# SYLLABUS FOR FALL 2008

**DATES AND READING**

Text: *Theory and Design for Mechanical Measurements* (4th ed.) by Figliola and Beasley

<table>
<thead>
<tr>
<th>WEEK</th>
<th>DATES</th>
<th>READING*</th>
<th>LECTURE TOPICS</th>
<th>LAB**</th>
<th>HW/ DUE DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9/3-9/5</td>
<td>CH. 1</td>
<td>Introduction and Organization/ Mechanical Measurements</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>9/8-9/12</td>
<td>4.1-4.6</td>
<td>Mechanical Measurements/ Probability and Statistics</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>9/15-9/19</td>
<td>4.7-4.8, 5.1-5.6</td>
<td>Probability and Statistics/ Uncertainty Analysis</td>
<td>2</td>
<td>HW 1 Due 9/24</td>
</tr>
<tr>
<td>4</td>
<td>9/22-9/26</td>
<td>5.7-5.9, 2.1-2.4</td>
<td>Uncertainty Analysis/ Characteristics of Signals</td>
<td>3</td>
<td>HW 2 Due 10/1</td>
</tr>
<tr>
<td>5</td>
<td>9/29-10/3</td>
<td>2.4-2.6, 3.1-3.2</td>
<td>Static and Dynamic Characteristics of Signals</td>
<td>4,5</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>10/6-10/10</td>
<td>3.3</td>
<td>EXAM NO. 1 ON 10/8</td>
<td>4,5,6,7</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>10/13-10/17</td>
<td>3.3-3.7</td>
<td>Measurement System Behavior</td>
<td>6,7</td>
<td>HW 3 Due 10/22</td>
</tr>
<tr>
<td>8</td>
<td>10/20-10/24</td>
<td>6.1-6.4</td>
<td>Review, Project Handout, Intro. to Electrical devices/ Measurements</td>
<td>4,6,7</td>
<td>HW 4 Due 10/29</td>
</tr>
<tr>
<td>9</td>
<td>10/27-10/31</td>
<td>6.5-6.9</td>
<td>Analog Electrical Devices/ Filters</td>
<td>4,6,7</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>11/3-11/7</td>
<td>7.1-7.4</td>
<td>EXAM NO. 2 ON 11/5</td>
<td>Project</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>11/10-11/14</td>
<td>7.5-7.9</td>
<td>Sampling, A/D Conversion Measurement Systems</td>
<td>Project</td>
<td>HW 5 Due 11/19</td>
</tr>
<tr>
<td>12</td>
<td>11/17-11/21</td>
<td>Chapters 9-11 (Selected Topics)</td>
<td>Measurement systems, Sensors, and actuators: Pressure, Flow, Velocity, Temperature, Force, Strain. Reading assigned in class</td>
<td>Project</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>11/24-11/28</td>
<td>Chapters 9-11 (Selected Topics)</td>
<td>Class time on 11/24 devoted to final project</td>
<td>Project</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>12/1-12/5</td>
<td>Chapters 9-11 (Selected Topics)</td>
<td>FINAL DESIGN PRESENTATIONS AND REPORTS DUE ON 12/3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>12/8-12/12</td>
<td>REVIEW</td>
<td>Presentations and Review for Final Exam</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Homework Assignments will be distributed in class on the dates indicated.**

**Footnote Key:**
* All assigned reading is from Figliola and Beasley. Additional suggested reading will be assigned in class.
** All lab reports are due at the start of the subsequent lab period.

*This schedule represents a nominal timeline and outline of topics to be covered in this course. As the semester unfolds there may be modest changes.*
ME 310

Instrumentation and Theory of Experiments

FALL 2008

LECTURE: M-W 4-6, PHO 203

LAB: Rm 113, AME (110 Cummington St.). 4 sections: TBD


ME 310 Lab Handouts

LAB NOTEBOOKS: Square-ruled lab notebooks, preferably with page numbers, at least 1 needed

PROFESSOR: Todd Murray twmurray@bu.edu
110 Cummington, Rm 421 353-3951 office
Office Hours T 2-3:30, W 10:30-12, or by appointment

TF’s: Robert Valtierra rvaltier@bu.edu
Ozgur Ozsun ozgur@bu.edu
Xiaoning Wang wxn@bu.edu
Robert Hammond-Oakley roakley@bu.edu

GRADING:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>(Class Attendance)</td>
</tr>
<tr>
<td>15%</td>
<td>(Design Project)</td>
</tr>
<tr>
<td>15%</td>
<td>(Homework Sets)</td>
</tr>
<tr>
<td>35%</td>
<td>(Labs and Lab Reports)</td>
</tr>
<tr>
<td>20%</td>
<td>(In-class Exams)</td>
</tr>
<tr>
<td>10%</td>
<td>(Final Exam)</td>
</tr>
</tbody>
</table>

There will be 2 hourly exams, 5 homework sets, 7 labs plus 1 design project, and 1 comprehensive final exam.

