SAN JOSÉ STATE UNIVERSITY
Department of Mechanical and Aerospace Engineering

ME 120 Experimental Methods — Fall 2006

Instructor: Dr. Buff Furman Office: E310G Phone: 408-924-3817
Email: bjfurman@sjsu.edu FAX: 408-924-3995

Office Hours: M 11:30 – noon, Tu 13:30 – 15:00, W 9:00 – 10:30, Th 14:30 – 15:00, Fri 17:30 – 18:00, or by appointment.

Prerequisites: E 100W; C- or better in ME 111, 130, and CE 112

Class Codes/Hours:

SEM:	Sec. 07	49424	W	08:00 – 08:50	room E341
LAB:	Sec. 02	41736	Tu	13:30 – 16:20	room E133
LAB:	Sec. 03	44852	Th	08:30 – 11:15	room E133
LAB:	Sec. 04	44853	F	08:30 – 11:15	room E133
LAB:	Sec. 05	46384	M	17:30 – 20:30	room E133
LAB:	Sec. 06	46385	Tu	17:30 – 20:30	room E133

Final Exam: **Friday, December 15, 2006 07:15 - 09:30, room E341**

Course Description
Introduction to experimental methods, sensors, and computer-aided data acquisition with emphasis on mechanical and aerospace engineering applications. Statistical methods for the analysis of data from experiments. Survey of transducers and measurement methods for a broad range of phenomena significant for mechanical and aerospace engineers. Particular emphasis will be given to oral and written communication of experimental results. Laboratories experiments will give students hands-on experience with instrumentation and modern computer-aided data acquisition methods.

Text (required): *Experimental Methods for Engineers*, Custom Ed. by Pearson Custom Publishing, Boston, MA, 2004, ISBN 0536215405. (Note: this is a custom published bundle of three items: Introduction to Engineering Experimentation, 2nd ed. by Wheeler and Ganji ($99 in hardcover); Chapters 1-3 and Appendix A of Engineering Problem Solving with Matlab, by Etter ($70 for 3rd ed.); and LabVIEW 8 Student Edition (with full Lab View 8 software), by Bishop ($84).

Homework: Homework will generally be assigned every week, and will be due one week later unless otherwise indicated. Late homework will generally not be accepted, unless prior arrangements have been made for extraordinary circumstances.

Examinations: Regular quizzes and one 135-minute final examination. (Note: quizzes may be given unannounced, so the student is *strongly* advised to be in attendance and be prepared). Quizzes may be in class or via WebCT.

Lab Reports: Laboratory reports are very important in this class. They must be well done and conform to good engineering report practice. (See the ME 120 Lab Manual for details).

Oral Presentations: Each laboratory team will give at least one oral presentation describing an experiment and its results

Term Project: Students will devise and carry out an open-ended experiment as a term project.

Grading (weighting):

Homework:	15%
Oral Presentations:	10%
Lab Reports:	20%
Quizzes:	15%
Term Project	20%
Final Exam:	20%

Grades (overall):

Overall percentage	Grade
100 – 93%	A
92 – 90%	A-
89 – 87%	B+
86 – 83%	B
82 – 80%	B-
79 – 77%	C+
76 – 72%	C
71 – 69%	C-
68 – 66%	D+
65 – 62%	D
61 – 59%	D-
<58%	F

Academic Integrity

Students in this course are expected to maintain high ethical standards in *all* matters pertaining to the course, including, but not limited to, examinations, homework, course assignments, presentations, writing, laboratory work, team work, treatment of class members, and behavior in class. Cheating and plagiarism are violations of the SJSU Policy on Academic Integrity (S04-12) and will not be tolerated in the class. Students are expected to have read the Policy, which is available at:

http://www2.sjsu.edu/senate/S04-12.pdf

Plagiarism is defined as, *the use of another person's original (not common-knowledge) work without acknowledging its source.*[1] Thus plagiarism includes, but is not limited to[2]:

- copying in whole or in part, a picture, diagram, graph, figure, etc. and using it in your work without citing its source
- using exact words or unique phrases from somewhere without acknowledgement
- putting your name on a report, homework, or other assignment that was done by someone else

For example, in ME 120, homework is to be an ***individual*** effort. Collaboration with classmates is encouraged, however only to the extent of developing solution *strategies* and comparing results. Copying solutions in whole or in part is plagiarism and will not be tolerated. Similar guidelines apply for lab reports. Writing a lab report is to be an ***individual*** effort. Collaboration with classmates is again encouraged, however only to the extent of deciding on the structure, content, layout, etc. Data can be shared, but written work, graphs, tables, etc., must be done individually.

