Engineering Technology –MET Option

Course Number and Name: ET 422, Mechanical Measurements

Credits & Contact Hours: 3cr., two weekly lectures of 50 min. each, and one weekly 2.5-hour laboratory session. Total semester contact hours are approximately 55.

Instructor's name: Paul Ricketts
Textbook *title,* author, and year: *Mechanical Measurements*, Beckwith, T. G.; Maragoni, R . D.; and Lienhard, J. H., 2004.
Supplemental materials: *Instrument Engineers Handbook – Process Measurement and Analysis*, Lipták, B. G, Ed., 2009 and *Measurement Fundamentals*, http://zone.ni.com/devzone/cda/tut/p/id/4523.

Specific Course Information:

a. **Course Catalog Description -**
Techniques in mechanical measurements, including topics in experimental techniques, measurement devices and systems, data acquisition, data transmission, signal conditioning, data analysis, data verification, and report writing.

b. **Prerequisite** – Senior standing in ET.

c. **Laboratory** – See information below.

d. **Augmenting** – This is a required course in the MET curriculum.

Course Goals and Objectives:

Student understands the physical concepts and basic principles of mechanical measurements and instrumentation. The student becomes knowledgeable in applying relevant problem-solving tools and techniques of good practice. Student also becomes more familiar with laboratory procedures and the processing, evaluation, and professional presentation of experimental data. Through all of the above, the student gains experience in application of the fundamentals that underlie the design, testing, and performance evaluation of mechanical measurement and instrumentation systems.

Related ABET Outcomes:

The **following** are the MET (x.) and ABET student outcomes that directly relate to Criterion 3. *An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline;* to include:

(1.) **Algebra**, trigonometry, **Boolean mathematics**, **calculus**, **statistics** and **probability**, **fundamental principles and concepts of science and engineering technology**, **good practice in problem solving**, and **methods of standard practice in the analysis** and applied design **of mechanical systems**.
Also ABET 3.a., 3.b., 3.c., 3.d., 3.e., 3.f., and 3.k.

(2) **Fundamental aspects** of **AC and DC circuits**, **electrical components**, computer programming logic, **instrumentation principles**, **experimental techniques**, and **methods of standard practice, safety consciousness**, **critical thinking skills** and **codes and standards** in the **testing** and **evaluation** of **mechanical systems**.
Also ABET 3.a., 3.b., 3.c., 3.d., 3.e., 3.f., and 3.k.

(4.) **Current software corresponding to good practice in the application of mechanical engineering technologies. Software application functions to include:** word processing, **spreadsheet calculations**, **graphing**, presentation media, computer assisted drafting and manufacturing, manufacturing processes, **statistics**, **data acquisition**, project management, and **the analysis** and **applied design of systems involving mechanisms, machines**, or **fluid and thermal processes**.

Also ABET 3.a., 3.b., 3.c., 3.d., 3.e., 3.f., and 3.k.

Course topics and class hours devoted to each topic:

Topics	**Class Hours**
· Course overview, the process and standards of measurement	1
· Evaluation and presentation of experimental data	2
· Measurement system response	2
· Sensors for measurement of physical variables	2
· Signal conditioning	2
· Digital techniques in mechanical measurements	1
· Readout and data processing	1
· Measurement of counts, events, and time	1
· Measurement of displacement	1
· Strain measurement and stress analysis	2
· Measurement of force and torque	2
· Measurement of pressure	1
· Measurement of fluid flow	2
· Measurement of temperature	2
· Measurement of acoustic parameters	1
· Data acquisition and signal processing	2
· Examinations	3
· Topic Reviews	2

Laboratory topics and lab session hours devoted to each topic:

Topics	**Lab Hours**
· Introduction: laboratory overview, relevance, and significance	1
· Safety in laboratory practice	1
· Professional ethics: a contemporary case study	1
· Use of codes and standards in practice	1
· Good practice in the graphing of experimental data for technical reports	1
· Terminology of statistical concepts; review of	1
· Application of sample statistics in the evaluation of experimental data	1
· Application of error analysis in the planning of an experiment	1
· Instrument characteristics; review of	1
· Concept of the generalized measurement system in practice	1
· Data acquisition using a microcomputer	2
· Topics specific to assigned pre-lab and lab exercises for particular semester (see *Laboratory Exercises* below)	16
· Exposure to industrial measurement and control systems in practice; via a field trip to a local food processing plant, a large-scale commercial building, or on-campus solar furnace.	2

Laboratory Exercises: typical topics for five cycles, each of two consecutive lab periods (prelab exercise and laboratory report required):

Ductile-to brittle transition in a mild-carbon steel
(with *Charpy* impact testing machine, heating and cooling apparatus and procedures for test specimens, and stringent safety constraints).

Pressure sensor calibration
(with Bourdon tube pressure gauge and dead weight tester).

Calibration of a *Wheatstone* bridge
(with Wheastone bridge, digital multi-meter, and LabView data acquisition system).

Performance evaluation of a vapor compression refrigeration system
(with refrigerator, thermocouple sensors, pressure transducers, and LabView data acquisition system).

Performance evaluation of a solar collector
(with solar collector, thermocouple sensors, air velocity sensor, and graphing-calculator based data acquisition system).

Airfoil test and performance evaluation
(with lab-scale wind tunnel, lift and drag sensors, air velocity sensor, barometer, and microcomputer- based data acquisition system).

Failure theories for ductile materials
(with rosette strain gages and data acquisition via digital strain indicator).

Beam flexure and deflection analysis
(with rosette strain gages and data acquisition via digital strain indicator).

Programming of a digital control unit for data collection and control
(with digital control unit, graphing-calculator- or and microcomputer-based data acquisition system).

Measurement of the viscosity of a Newtonian fluid using a rotating drum viscometer
(with rotating drum viscometer, torque meter, and LabView data acquisition system).

Evaluation of whirl for a rotating shaft with disk
(with rotor kit, proximity sensors, oscilloscope, handheld vibration meter, and LabView data acquisition system).

Measurement of the piston acceleration of a slider crank
(with slider crank assembly, accelerometer, oscilloscope, handheld vibration meter, and LabView data acquisition system).

Other Typical Lab Assignments and Topics (1 lab period each):

Discussion of laboratory safety and requirements for pre-lab exercises and lab reports.

An exercise in professional ethics toward further development of professional ethics in the workplace (via a contemporary case study). Concept worksheet required.

Exercise in the good practice of graphing experimental data (with microcomputer and graphing software package). Table of data and professional-quality graph required. Concept worksheet required.

Computer lab exercise on data acquisition using microcomputer-based software application, *LabView*.

Demonstration of the effect of a low-pass, active filter on the output of a pressure transducer. (with variable reluctance pressure transducer, carrier demodulators, and LabView data acquisition system).

Demonstration of the effect of an active filter on the output of a thermocouple. (with variable reluctance pressure transducer, carrier demodulators, and LabView data acquisition system).

Analysis of the fundamental principles of operation of an oscillograph chart recorder. Concept worksheet required.

Field trip to local plan, large office building, or on-campus solar furnace. Concept worksheet required.

Oral and Written Communication Requirements:

Students engage in discussions (led by instructor) during pre-lab and lab exercise sessions to share insights and recommended techniques and procedures for relevant lab exercise. All lab exercises require a laboratory exercise documentation sheet and a memorandum report.

Prepared by: Craig Ricketts, Coordinator **Date**: 12/30/10