CLASS: Class will be lively, informative, and PART OF YOUR ASSIGNED GRADED WORK. Come to class and be prepared to use the knowledge you already have, and to think on your feet. I will pass out an attendance signup sheet. It is your responsibility to sign it yourself (only for yourself).
**HOMEWORK:** Homework assignments will be given out periodically throughout the semester (see syllabus for exact dates). They are due at the BEGINNING of class on the due date listed. LATE HOMEWORK WILL NOT BE ACCEPTED unless circumstances merit the exception. Homework solutions will be posted on the Courseinfo web site.

**EXAMS:** The exams will cover a specific section of the course material. They will be thorough and challenging. "Make-up" exams will rarely be given, and **never** in the case of prior knowledge of a time conflict (you must arrange to take the test before you are away). A "make-up" exam will be different from the exam given in the class, and will likely be oral.

The final exam will be comprehensive. The final exam is TBD. **DO NOT UNDER ANY CIRCUMSTANCE SCHEDULE TRIPS OR FLIGHTS HOME UNTIL AFTER THE OFFICIAL UNIVERSITY EXAM PERIOD.**

**DESIGN PROJECT:** The design project will occupy the final 3-4 weeks of laboratory meetings. Note that it is a design as well as lab project, and as such there will be significant work done outside and before lab.

**DROP DATES:** Pay attention to the University's schedule of drop dates. You cannot drop this course after the last “W” date because of an impending low grade – you will receive your current grade if you drop after the official W date. "Incomplete" grades are reserved for the most extreme of circumstances, and are a **NEGOTIATED CONTRACT** between the student and myself.

**PREREQUISITES:** EK 301, 303 and 307.

**COLLABORATION:**

A. Homework: Do it individually. However, you are encouraged to consult with classmates on general concepts.

B. Lab reports: Also to be done individually. Pre-labs should be done individually. For some experiments, there will only be one copy of your raw data/results, which you must copy later for inclusion in your own reports. Your lab report should be a stand-alone document, and therefore you may not ‘reference’ any section in one of your lab partners’ reports. However, you must consult with your lab partners even after the lab period to discuss findings and results.

C. Design project: This is a group collaborative project, and I expect to see an equal division of labor here. There will only be 1 report per group, and so each group member will receive the same grade. Despite the division of labor, since this is a class, each member of the group must understand the other member’s contributions.
LAB AND LAB REPORT POLICIES AND PROCEDURES:

1. **Groups**
   On the first day of class, you will be divided into approximately 12 groups, with 4 students in each group. Each of these groups will perform the experiments and design project together. However, remember that lab reports are done individually.

2. **Notebooks and Reports**
   a. **Lab Notebook:** Buy at least 1 square-ruled lab notebooks (with page numbers, preferably). You will record all your in-lab data and observations for ALL LABS in this notebook. A photocopy of the relevant pages from your lab notebook will be turned in with your post lab report. Identify your notebook on the cover with your name, term and year, course number, and lab partner’s names.
   b. **Lab Report:** Each student will generate a lab report for each experiment, the elements of which are spelled out in the sections below. These reports will be generated on a word processor with inclusion of graphs and plots (typically generated in a spreadsheet or other calculation program) and also with the inclusion of the photocopied pages of the lab notebook corresponding to the experiment.
   c. All entries (notebook especially) must be in permanent ink. Pencil is only used for drawings and graphs. Do not erase or ‘white-out’ mistakes, but rather cross out with ONE mark and explain. Use only the right-hand side of pages.
   d. Format, content and neatness will be graded. Your writing or typing must be legible, intelligible, and concise but complete. Be sure to properly reference information from a previous class or from textbooks.
   e. The pre-lab section of the report is due at the beginning of the lab. The TF will check, sign and date the prelab or you will receive no credit.
   f. The in-lab data section completed in the notebook must also be signed and dated by the TF, or no credit will be received.

