THE UNIVERSITY OF TEXAS AT AUSTIN
Department of Aerospace Engineering and Engineering Mechanics

ASE 269K MEASUREMENTS AND INSTRUMENTATION
Spring 2013

SYLLABUS

UNIQUE NUMBER: 13400, 13405, 13410, 13415, 13420

INSTRUCTOR: Dr. Nanshu Lu
WRW 305C, 471-4208, nanshulu@utexas.edu
Office hour: Wednesday 5:00 – 6:00

TIME:
Lecture: MW 12:00 - 1:00 PM
Lab: 13400 W 1:00 – 3:00 pm
13405 T 9:30 – 11:30 am
13410 M 1:00 – 3:00 pm
13415 M 3:00 – 5:00 pm
13420 W 3:00 – 5:00 pm

LOCATION:
Lecture: WRW 113; Lab: WRW 12

TA:
Name                      Email                     Office
Shixuan Yang   rock002008@utexas.edu   WRW 311
Zheng Wang   wangzheng1989830@gmail.com   WRW 311

WEB PAGE: Blackboard

CATALOG DESCRIPTION:
Design of measurement systems; standards; calibration; digital signal processing, time-domain and frequency-domain representation of data; transducers and signal conditioning; measurement of acceleration, displacement, force, length, strain, and temperature; safety. Written reports. Two lecture hours and three laboratory hours a week for one semester.
(http://registrar.utexas.edu/catalogs/ug08-10/ch07/ug08.cr07a.ge-bme.html)

PREREQUISITES:
Prerequisite: Engineering Mechanics 319 with a grade of at least C, Electrical Engineering 331 or Mechanical Engineering 340 with a grade of at least C, and credit with a grade of at least C or registration for Aerospace Engineering 333T (or another approved engineering communication course).

OBJECTIVES:
The objectives of this course are: to introduce the students to the principles of measurement; to provide the students hands-on laboratory experiences with a variety of transducers and instruments; and to provide the students opportunities to write technical reports.
KNOWLEDGE, SKILLS, AND ABILITIES STUDENTS SHOULD HAVE BEFORE ENTERING THIS COURSE:
The student must have credit for EM 319 - Mechanics of Solids, and EE 331K - Electric Circuits and Electronics, and either have credit for, or be, enrolled in an approved communication elective. The student should also be able to use a word-processor computer program and a spreadsheet program to create text and graphs for computer-generated lab reports. Credit for, or enrollment in, ASE 330M - Linear System Analysis, and ASE 324L - Aerospace Materials Laboratory, is desirable.

KNOWLEDGE, SKILLS, AND ABILITIES STUDENTS GAIN FROM THIS COURSE:
The purpose of this course is to provide the student with a basic understanding of the theory and practice of measurement and instrumentation. Upon completion of this course, the student should:

a) recognize the basic elements of common measurement systems;
b) be able to estimate the accuracy of a measurement, identify possible sources of measurement error, and be aware of the importance of considering measurement uncertainty in designing an experiment;
c) be aware of the physical principles of operation of transducers (accelerometers, strain gages, force transducers, thermocouples, etc.);
d) understand the basics of digital signal processing and the Digital Fourier Transform, and be aware of the relationship between the time-domain representation of a signal and its frequency-domain representation;
e) be familiar with the dynamics of first-order and second-order measurement systems;
f) be able to operate a number of laboratory instruments (e.g., digital multimeter, oscilloscope, function generator, strain indicator) and virtual instruments (virtual oscilloscope and virtual spectrum analyzer); and
g) be able to write a grammatically correct report that describes accurately and efficiently how a laboratory experiment was performed, presents the results of the experiment in tabular and/or graphical form, and discusses the significance of the results obtained.

IMPACT ON SUBSEQUENT COURSES IN CURRICULUM:
This course is a prerequisite for ASE 363Q - Design and Testing of Aerospace Structures. It also provides valuable background for ASE 365 - Structural Dynamics, and ASE 370L - Flight Control Systems.

