MAE 170
Experimental Techniques

Designation: Required course

Catalog Data:
MAE 170 Experimental Techniques (4)

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 Phys. 2CL.

Prerequisites by Topic: Linear circuit theory and lab course using oscilloscopes, simple circuits (e.g. LCR resonating circuit).

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

Class/Laboratory Schedule: 2 lecture hours and 3 laboratory hours per week (with 11 sections per week)

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: Measurement of storage capacity on CD & DVD using laser diffraction
Using basic concept of diffraction to calculate storage capacity on a compact disc and DVD with a green and red laser.

Course Objectives:
(Numbers in parenthesis refer to 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, ME13).

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

Methods of Evaluation:

1. Lab reports
2. Quizzes
3. Midterm
4. Continuous assessment (by TAs)
5. Lab final
6. Final

Performance Criteria:
(Numbers in parentheses refer to the methods of evaluation used to assess student performance.)

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 (1, 2, 3)

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 (1, 3).

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 (1, 2, 3).

Objective 4
4.1 The students must prepare a laboratory report for each experiment (1).

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

Program Outcome 7g (communication) is addressed throughout the curriculum. The laboratory courses (MAE 170, MAE 171A) address written communication skills through required labs, presentations and reports. In these cases, the emphasis is not only on content and style but also on clarity through focus on organization and coherence. In the design courses (MAE 3 and MAE 155A,B), the students learn how to develop a web page covering their design project. In MAE 155B, students use graphic tools (e.g. AutoCAD, 3D Biz, MathCAD, Power Point, Star Office) for the visual presentation of their design products.

Contribution of Course to Professional Component:
Engineering Science

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