3. **Due dates**
   Lab reports are due at the beginning of the subsequent laboratory (which may be 1 or 2 weeks later). LATE LAB REPORTS WILL NOT BE ACCEPTED OR GRADED unless dire circumstances warrant the exception.

4. **Error Analysis**
   An estimate of your errors, their sources and impact on results is required in every lab report. Additionally, SPECIFIC LABS require a full formal uncertainty analysis. I have scheduled 1 free lab period following Lab 6 to ensure adequate time for preparation of the longer and more extensive lab report.

5. **Late or missed labs**
Only in the most extreme of circumstances will you be allowed to be late or miss a lab and schedule a makeup. These labs require a large amount of overhead in terms of equipment, prep, coordination and manpower, and it is not fair to anyone to reschedule without compelling cause.

6. **Lab Report Content**
   On the following pages you will find a section-by-section breakdown of what is expected.

7. **Safety**
   Safety is paramount. Never work alone. Tie up loose ends: this includes hair, clothing and jewelry. Keep workspaces free of clutter. NO FOOD OR DRINK IS ALLOWED IN THE LAB!
AM 310 LAB REPORT CONTENT AND LAB NOTEBOOK USE

GENERAL INFORMATION
- Number the pages of both the pre-lab and post-lab reports.
- Reports should be clear and concise, and free from typographical errors or grammatical mistakes.

PRE-LAB REPORT: PREPARATION BEFORE LAB (25% of your grade)

The pre-lab report should contain the following sections:

- Title page
- Objectives of lab
- Theory
- Spot check preparation
- Listing of data needs
- Tentative equipment lists
- Procedure checklist

A description of each section, as well as a rough guideline for the length of each section, is given below

1. Title Page (1 page)
   This should include only the title of the experiment, the date the experiment was actually done, your name, and all other students who did the experiment with you, using your apparatus.

2. Objectives (1-2 paragraphs, typically 1/3-1 page)
   Before each lab you must read and understand the lab write up. Then you must prepare your notebook for the lab. First, the objectives of the lab should be stated. This should be a brief and concise statement of what the scientific and/or engineering goals of the experiment are (e.g., investigate a phenomenon and/or demonstrate a theorem).

   Do not just copy the handout. In the conclusion section at the end of your lab you should return to the objectives to ascertain how well the objectives were realized. Since the conclusions depend on the results of the experiment, what is included in the results section will also depend on the objectives, so check what is asked for (or what will be obtained) in the results section before writing your objectives.

3. Theory (not to exceed 3 pages, typically 1-2 pages)
   Next, a brief summary of pertinent theory or established empirical evidence related to the experiment should be given. The purpose of this is to clarify what data you are
looking for in the experiment and how these data are to be reduced to meet the lab’s objectives. Any equations that are to be used to analyze your results, or compare results to theoretical values, should be discussed in this section. It is your responsibility to understand the theory well enough to know what measurements need to be made (e.g., if a Reynolds Number is required, then you need to measure temperature, which will allow you to look up the fluid’s viscosity). Also, if the handout asks you to perform a derivation or dimensional analysis, it should be done in this section.

4. Spot Check Preparation (not to exceed 2 pages, typically 1 page)
It is almost always desirable to do an analysis of some data points in the lab while the experiment is running. This is called a spot check. A spot check permits you to see if the results make sense, or if the experiment is generating data that is obviously erroneous, and either the experiment or your method of analysis needs correcting. As an example, in the Reynolds Apparatus experiment performed in EK 303, you were looking for the Re that corresponds to the laminar to turbulent transition region. Were this lab done in AM310, you would outline in your prelab how to do this (such as viscosity tables and a calculator). Then, during your lab you could check that your results were consistent with the expected values for flow transition.

All AM310 labs include spot checks to help you identify bad data, bad analysis, bad lab technique or faulty equipment. Sample calculations for spot checks should be prepared in your prelab. These should include unit conversions and constants to reduce in-lab time. In the lab, you will only need to plug in your experimental values.

5. Data Needs (typically ½ -2 pages, depending on lab)
In each laboratory, you will be collecting experimental data over some range of parameters. For instance, you may look at the magnitude response of a low pass filter (Volts) over a frequency range of 0.1 to 10 MHz in steps of 0.1 MHz. In your prelab, make a clear and informative list of the data that will be taken. For the example given above, one would write:

Part 1. Low Pass Filter Analysis
1. The magnitude response (in units of volts) of the low-pass filter will be recorded as a function of frequency over the frequency range of 0.1 to 10 MHz in steps of 0.1 MHz.

