ME 341 – EXPERIMENTAL METHODS IN MECHANICAL ENGINEERING

Designation as a 'Required' or 'Elective' course
TYPE OF COURSE: Required for BSME Major

Course (catalog) description
COURSE DESCRIPTION: ME 341 Experimental Methods in Mechanical Engineering, 3 Hours. Introduction to the theory and practice of experimental methods, measurement techniques, instrumentation, data acquisition and data analysis in mechanical and thermal-fluid systems. Experiments and reports.

Prerequisite(s)
PREREQUISITE(S): CEMM 203 Strength of Materials (3 Hours) and ME 211 Fluid Mechanics (3 Hours)

Textbook(s) and/or other required material
SAMPLE SOURCES AND RESOURCE MATERIALS:

Course objectives
COURSE OBJECTIVES:
This course introduces the students to the measurement concepts including the design of a complete measurement system as well as individual measurement system components such as different types of sensor, data acquisition and signal conditioning, data presentation and analysis. Students learn to design a measurement system, plan experiment, conduct experiments, and analyze the results using different sensors and applications. Students conduct twelve experiments during the semester and write a pre-lab report before each lab, and a lab report after each lab.

Topics covered
MAJOR TOPICS: Hrs
Week 1 Introduction to Measurement Systems, Lab Overview. 5
Week 2 Characteristics of Measurement Systems + Experiment 1 5
Week 3 Experimental Uncertainty Analysis + Experiment 2 5
Week 4 Experimental Uncertainty Analysis + Experiment 3 5
Week 5 Statistical Analysis of Experimental Data + Experiment 4 5
Week 6 Statistical Analysis of Experimental Data + Experiment 5 5
Week 7 Dynamic Behavior of Measurement Systems + Experiment 6 + Midterm 1 5
Week 8 Measurement Systems with Electrical Signals + Experiment 7 5
Week 9 Computerized Data Acquisition Systems + Experiment 8 5
Week 10 Discrete Sampling and Analysis of Time Varying Signals + Experiment 9 + Midterm 2 5
Week 11 Measurement of Solid-mechanical Quantities: Strain, Displacement, Velocity, Acceleration, + Experiment 10 5
Week 12 Measurement of Solid-mechanical Quantities: Force and Torque + Experiment 11 5
Week 13 Measurement of Pressure, Temperature and Humidity + Experiment 12 5
Week 14 Measurement of Fluid Flow, Fluid Velocity, Fluid Level 5
Week 15 Special Topics: Non Destructive Testing, NIST Standards, Review of Course Material 5

Total 75

Class/laboratory schedule, i.e., number of sessions each week and duration of each session
CREDIT HOURS: 3 Hours
TYPE OF INSTRUCTION:
<table>
<thead>
<tr>
<th>Type of Instruction</th>
<th>Contact Hours/Week</th>
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<tbody>
<tr>
<td>Lecture-Discussion</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory</td>
<td>3</td>
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Contribution of course to meeting the professional component
This course teaches and provides hands-on laboratory experience for designing and using measurement systems. The students learn to use various sensor types in mechanical vibration, motion and thermal-fluid systems. They learn about the sensor calibration and measurement accuracy and its implication in industry in terms of production, monitoring and quality control. They also learn about the importance of sensor and measurement system reliability and its implication to manufacturing environment safety.

Relationship of course to program outcomes
As shown in the BSME Course Outcomes Matrix:

a. Ability to apply knowledge of mathematics, science and engineering
b. Design and conduct experiments, as well as analyze and interpret data.
d. Function on multi-disciplinary teams
g. Communicate effectively
h. Broad education necessary to understand the impact of engineering solutions in a global and societal context
k. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Person(s) who prepared this description and date of preparation
Carmen M. Lilley, Assistant Professor of Mechanical Engineering, January 18, 2008
Revised by Soyoung S. Cha, Professor of Mechanical Engineering, August 20, 2008

Comments on outcomes
a. In the lecture portion of the class, students learn the theory behind various sensors and measurement systems such as the use of Wheatstone bridge circuit in many different sensors as a way to convert variation in resistance or capacitance into a proportional voltage output from the sensor, sampling theorem and its implications to the computer data acquisition sampling rate, measurement impedance matching, sensor transient and steady state characteristics.
b. The strongest contribution of this course is in this area—design and conduct experiments. Students conduct twelve experiments. They do not change the design of the experiments, but they plan the specific data and conditions to conduct the experiments. About half of the labs are related to the vibration, signal processing, frequency spectrum analysis of signals. The other half are related to the thermo-fluid systems involving pressure, temperature, and flow measurements.
d. Each lab is performed by a group of five to six students. ME and IE students are mixed into different groups in order to encourage multi-disciplinary team experience. Each week, a different student acts as the team leader.
g. Since the students have to work as part of a team and write a formal lab report every week, explaining the purpose, setup and scope of the experiments, expectations, the procedure of conducting experiment, collected data and interpretation and presentation of the data, students gain significant experience in improving their verbal and written communication skills. Weekly lab reports vary in length from 10 to 20 pages. someone buys a product, he/she expects it to meet the specified dimensions or performance.
k. Writing laboratory reports necessitates the use of a word processor, a graphics program for illustrations, and data plotting program for data analysis and presentation. Students use spreadsheet programs for plotting and data analysis. They also learn computer data acquisition software similar to the LabView package.

These outcomes are what students are expected to gain from this course.