MAE 170 (4 units)
Experimental Techniques (4)

Class/Laboratory Schedule: Two hours lecture, three hours lab, seven hours outside preparation. 12 hours/week total

Course Coordinator(s): Farhat Beg

Textbook, Recommended Materials: Introduction to Experimental Techniques by Wheeler and Ganji

Catalog Description: Principles and practice of measurement, control and the design and conduct of experiments. Technical report writing. Lectures relate to dimensional analysis, error analysis, signal to noise problems, filtering data acquisition and data reduction, as well as background of experiments and statistical analysis. Experiments relate to the use of electronic devices and sensors.

Prerequisites: Admission to an engineering major and a grade of C- or better in Physics 2CL. Recommended: MAE 140 or ECESS

- ■ Required Course
- □ Technical Elective Course
- □ Other: _____

Performance Criteria:

Objective 1

1.1 There is a series of questions in each lab that test whether the student succeeded in properly performing the lab. An in-class lab practical given at the end of the quarter, further tests the hand-on laboratory skills the students are expected to master

Objective 2

2.1 There is a series of questions in each lab that test whether the student understands the fundamental physical principles involved in each experiment. The written final also contains questions concerning the underlying physics when appropriate

Objective 3

3.1 There are weekly LabView assignments during the course and a LabView program to write as part of the in-class lab practical.

Objective 4

4.1 The students must prepare a laboratory report for each experiment.

Objective 5

5.1 Continuous assessment by interacting with students and monitoring their lab notebooks. This task is performed by teaching assistants.

B.4.4.2.3 Laboratory Experience

In MAE 170 Experimental Techniques during the junior year, all engineering students learn fundamental measurement techniques in electronics, mechanics, fluid flow, and heat transfer. The use of computers in data acquisition, including LabView software, is presented.

B.4.4.2.5 Oral and Written Communication

Course Objectives:
(Numbers in parentheses refer to the specific MAE Program Outcomes)

Objective 1: To introduce students to the "art" of scientific measurements, data and error analysis (1a, 2b).

Objective 2: To revisit some of the basic physics concepts associated with heat transfer, oscillating springs, strain, and diffraction (1a,2b).

Objective 3: To familiarize students with LabView (data acquisition/analysis software) (2b,11k).

Objective 4: To learn to write a technical laboratory report (7g).

Course Topics:

Lab 1: Intro to Instrumentation and LabView

Familiarize student with operating oscilloscope (determine frequency, peak to peak voltage, rms voltage, triggering, etc), function generator, digital multimeter, LabView (calculator.vi), Ohm's Law, Kirchoff's Laws, error analysis

Lab 2: A/D Conversion and Sampling Rates

Determine resolution of the A/D board, importance of sampling rate, aliasing, FFT, Excel, LabView (resolution.vi)

Lab 3: Filters and resonant circuits

Voltage dividers, low pass and high pass filters, and LC (resonant) circuits, LabView (dB.vi)

Lab 4: Operational Amplifier and Wheatstone Bridge Circuits

Build/analyze inverting and non-inverting operational amplifier circuits (LM 741 in lab) and Wheatstone bridge, LabView

Lab 5: Temperature Measurements and Heat Transfer Coefficients

Calibrate thermocouple (two different cold junctions) and thermistor,introduction to least squares fit, correlation coefficient, LabView (Signalfft.vi),determine Biot numbers and heat transfer coefficient of aluminum and brass spheres in forced and free convection flows, introduction to dimensional numbers (Biot, Nu, Re, Pr), Newton's Law of Cooling, LabView (Lissajous.vi).

Lab 6: Measurements of Pressure and Acceleration

Calibrate pressure and accelerometer transducers. Determine spring constant using static and dynamic methods.

Lab 7: Measurement of Strain

Using strain gauges mounted a cantilever beam to determine: spring constant, Young's modulus, Poisson's ratio, strain and Gauge Factor.

Lab 8: Feedback control of servo motor

Using basic concepts of position and velocity measurement and application of a proportional and derivative control.

Prepared by: Nathan Delson, April 2000
Revised: June 2006
Reviewed TWG: June 2010; July 2010
Reviewed: TWG, August 2012