6. Equipment List (typically ½-1 page)
Next should come a tentative list of equipment based on the information given in the lab handout. Additional details regarding the equipment used should be recorded in your lab notebook (see following section).

7. Procedure Checklist (typically ½ -1 page)
The last part of the prelab should be the procedure checklist. Present a concise, but detailed, list of the steps required to set-up and complete the lab. This is to help you to remember, for example, when to turn crucial valves and when to take required data or perform spot checks. The labs can become somewhat confusing while in progress, and the procedure checklist helps to ensure that sections are not overlooked.
IN-LAB REPORT SECTION IN LAB NOTEBOOK (10% of your grade)

Attach a photocopy of the relevant pages of your lab notebook to the back of your post-lab report.

- Complete equipment list
- Make and record a safety inspection
- Follow procedure checklist
- Take data
- Perform spot checks
- Note general observations

1. Complete Equipment List
Include the make, model, serial number and accuracy information where applicable. Record this information directly in your lab notebook.

2. Make Safety Inspection
Before beginning the experiment, consider and note in your lab notebook the safety issues related to this experiment. Include both issues that were addressed (e.g. wearing safety glasses for the Mechanical Second Order Experiment) and also those that were not addressed. For those issues that were not addressed, comment on how the safety of the experiment might be improved in the future. Note that this includes safety FOR the equipment, not just FROM it – you should be aware of the limitations of all equipment you use, and take appropriate steps to ensure no input or output loads exceed those limits.

3. Follow Procedure Checklist
Check off each step in your prelab as you proceed through the checklist. You should pen in procedure changes if they become necessary. If there is extensive revision of the procedures necessary, you should record the revised procedures in the lab notebook.

4. Take Data
Construct data tables based the “Data Needs” section of your prelab. Record data in these tables in the lab notebook along with appropriate units and other comments (e.g., which of a choice of instruments you were using – e.g., which rotameter – or which scale you were using on your instrument). Be sure to record the raw data before you make any calculations, e.g., the height of each column of a differential manometer and not just the difference in heights (which would be the result of a calculation and result in the loss of some information – e.g., where on the scales you were working). All data must be recorded neatly and be easily legible to the graders (including the units of the
data) or else loss of credit will result. The credit given for this section is primarily given for format, presentation, and completeness.

5. Perform Spot Checks
Usually you will be told what spot checks to do, but for some labs you are expected to come up with some of your own. Regarding spot checks, it is not enough to simply do them. Comment on what information they supply, e.g. “demonstrates a linear relationship” or “corresponds to a theoretical expectation.” Spot checks should be performed in the data section, near the relevant data.

6. Note general observations
In addition to taking data, general observations that relate to the lab, such as problems and inconsistencies, should be recorded. However, problems that can be corrected by the students (e.g., poor flow meter calibration) should be corrected as well as noted.

POST-LAB REPORT SECTION (60% of your grade)
- Title and Abstract
- Analysis
- Uncertainty analysis
- Results
- Discussion and Conclusions

1. Title and Abstract
The abstract should be the last section that you write before completing the lab. This gives a brief summary of the goals of the laboratory, and important results and conclusions. The abstract should not exceed 300 words.

2. Analysis
The analysis section will include a) the data taken in lab in tabular form with clear labels including correct units b) intermediate calculations required in order to process the data c) calibration curves or other reference data or reference sources used in the analysis of the data.

The analysis section should be a clear a concise presentation of the data and analysis. In many cases, the data should be presented in tabular form in clearly labeled spreadsheets. Below each spreadsheet should be a paragraph describing each column of data and the equations used in the analysis. For example, one may write “column three gives the volume (V) of the sphere (in units of m³), calculated through \( V = \frac{4}{3} \pi r^3 \), where \( r \) is the measured sphere radius (in units of m) given in column 2.”

Please note the following:
- All tables must have titles and clearly labeled columns and rows (variable names and units)
- Units must be consistent such that one can easily get from one column to the next by plugging in the given equations. While sample calculations are not
included in this section, it is recommended that students do sample calculations to ensure that there are no mistakes on the spreadsheets.

- The source of data must be stated. This could either be a page number from your lab notebook, a reference to a text, or a reference to a page in the lab handout.
- Calibration curves (graphs) should be included in the analysis section when required for data analysis. Graphs should be made on a computer, and be clearly labeled and easy to read. Graphs should also have a descriptive title.