ABET CRITERIA 2000 OUTCOMES ACHIEVED:
This course contributes to the following EC2000 Criterion 3 outcomes and those specific to the EAC accredited Aerospace Engineering program:

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. An ability to apply knowledge of mathematics, science, and engineering</td>
<td>g. An ability to communicate effectively</td>
</tr>
<tr>
<td>b. An ability to design and conduct experiments, as well as to analyze and interpret data</td>
<td>h. The broad education necessary to understand the impact of engineering solutions in a global/societal context</td>
</tr>
<tr>
<td>c. An ability to design a system, component, or process to meet desired needs</td>
<td>i. A recognition of the need for and an ability to engage in life-long learning</td>
</tr>
<tr>
<td>d. An ability to function on multi-disciplinary teams</td>
<td>j. A knowledge of contemporary issues</td>
</tr>
<tr>
<td>e. An ability to identify, formulate, and solve engineering problems</td>
<td>k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
</tr>
<tr>
<td>f. An understanding of professional and ethical responsibility</td>
<td></td>
</tr>
</tbody>
</table>
ABET PROGRAM CRITERIA OUTCOMES ACHIEVED:

<table>
<thead>
<tr>
<th>Criterion</th>
<th>√</th>
<th>Criterion</th>
<th>√</th>
<th>Criterion</th>
<th>√</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Aerodynamics</td>
<td></td>
<td>G. Orbital Mechanics</td>
<td></td>
<td>M. Preliminary/Conceptual Design</td>
<td></td>
</tr>
<tr>
<td>B. Aerospace Materials</td>
<td></td>
<td>H. Space Environment</td>
<td></td>
<td>N. Other Design Content</td>
<td></td>
</tr>
<tr>
<td>C. Structures</td>
<td>√</td>
<td>I. Attitude Dynamics and Control</td>
<td></td>
<td>O. Professionalism</td>
<td></td>
</tr>
<tr>
<td>D. Propulsion</td>
<td></td>
<td>J. Telecommunications</td>
<td></td>
<td>P. Computer Usage</td>
<td></td>
</tr>
<tr>
<td>E. Flight Mechanics</td>
<td></td>
<td>K. Space Structures</td>
<td></td>
<td>Q. Structural Dynamics</td>
<td></td>
</tr>
<tr>
<td>F. Stability and Control</td>
<td>√</td>
<td>L. Rocket Propulsion</td>
<td></td>
<td>R. Measurements and Instrumentation</td>
<td></td>
</tr>
</tbody>
</table>

PROFESSIONALISM TOPICS:
This course includes a discussion of the responsibility of aerospace engineers for the safety of aircraft passengers and for the success of military and space missions. The students are required to maintain original lab data in neat laboratory record books. They are given written information and a lecture on the requirement for honesty in the writing of their technical reports and their ethical and legal responsibilities as professional engineers. The University policies can be found at http://deanofstudents.utexas.edu/sjs/scholdis_whatis.php.

TOPICS:

1. Fundamental Concepts of Measurement Systems: components of measurement systems, measurement accuracy and uncertainty, design of experiments, standards and calibration, etc. (6 lectures) a, b, c; N, R.

2. Waveforms, Digital Signal Processing, and Behavior of First-order and Second-order Systems: Waveform characteristics, digital signal processing and the DFT, and dynamic response of first-order and second-order mechanical and electrical systems. Virtual instruments. One formal report. (7 lectures and 4 labs) a, b, e, g, k; F, O, P, R.

3. Mechanical Measurements: Introduction to electronic instruments; measurement of length and displacement, strain, force and acceleration, and temperature. Vibration of beams. (13 lectures and 6 labs) a, b, e, g, k; O, P, Q, R.

4. Data Analysis and Technical Writing: Reports that are graded for technical content, presentation style, etc. b, g, k; O, P, R.

DESIGN ASSIGNMENTS:
Design of experiments is discussed in class and a design project counts 20% of the final grade in the course. The emphasis in this design project is for the students to select measurement system components and obtain vendor information about them from the web.

LABORATORY ASSIGNMENTS:
The topics covered by the ten laboratory exercises are noted in the Topics and Preliminary Schedule sections.

COMPUTER:
This course utilizes virtual instruments in four lab exercises. The virtual oscilloscope and virtual spectrum analyzer consist of a Windows computer with a National Instruments data acquisition board and executable LabVIEW scope and spectrum analyzer software.

TEXT:
Lab notes distributed by the Instructor.
REFERENCES:
Various vendor data sheets from National Instruments, PCB Piezotronics, etc are available in the laboratory.

CLASS/LAB FORMAT:
Two 50-min lectures per week. Ten two-hour hands-on laboratory during the semester.

