading and impedance effects
3. *Theory of Error and Measurement Classification*
   - Static error propagation and uncertainty analysis
   - Probability models of random effects in data
   - Statistical analysis of random effects in data
   - Normal and Student-t distribution, confidence intervals
   - Sensor calibration, curve-fits and error models
4. *Applications of Mechanical Measurements*
   - Pressure measurements
   - Temperature measurement
   - Strain and acceleration measurements
5. *Dynamic Characterization of Measurement Systems and Signals*
   - Time response of sensors and the effects on data, 1st, 2nd-order systems
   - Sampling of time-varying signals, analog to digital signal conversion
   - Sampling effects including resolution, Nyquist frequency, bandwidth, and aliasing
   - Vibration measurements
6. *Introduction to Advanced Analog Measurement Concepts and Digital Devices*
   - Operational Amplifiers and active signal conditioning, including filtering
   - Integrated circuits, TTL, CMOS, CCD, sinking and sourcing devices
   - Serial communication, RS-232, 422, 485, USB
   - Programmable Logic Circuits (PLCs)

Class Schedule: 2 Days per Week, 2.5 Hours Lecture, 2 Hours Lab

Course Assessment Measures:

Exams will cover material presented in class, in the laboratory, plus material in the text covered by the assigned reading. Regular laboratory reports will be turned in at the start of the following laboratory period. Reports may include homework exercises. Grades assigned based on a relative comparison of total student scores. Each lab section will complete a final project with a written report and oral briefing. Each student will be peer-evaluated by other members of the laboratory section

1. Homework (10%)
2. Laboratories (30%)
3. Midterm Exam (30%)
4. Final Project (30%)
    - *a. Written Report (10%)*
    - *b. Oral Presentation (10%)*
    - *c. Peer Evaluations (10%)*

Contribution of course to meeting the requirements in ABET Criterion 5:

Mathematics and Basic Sciences: 0 credit hour(s).
Engineering Sciences and Design: 3 credit hour(s).
General Education Component: 0 credit hour(s).

Professional Component Content			
Math & Basic Sciences	Engineering Topics	General Education	Engineering Design
	✓		✓

Relationship of course to program outcomes:

	Student Outcomes	**Course * Outcomes**
a)	an ability to apply knowledge of mathematics, science, and engineering,	✓
b)	an ability to design and conduct experiments, as well as to analyze and interpret data,	✓
c)	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	
d)	an ability to function on multi-disciplinary teams,	
e)	an ability to identify, formulate, and solve engineering problems,	✓
f)	an understanding of professional and ethical responsibility	
g)	an ability to communicate effectively	✓
h)	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	
i)	a recognition of the need for, and an ability to engage in life-long learning	✓
j)	a knowledge of contemporary issues,	
k)	an ability to use the techniques, skills, and modern engineering tools	✓

	necessary for engineering practice	
l)	an ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems.	✓
*An ✓ indicates that this course helps the students to achieve the Program Outcomes.		

Course Coordinator: Stephen A. Whitmore

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