ME 250 Precision Machine Design

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Office hrs: Monday and Tuesday 1:30 pm – 3 pm; Wednesday 9:30 – 10:30 am; or by appointment only

Prerequisites: BSME degree or instructor consent. Knowledge of the elements of machine design and mechanical systems design will be assumed.

Class time/Loc: Thursday, 17:00 – 19:50; Lockheed, Bldg. 154, room TBD

Class codes: 49076

Final Exam: Thursday, December 22, 2005; 17:00 – 19:50

Course Description:
Overview of principles for engineering design where the control of motion or dimension is many orders of magnitude smaller than the entity being designed. Lectures will be augmented by experts from local industry and/or academia. Students will work in teams on a term project to enable them to put into practice what they have learned in the course


Grading: Homework 15%, Presentation 20%, Term Project 25%, Quizzes 20%, Final Exam 20%. Overall grades will be determined using the following chart:

<table>
<thead>
<tr>
<th>Overall percentage</th>
<th>Grade</th>
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<tbody>
<tr>
<td>100 – 93%</td>
<td>A</td>
</tr>
<tr>
<td>92 – 90%</td>
<td>A-</td>
</tr>
<tr>
<td>89 – 87%</td>
<td>B+</td>
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<tr>
<td>86 – 83%</td>
<td>B</td>
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<tr>
<td>82 – 80%</td>
<td>B-</td>
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<td>79 – 77%</td>
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<td>76 – 72%</td>
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<td>71 – 69%</td>
<td>C-</td>
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<td>68 – 66%</td>
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<td>65 – 62%</td>
<td>D</td>
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<tr>
<td>61 – 59%</td>
<td>D-</td>
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<tr>
<td>&lt;58%</td>
<td>F</td>
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</tbody>
</table>

Homework: Homework will generally be assigned weekly, and problem solutions are generally due one week after their assignment unless otherwise indicated. Late homework will generally not be accepted, unless prior arrangements have been made for extraordinary circumstances.

Oral Presentation: Students in teams will give one presentation on a precision engineering subject discussed in a paper(s), book, article, or gleaned from a project. A description of the oral presentation assignment can be found on the ME 250 website.
Term Project: Students in teams will get an opportunity to apply what they have learned in class to design a solution to a precision engineering problem. A description of the term project assignment can be found on the ME 250 website.

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 Dishonesty (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 to²:

- 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 250, 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.

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

ME 250 Course Goals

1. To provide the student with an overview of the principles of precision machine design, and develop within him or her, the necessary understanding and discipline to successfully design and develop precision machines and mechanisms
2. To introduce the student to the field of precision engineering and the body of literature in this field
3. To sharpen research skills and written and oral communication skills

ME 250 Student Learning Objectives

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

1. Explain in his or her own words and distinguish the meanings of accuracy, repeatability, precision, cosine error, and Abbe error.


ME 250 Precision Machine Design

2. Describe the concept of kinematic constraint, analyze and evaluate existing kinematic design approaches to determine degrees of freedom and ability to meet the design intent, apply the concept of kinematic design for a particular application

3. Explain in his or her own words the pros and cons of flexure design, identify where a flexure could be used to accomplish a particular design requirement, and conceptually design a flexural system to achieve the desired “stiff” and “flexible” degrees of freedom

4. Explain what is meant by and identify the structural and measurement loops in a precision device

5. Apply the concept of error budgeting to the design of an instrument

6. Select appropriate materials to design a precision component or device considering tradeoffs in performance, cost, machinability, etc.

7. Explain in his or her own words the concept of self-calibration and where it can be used

8. Select a bearing approach to satisfy a particular precision design requirement and explain the reasons for your choice

9. Describe some of the important manufacturing processes used in precision engineering and the reasons why one might select such a process

10. List some of the important sensors used in precision instruments, explain their performance characteristics, and select an appropriate one for a particular application

11. List some of the important actuators used in precision instruments, explain their performance characteristics, and select an appropriate one for a particular application

12. Explain the fundamental concepts in Geometric Dimensioning and Tolerancing

COURSE SCHEDULE (Tentative, especially dates of tours and guest speakers!!)

<table>
<thead>
<tr>
<th>Date/Wk</th>
<th>Subject</th>
<th>Reading</th>
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<tbody>
<tr>
<td>9/1</td>
<td>Enrollment, introduction to the course and subject Accuracy, repeatability, precision, resolution, cosine error, Abbe error</td>
<td>SC 1, 3.5</td>
</tr>
<tr>
<td>9/8</td>
<td>Kinematic constraint, semi-kinematic constraint, kinematic coupling</td>
<td>SC 3 Blg. p. 1-33</td>
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<tr>
<td>9/15</td>
<td>Flexures</td>
<td>SC 4 various papers</td>
</tr>
<tr>
<td>9/22</td>
<td>Structural loop, measurement loop, metrology frames, compensation mechanical and thermal errors, error budgets</td>
<td>SC 3.4</td>
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<tr>
<td>9/29</td>
<td>Actuators, drives, and couplings for precision motion control Structural considerations for precision design, vibration isolation</td>
<td>SC 5, 6, 7</td>
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<td>10/6</td>
<td><strong>Tour:</strong> Ultratech, Inc., Ray Ellis, 3050 Zanker Road, San José, 95134 <a href="http://www.ultratech.com/">http://www.ultratech.com/</a></td>
<td>SC 10</td>
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<tr>
<td>10/13</td>
<td>Paper presentations</td>
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<tr>
<td>10/20</td>
<td>Material considerations for precision design</td>
<td>SC 8</td>
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<tr>
<th>Date/Wk</th>
<th>Subject</th>
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<tbody>
<tr>
<td>11/3 10</td>
<td>Guest speaker: Prof. Dan DeBra, Stanford University, Bearings for precise linear and angular motion</td>
<td>SC 9</td>
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<tr>
<td>11/10 11</td>
<td>Sensors for precision applications, Reversal, self-calibration</td>
<td>SC 7 paper by Evans, et. al</td>
</tr>
<tr>
<td>11/17 12</td>
<td>Tour: Lockheed, Bert Haugen, Precision Angular and Displacement Measurements</td>
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11/24 13 THANKSGIVING HOLIDAY BEGINS – No Class Tonight!

12/1 14 Guest speaker: Bill Tandler, President of Multimetrics, Inc., on Geometric Dimensioning and Tolerancing (GD&T) for Design and Metrology | ME 250: Course Materials page |

12/8 15 Guest speaker: TBD (maybe Kevin Fine, Agilent, “The Precision Engineers Toolbox” or Todd Belt, or…??)

12/15 16 Term project poster fair
Course review

12/22 17 Final Examination

Legend:

Blng = Blanding         Jones = R. V Jones
Evans = Evans, et. al.   SC = Smith and Chetwynd

References:

(The references denoted ‘RBR’ below are on reserve in the MLK Jr. Library for your reading pleasure)


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