Students are expected to familiarize themselves with how to avoid plagiarism. Several helpful resources can be found at:

http://www.stanford.edu/dept/vpsa/judicialaffairs/students/plagiarism.sources.htm

[1] Definition adapted from "Defining and Avoiding Plagiarism: The WPA Statement on Best Practices," http://www.ilstu.edu/~ddhesse/wpa/positions/WPAplagiarism.pdf; and "What is Plagiarism?," http://www.stanford.edu/dept/vpsa/judicialaffairs/students/plagiarism.sources.htm.

[2] Adapted from, "Avoiding Plagiarism," http://owl.english.purdue.edu/handouts/research/r_plagiar.html.

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ME 120 Course Goals

1. To understand modern engineering experimentation including experiment design, system calibration, data acquisition, analysis and presentation.
2. To develop and apply an understanding of statistical methods to select the best experimental approach to satisfy given requirements of accuracy.
3. To understand how to quantify error and uncertainty in physical measurements.
4. To understand how to apply statistical methods to the analysis and presentation of experimental results.
5. To understand modern data acquisition concepts and requirements.
6. To understand the various categories of mechanical measurements and the sensor technologies that they are based on.
7. To gain hands-on experience with modern instrumentation and systems-level experimentation.
8. To improve written and oral communication skills, to develop the ability to write engineering reports of high quality, and to improve the student's ability to function as a member of an engineering team.

Student Learning Objectives

At the end of the course, the student who has mastered the course material will be able to:

1. Draw a concept map for a generalized measurement system that identifies the most important concepts.
2. Apply basic statistical methods to design experiments, to analyze, and to present the results of experiments. Such methods may include identification of probability distributions of experimental data, estimation of population statistics from large and small samples, classification and propagation of error sources for experiment design and analysis of results, and graphical presentation of statistical descriptions
3. Identify and describe the elements making up computer-based data acquisition systems, including alternative configurations and technologies.
4. Design a data acquisition system for a given application by analyzing and specifying requirements, selecting appropriate commercial hardware, and writing a computer program to acquire, analyze, and present the desired data.
5. Identify and describe the various types of mechanical measurements including temperature, pressure, sound, motion and position, force and torque, stress and strain, flow visualization and measurement (e.g., volume flow rate, velocity, etc.) and explain the transduction principles that underlie them.
6. Operate modern instrumentation systems that include mechanical and electro-optical technologies and computer-based data acquisition systems.
7. Communicate effectively in written form and in oral presentations information relating to the design and/or results of an engineering experiment.
8. Work productively and effectively in an engineering team.

Learning Resources

Make it a point to visit the ME 120 website at: (http://www.engr.sjsu.edu/bjfurman/courses/ME120/measurementresources.htm) for additional resources relating to experimentation, statistics, measurements, and sensors.