3. Uncertainty Analysis
The uncertainty analysis should include your estimated elemental experimental uncertainty in each measurand (both bias and precision, identified as such, as well as total uncertainty), statistical analysis of data where appropriate, and uncertainty propagation for formulas. In this section you will also discuss, combine and propagate the uncertainties introduced by your equipment.

It is your responsibility to clearly explain how your uncertainty analysis was performed (detail every step) and to present all formulas used.

At the end of this section, you must present a summary of your uncertainty results. Uncertainty in all values and results must be calculated and displayed in tables.

4. Results
Results should be given in terms of tables and graphs whenever possible (refer to above paragraph on graphs for format). Do not include intermediate calculations (those belong in the analysis section), just final results in the results tables. Final results are those you need to meet the objectives of the experiment. Data points should have error or uncertainty ranges indicated, where appropriate, in both tables and graphs (on graphs it should be represented as error bars when possible). Avoid too many significant figures in reporting results, even intermediate results.

5. Discussion and Conclusions
In the discussion section you should evaluate your results and discuss the physical meaning of the numbers and graphs. If there are relevant theoretical or empirical results available, compare your results with them, and attempt to explain any discrepancies. Answer any and all questions asked in the procedure section of the lab handout. Mention experimental limitations and ways the lab might be improved. Were the lab’s objectives met? Remember to include uncertainty in this discussion.

ADDITIONAL GRADING

1. Presentation
The presentation quality of your lab report will, at a minimum, be graded for readability, completeness and placement of items in the proper section.
### SUMMARY OF LAB REPORT ORDER AND CREDIT

<table>
<thead>
<tr>
<th>Section</th>
<th>Max. Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prelab (25%)</strong></td>
<td></td>
</tr>
<tr>
<td>Title page</td>
<td>1%</td>
</tr>
<tr>
<td>Objective</td>
<td>4%</td>
</tr>
<tr>
<td>Theory</td>
<td>5%</td>
</tr>
<tr>
<td>Spot check preparation</td>
<td>4%</td>
</tr>
<tr>
<td>Data needs</td>
<td>4%</td>
</tr>
<tr>
<td>Equipment list</td>
<td>3%</td>
</tr>
<tr>
<td>Procedure checklist and safety</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Inlab (10%)</strong></td>
<td></td>
</tr>
<tr>
<td>Complete Notebook Pages</td>
<td>6%</td>
</tr>
<tr>
<td>• Complete equipment list</td>
<td></td>
</tr>
<tr>
<td>• Safety inspection</td>
<td></td>
</tr>
<tr>
<td>• Data</td>
<td></td>
</tr>
<tr>
<td>Spot checks</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Postlab (60%)</strong></td>
<td></td>
</tr>
<tr>
<td>Title and Abstract</td>
<td>5%</td>
</tr>
<tr>
<td>Analysis</td>
<td>15%</td>
</tr>
<tr>
<td>Uncertainty analysis</td>
<td>15%</td>
</tr>
<tr>
<td>Results</td>
<td>10%</td>
</tr>
<tr>
<td>Discussion</td>
<td>15%</td>
</tr>
<tr>
<td><strong>All Sections</strong></td>
<td></td>
</tr>
<tr>
<td>Presentation</td>
<td>5%</td>
</tr>
</tbody>
</table>
ENG AM 310 Instrumentation and Theory of Experiments

2006-2007 Catalog Data:
ENG AM 310 Instrumentation and Theory of Experiments Prereq: ENG EK 303 and ENG EK 307. Designing, assembling and operating experiments involving mechanical measurements; analyzing experimental data. Safety considerations in the laboratory. Wind tunnel testing. Mechanical and electrical transducers for flow, pressure, temperature, velocity, strain and force. Electric circuits for static and dynamic analog signal conditioning. Computer use for digital data acquisition and analysis; instrument control. Professional standards for documenting experiments and preparing reports, including formal uncertainty analysis involving elementary statistics. Interpretation of experimental results. Includes lab. 4 cr, either sem.

Course Schedule:
4 lec hr/ wk, 12 - 4hr. labs per semester

Textbooks:

Boston University Course Packet for AM 310, including Lab Manual and Class Handouts, 2006/2007.

Coordinator:
R. Glynn Holt, Associate Professor of Aerospace and Mechanical Engineering

Prerequisites by topic:
1. Basic calculus and differential equations.
2. Free vibration of a spring-mass system.
3. Basic fluid mechanics.
4. Basic circuit theory (both DC and AC).

