ME 250 Precision Machine Design Fall 2007

Instructor: Prof. Ray Ellis Office: Ultratech Phone: (408) 577-3577
E-mail: rellis@ultratech.com

Office hrs: by appointment only

Prerequisites: BSME degree or instructor consent. Knowledge of the elements of machine design and mechanical systems design. ME157 or equivalent strongly recommended. Experience with engineering labs and writing lab reports.

Class time/Loc: Tuesday and Thursday, 5:30 – 6:45, IS215

Final Exam: Tuesday, December 18, 5:15 – 7:30 pm

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. The course focuses on practical concepts that can be directly applied to the design process. Lectures will be augmented by hands-on group laboratory sessions that put the principles into action. Course will include at least one tour of businesses where precision machine design is practiced.

Required Text: Smith, S. T., Chetwynd, D. G., *Foundations of Ultraprecision Mechanism Design*, Taylor & Francis, 1992, ISBN 2884490019.

Grading: Homework 20%, Quizzes 20%, Labs 40%, Final Exam 20%. Letter grades will be determined for each assignment based on performance relative to classmates and the expectations of the Proffesor. The letter will be assigned a numerical value (such as A=100, B+=89). The final grade will be determined by averaging all assignments and comparing the result to the following chart.

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

In borderline cases, the professor reserves the right to adjust final grades slightly based on the following criteria.

- Completion of all assignments on time.
- Asks questions and joins in discussions frequently.
- Contributes new knowledge based on experience or independent study.

- Is valuable contributor to group in labs and group activities.
- Demonstrates original creative thinking.

Labs: Participation in the labs is critical for this class. Missed labs can not be made up unless prior arrangements have been made for extraordinary circumstances. Make ups must be arranged with the student lab assistants if available. If a lab is missed for extraordinary circumstances and can not be made up, it will not be averaged in the final grade.

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. Missed homework assignments will be assessed an F grade.

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*.[i] Thus plagiarism includes, but is not limited to[ii]:

- 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

[i] 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.

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

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.
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

References:

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

Blanding, D. L., *Exact Constraint: Machine Design Using Kinematic Principles*, ASME, New York, 1999. (TJ230 .B593, RBR)

Braddick, H. J. J., *Mechanical Design of Laboratory Apparatus*, Chapman & Hall, London, 1960. (QC53 .B7, RBR)

Braddick, H. J. J., *The Physics of Experimental Method*, Wiley, New York, 1954. (QC41 .B7, RBR)

Evans, C. E., *Precision Engineering: An Evolutionary View*, Cranfield Press, Bedford, UK, 1989. (TJ15 .E9 1989, RBR)

Evans, C. E., Hocken, R. J., Estler, W. T., *Self-Calibration: reversal, redundancy, error separation, and "absolute testing*," CIRP Annals, vol. 45/2, 1996.

Franse, J., "Manufacturing Techniques for Complex Shapes With Submicron Accuracy," Rep. Prog. Phys., vol. 53, 1990, pp. 1049-1094.

Jones, R. V., *Instruments and Experiences, Papers on Measurement and Instrument Design*, John Wiley & Sons, Chichester, 1988.

Moore, W. R., *Foundations of Mechanical Accuracy*, The Moore Special Tool Company, Bridgeport, Connecticut, 1970. (TJ1167 .M67, RBR)

Nakazawa, H., *Principles of Precision Engineering*, Oxford University Press, Oxford, 1994. (TJ145.N3513, RBR)

Rolt, F. H., *Gauges and Fine Measurements*, vols. 1 and 2, Macmillan and Co. Ltd., London, 1929. (TJ1166 .R6, RBR)

Slocum, A. H., "Precision Machine Design," Society of Manufacturing Engineers, Dearborn, MI, 1992. (TJ230 .S66x 1992 RBR)

Smith, S. T., Chetwynd, D. G., *Foundations of Ultraprecision Mechanism Design*, Gordon and Breach Science Publishers, Switzerland, 1992. (TJ233 .S65 1992, RBR)

Strong, J., *Procedures in Experimental Physics*, Prentice-Hall, New York, 1938. (QC41 .S8, RBR)

Whitehead, T. N., *The Design and Use of Instruments and Accurate Mechanism*, Dover, New York, 1954. (Q185 .W5 1954, RBR)