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Approximate Course Schedule

Wk	Lecture Topics	Reading Assignment*	Lab Work
1	Introduction, Generalized Measuring System, Significant Digits, Rounding, Truncation	EMfE Chap. 1 – 2.1; LV Chap 1-5.2; and http://www.angelfire.com/oh/cmulliss/index.html	No labs!
2	Accuracy, Precision, Error in Measurement, Calibration	EMfE Chap. 2.2 – 2.4; LV Chap 5.3-6.4, 7	LabView – Week 1
3	Probability, distributions, parameter estimation	EMfE Chap. 6.1 – 6.8; LV Chap 6.5-6.10, 9	LabView – Week 2
4	Uncertainty Analysis – Pt.1	EMfE Chap. 7.1 – 7.6; LV Chap 8	LabView – Week 3
5	Uncertainty Analysis – Pt.2	EMfE Chap. 7.7 – 7.11; LV Chap 8	Waveform Logger
6	Displacement and Dimensional Measurement	EMfE Chap. 8.1 – 8.2; see ni.com resources on displacement measurement; http://www.rdpelectrosense.com/displacement/lvdt/lvdt-principles.htm and http://claymore.engineer.gvsu.edu/~jackh/eod/manufact/manufact-92.html	
7	Data Acquisition, Signals, Signal Conditioning, Sampling	EMfE Chap. 4; O: Transactions vol. 2 (on Data Acq.) http://www.engr.sjsu.edu/bjfurman/courses/ME120/me120pdf/DAQbasics.pdf	Metrology and SPC
8	Time-dependent Measurement Characteristics	EMfE Chap. 5; see ni.com resources on FFT Signal analysis	** See below
9	Sound Measurement	http://hyperphysics.phy-astr.gsu.edu/hbase/sound/soucon.html and other resources at: http://www.engr.sjsu.edu/bjfurman/courses/ME120/measurementresources.htm	
10	Motion Measurement	EMfE Chap. 8.3 – 8.5; O: Piezoelectric Accelerometers; see ni.com resources on motion measurement	
11	Temperature Measurement	EMfE Chap. 9.2; O: Practical Temperature Measurements (parts 1 and 2), Principals of Infrared Thermometry; also see ni.com resources on temperature measurement and those for ME 146	
12	Pressure Measurement	EMfE Chap. 9.1; O: Pressure Reference Section and Transactions vol. 3 (Force-Related Meas.); see also ni.com resources on pressure measurement	
13	Force and Torque, Stress, and Strain Measurement	EMfE Chap. 8.6 – 8.7; O: Practical Strain Gage Measurements and Transactions vol. 3 (Force-Related Meas.); see ni.com resources on strain measurement	
14	Fluid Flow Measurement	EMfE Chap. 10.1 – 10.3; O: Liquid Flowmeters and and Transactions vol. 4 (Flow and Level-Related Meas.); see omega.com resources on flow measurement	
15	Special Topics	TBD	
16	Special Topics	TBD	
17	Final Examination		

* Legend:

EMfE ≡ Experimental Methods for Engineers text

LV ≡ LabVIEW 8 Student Edition (See also the LabView User Manual and LabView Resources:
http://www.engr.sjsu.edu/bjfurman/courses/ME120/me120pdf/LabViewUserManual.pdf
http://www.engr.sjsu.edu/bjfurman/courses/ME120/LabViewstuff.htm)

O ≡ Omega Engineering Technical Reference (see instructor for CD or go to http://www.omega.com/)

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** Lab work from week 8 onward will be done on a rotation basis, because there is only one set of experimental hardware for each of the following experiments:

- Sound Measurement
- Cantilever Vibration Mode
- Viscosity
- Beam Displacement

Additionally, students will work on an open-ended measurement project of their own design from week 8 onward.

Important Notes:

- Campus policy in compliance with the Americans with Disabilities Act: If you need course adaptations or accommodations because of a disability, or if you need special arrangements in case the building must be evacuated, please communicate this to the instructor as soon as possible. Presidential Directive 97-03 requires that students with disabilities register with the Disability Resource Center (DRC) to establish a record of their disability."
- If you must be absent from class, please give me a call, or send me an email as soon as you know that you will not be coming. Don't just not show up!
- Please make it a point to ask questions in class or in office hours whenever you don't understand something! If you don't, then you are essentially paying tuition for nothing! The pace of this class is relatively fast, and the workload is heavy for 2 units, so don't slack off.
- Lab experiments are intended to be performed in a group of two students. The laboratory reports are to be written *individually* (except the term project report, where the project team will turn in one report). It is acceptable to work *collaboratively* with your lab partner or other students in the class on the lab reports, but it is **NOT** acceptable to copy someone else's report, in whole or in part. Examples of collaboration are: reviewing the data you gathered with your lab partner for consistency, jointly developing an outline of the key points to be included in the report, deciding together on the format and content of figures, etc. Examples of plagiarism are: copying and inserting sentences, paragraphs, or other text into your report that your lab partner or someone else wrote; copying figures or tables that your lab partner or someone else put together, etc.

Last day to drop without penalty: **September 5th, 2006**

Last day to add or register late, or request Academic Renewal: **September 12th, 2006**

References

1. Figliola, R. S., Beasley, D.E. (2006) *Theory and Design for Mechanical Measurements* 4th ed., John Wiley & Sons, Inc., Hoboken, NJ. ISBN: 0-471-44593-2
2. Dunn, P. F. (2005) *Measurement and Data Analysis for Engineering and Science*, McGraw-Hill, New York, NY. ISBN: 0-07-282538-3
3. Doebelin, E.O. (2004) *Measurement Systems: Application and Design*, 5th ed., McGraw-Hill, New York, NY. ISBN: 0-07-243886-X
4. Taylor, J. R. (1997) *An Introduction to Error Analysis*, 2nd ed., University Science Books, Sausalito, CA. ISBN: 0-935702-75-X