Goals:
This course has four main goals: 1. To teach techniques for designing experiments and analyzing data; 2. To introduce the operating principles and uses of transducers, output devices and signal conditioning elements of measurement systems; 3. To introduce the concepts of signals and systems and their interaction in both static and dynamic measurements; and 4. To provide hands-on experience conducting experiments in with emphasis on safety, documentation, data analysis, computer use and uncertainty analysis.

Course Learning Outcomes:

As an outcome of completing this course, students will:

i. Become proficient in designing and implementing experimental solutions to engineering problems, including static and dynamic mechanical, electrical and thermal measurements, and understanding the tradeoffs between cost, performance and complexity of measurement schemes. (1b, 1c, 3a-c. 4b)

ii. Become proficient in analysis of uncertainty of experimental results, including the identification of sources and types of uncertainty, combination and propagation of uncertainties, and application of appropriate statistical models for precision uncertainty of finite samples. (1b, 3b, 3c)
iii. **Become proficient in reporting and documentation of experimental work** through use of standardized lab reporting policies and requirements. (1b, 2a, 2c)

iv. **Gain experience in the operating principles and uses of transducers, output devices and signal conditioning elements of measurement systems**, including flow, pressure, temperature, velocity, strain, force, and optional transduction systems, and including electric circuits for static and dynamic analog signal conditioning, and computer use for digital data acquisition, analysis and instrument control. (1b, 1c)

v. **Gain experience with the concepts of signals and systems and their interaction in both static and dynamic measurements**, including mathematical modeling of such systems' static and time-dependent behavior. (1a, 1b, 1c, 3a)

vi. **Gain experience and confidence in self-instruction on the use of data acquisition software and hardware systems**, including standard multifunction analog-digital conversion boards, and LabVIEW or other GUI interface data acquisition control software. (1b, 1c, 5a)

vii. **Gain experience in efficient organization and teaming** by performing labs and projects in both self-organized and instructor-organized groups. (2a, 2c)

**Course Learning Outcomes mapped to Program Outcomes:**
(For Program Outcomes, please see attached page or Department web site)

| Program: | 1a | 1b | 1c | 2a | 2b | 2c | 3a | 3b | 3c | 4a | 4b | 5a | 5b | 5c | 5d |
|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Course:  | v  | i, ii | iii | iv | v | vi | iii | vii | i, v | i, ii | i, ii | i | vi |    |
|          |    |     |     |    |    |    |     |     |     |     |     |    |    |    |

| Emphasis: | 3 | 5 | 5 | 3 | 1 | 3 | 5 | 5 | 5 | 1 | 3 | 3 | 1 | 1 |

**Topics:**
1. Introduction and definitions related to static measurements and calibration (1 week)
2. Errors, uncertainty, probability, statistics and uncertainty analysis (3.5 weeks)
3. Data analysis and presentation: graphing, curve fitting, linear regression (1.5 weeks)
4. Generalized measurement system and static (0\(^{th}\)-order) systems. (2.5 weeks)
5. Transducer fundamentals (1 week)
6. Dynamic measurements: First and second order system responses, complex signals and distortion (2.5 weeks)
7. Digital data acquisition. (0.5 week)
8. LC filters, RC filters. (0.5 week)
9. Exams. (1 week)

**Contribution of Course to Meeting the Professional Component:**

Engineering topics: 100%

**Status of Continuous Improvement Review of this Course:**

<table>
<thead>
<tr>
<th>Date:</th>
<th>Reviewed by:</th>
<th>Todd Murray</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preprared by:</td>
<td>R. Glynn Holt</td>
<td>Date: August, 2007</td>
</tr>
<tr>
<td>Week</td>
<td>Group #</td>
<td>Group #</td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>f</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>f</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>11</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>holiday</td>
<td>f</td>
<td>f</td>
</tr>
<tr>
<td>dec 4-5</td>
<td>f</td>
<td>f</td>
</tr>
</tbody>
</table>

Lab Descriptions on Courseinfo

Possible

1 Intro to scope and MM/DMM
2 Filters and Op-Amps
3 Strain Gauges
4 Pipe Flow

5 Marble density  shaded labs require
6 Flow Over a Sphere  formal error analysis
7 Temperature Measurement and Calibration
8 DESIGN PROJECT: Mechanical 2nd Order System  shaded labs require
and Digital Data Acquisition  formal error analysis

f Free lab period for your group: designed to give you more time for Lab 6 requiring uncertainty analysis