ENG ME 310 Instrumentation and Theory of Experiments

2008 - 2009 Catalog Data:
ENG ME 310 Instrumentation and Theory of Experiments Prereq: ENG ME 303 and ENG EK 307. Designing, assembling, and operating experiments involving mechanical measurements; analyzing experimental data. Safety considerations in the laboratory. Wind tunnel testing. Mechanical and electrical transducers for flow, pressure, temperature, velocity, strain, and force. Electric circuits for static and dynamic analog signal conditioning. Computer use for digital data acquisition and analysis; instrument control. Professional standards for documenting experiments and preparing reports, including formal uncertainty analysis involving elementary statistics. Interpretation of experimental results. Includes lab and design project. 4 cr.

Class/Lab Schedule: 4 lecture hours per week, 8 – 4 hour labs per semester + project labs

Status in the Curriculum: Required

Textbook(s) and/or Other Required Material:
R.S. Figliola and D.E. Beasley, Theory and Design for Mechanical Measurements, 4th ed., Wiley, 2006.
J.R. Taylor, An Introduction to Error Analysis, 2nd ed. University Science Books, 1997.

Coordinator: R. Glynn Holt, Associate Professor, Mechanical Engineering

Prerequisites by Topic:
1. Basic calculus and differential equations.
2. Free vibration of a spring-mass system,
3. Basic fluid mechanics.
4. Basic circuit theory (both DC and AC).

Goals:
This course has four main goals:
1. To teach basic techniques for designing experiments and analyzing data
2. To introduce the operating principles and uses of transducers, output devices and signal conditioning elements of measurement systems
3. To introduce the concepts of signals and systems and their interaction in both static and dynamic measurements
4. To provide hands-on experience in professionally conducting experiments in a modern, real laboratory setting with emphasis on safety, documentation, computer use and uncertainty analysis. The uncertainty analysis reflects standardized practice and usage documented in ISO/IEC Guide 98-3:2008, providing an introduction to professional codes and standards and elementary probability and statistics.

Course Learning Outcomes:
As an outcome of completing this course, students will:

i. Become proficient in designing and implementing experimental solutions to engineering problems, including static and dynamic mechanical, electrical and thermal measurements, and understanding the tradeoffs between cost, performance and complexity of measurement schemes. (B, C, E, K, L)

ii. Become proficient in analysis of uncertainty of experimental results, including the identification of sources and types of uncertainty, combination and propagation of uncertainties, and application of appropriate statistical models for precision uncertainty of finite samples. (E, K, L)
iii. Become proficient in reporting and documentation of experimental work through use of standardized lab reporting policies and requirements. (D, G, K)
iv. Gain experience in the operating principles and uses of transducers, output devices, and signal conditioning elements of measurement systems for flow , pressure, temperature, velocity, strain, and force. (B, K)
v. Gain experience with the concepts of signals and systems and their interaction in both static and dynamic measurements, including mathematical modeling of such systems' static and time-dependent behavior. (A, B, E, K, N)
vi. Gain experience and confidence in self-instruction on the use of data acquisition software and hardware systems, including standard multifunction analog-digital conversion boards, and LabVIEW or other GUI interface data acquisition control software. (B, I, K)
vii. Gain experience in efficient organization and teaming by performing labs and projects in both self- organized and instructor-organized groups. (D, G)
viii. Gain experience in oral presentation of experimental design, apparatus, and results. (G)

Course Learning Outcomes mapped to Program Outcomes:
(For Program Outcomes, please see attached page or Department Web Site)

Program:	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Course:	v	i, iv, vi	i	iii, iv	i, ii, v	ii, iii	ii, vii, viii	-	vi	i	i, iv, v, vi	i, ii	-	v
Emphasis:	4	5	3	4	4	2	4	1	3	3	5	5	1	2

Topics (time spent in weeks):
1. Introduction and definitions related to static measurements and calibration (1)
2. Errors, uncertainty, probability, statistics and uncertainty analysis (3.5)
3. Data analysis and presentation: treatment of outliers, graphing, curve fitting, linear regression (1.5)
4. Generalized measurement system and static (0th-order) systems. (2.5)
5. Transducer fundamentals (1)
6. Dynamic measurements: First and second order system responses, complex signals and distortion (2 .5)
7. Digital data acquisition. (0.5)
8. LC filters, RC filters. (0.5)
9. Exams. (1)

Contribution of Course to Meeting the Professional Component:
Engineering Topics: 100%

Status of Continuous Improvement Review of this Course:
Date: May 12, 2009 **Reviewed by:** Laboratory Committee
Prepared by: R. Glynn Holt **Date:** February 13, 2009