PRELIMINARY SPRING 2013 LABORATORY SCHEDULE:

<table>
<thead>
<tr>
<th>Week of</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 14</td>
<td>NO LAB</td>
</tr>
<tr>
<td>Jan 21</td>
<td>NO LAB</td>
</tr>
<tr>
<td>Jan 28</td>
<td>1 Introduction to instrumentation</td>
</tr>
<tr>
<td>Feb 4</td>
<td>2 Electronic instrumentation</td>
</tr>
<tr>
<td>Feb 11</td>
<td>3 Displacement measurement with LVDT</td>
</tr>
<tr>
<td>Feb 18</td>
<td>4 Digital data acquisition</td>
</tr>
<tr>
<td>Feb 25</td>
<td>5 Digital signal processing</td>
</tr>
<tr>
<td>Mar 4</td>
<td>6 Strain gages, beam deflection</td>
</tr>
<tr>
<td>Mar 11</td>
<td>SPRING BREAK</td>
</tr>
<tr>
<td>Mar 18</td>
<td>7 Acceleration measurement; vibration of beams</td>
</tr>
<tr>
<td>Mar 25</td>
<td>8 Tension testing; polymers and rubbers</td>
</tr>
<tr>
<td>Apr 1</td>
<td>9 Buckling of columns</td>
</tr>
<tr>
<td>Apr 8</td>
<td>Week of Mid Term Exam; NO LAB</td>
</tr>
<tr>
<td>Apr 15</td>
<td>10 Bending-torsion coupling</td>
</tr>
</tbody>
</table>

GRADING:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Reports</td>
<td>60%</td>
</tr>
<tr>
<td>Mid-Term Exam</td>
<td>20%</td>
</tr>
<tr>
<td>End-of-term Design Project</td>
<td>20%</td>
</tr>
</tbody>
</table>

TOTAL 100%

Grading Policy:
A: A cutoff around top 20%
B: A cutoff around top 50%
C: A cutoff around top 80%
D: A cutoff around top 90%

The plus-minus grading scheme will be used.

HOMEWORK POLICY:
Laboratory reports are due one week after each lab session. Late reports will not be accepted for grading unless you have made specific arrangements with the Instructor or TA prior to the due date.
Do not wait until the last minute to print your lab reports. Every lab session will start promptly. Submit your lab report within the beginning 5 min of each lab session. Later than 5 min but still
within the session will result in a late penalty of 10% of your total score for that particular lab report. Laboratory reports will be grades strictly according to the lab report template that will be posted on Bb.

INTEGRITY POLICY:
You and your lab partner(s) will work together to acquire the data specified in the lab handouts. You may also want to work with other students on lab assignments and preparing for exams. However, ALL work that you hand in MUST be your own work, not work that is copied from some other student's paper. TAs are fully authorized to perform penalty based on their own judgment.

Please read the issue of The Integrity Herald provided by the office of the Dean of Students. University policies and procedures will be strictly followed whenever plagiarism is suspected. Previous cases of plagiarism of portions of formal reports have resulted in disciplinary action by the Dean of Students. Please do not be the next person to suffer such a fate!

EXAMINATIONS:
There will be one in-class mid-term exam on Wed, Apr 10, 2013. This exam will cover ASE 269K reading assignments, lectures, and labs. There will be no make-up mid-term exam without prior permission. There will be no final exam. A final design project (5-page plus references) will be assigned on Apr 22, 2013 and the project report will be due on May 1, 2013 in class.

ATTENDANCE:
Regular attendance is expected. If, for some reason, you must miss a class or a lab, please notify the Instructor or TA in advance. There will be no makeup labs except for conflict of events, medical conditions, or family emergencies. If you have any of these conditions, you may do a make-up lab, provided that you notify the TA one week in advance of the lab that you expect to miss.

OFFICE HOURS:
Open. Please feel free to talk to me at any time (WRW 305C). Please contact me by e-mail if you wish to set up a special time for a visit, or if you have a question that can be answered via e-mail. (Note: Contacting me by e-mail is far easier and more reliable than by phone.)

IMPORTANT DATES:
Jan 14th, 2013, Tuesday Classes begin.
Jan 17th, 2013, Thursday Last day of the official add/drop period.
Jan 30th, 2013, Wednesday Last day to drop a class for a possible refund.
May 3th, 2013, Friday Last class day.

SPECIAL NOTES:
Upon request, The University of Texas at Austin provides appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TDD or the College of Engineering Director of Students with Disabilities at 471-4321.
EVALUATION:
Measurement and Evaluation Center forms for the College of Engineering will be used during the last week of class to evaluate the course and the Instructor. If, at any time during the semester, you have any comments or concerns regarding the course, please feel free to send them (anonymously, if you prefer) to the Instructor.

PREPARED BY: Nanshu Lu                              DATE: Mar. 6, 2013