SYLLABUS

ME220: Precision Manufacturing

Fall 2010, Tu Th 9:30 - 11 AM, 3109 Etcheverry Hall

Instructor: Professor David Dornfeld
Department of Mechanical Engineering
6143 Etcheverry Hall
dornfeld@berkeley.edu, (510) 643-7013

Office Hours: Tu 11-12, and by appointment

Website: http://bspace.berkeley.edu/

Description: Introduction to precision engineering for manufacturing. Emphasis on design and performance of precision machinery for manufacturing. Topics include machine tool elements and structure, sources of error (thermal, static, dynamic, process related), precision machining processes and process models (diamond turning and abrasive (fixed and free) processes), sensors for process monitoring and control, metrology, actuators, machine design case studies and examples of precision component manufacture, role of CAD/CAM in precision manufacturing, and aspects of sustainable manufacturing and design for sustainability.

Text: *Precision Manufacturing*, by David Dornfeld and Dae-Eun Lee, Springer, 2008.

Organization: 15 weeks of lecture. Homework assignments. No mid-term exams. Take home final exam. Group/individual project. Some laboratory exercises/demonstrations.

Grade: The grade will be determined on the following basis:

Homework/Labs	30%
Project	35%
Final	35%

Homework Policy: Homework will be assigned and due the following week unless otherwise indicated. Some homework assignments will include laboratory work, details of which will be announced. All HW assignments are due at 9:40 AM on the day of submission. Late homework will receive reduction in grade and will not be accepted one week after the due date. One free late homework will be allowed.

Course Project: One course project (group) will be required on one of the following general topic areas:

- metrology (instrumentation and application)
- sensors and control
- error budget determination
- error compensation and/or error measurement
- machine tool design
- process planning
- process modeling
- process characteristics
- form, dimension, surface, subsurface damage analysis
- kinematic models of machines/components
- software for precision manufacturing design and analysis
- software/web-based precision manufacturing tools
- environmentally benign manufacturing
- environmentally sustainable machines
- energy considerations in precision manufacturing
- energy efficient machine tool design

applied to a specific machine tool or process for precision manufacturing.

This is not an exhaustive list. Other project topics may be chosen in consultation with Athulan and may be ones associated with another graduate class you are enrolled in or your graduate studies. Special preference is given to projects related to CAD/geometric modeling of manufacturing process precision, spreadsheet-driven simulations of machine performance (errors, costs etc.,), computational and/or analytical process models, understanding energy usage in precision manufacturing processes, correlating manufacturing process precision and environmental impact. A final project presentation and report is required. Video format presentations are also encouraged. You and your team may also develop "instructional" simulations or experiments for future ME 220 classes.

Additional Reading:
(on 1-day reserve in the Bechtel Engineering Library)

- Dornfeld, D., and Lee, D. E., *Precision Manufacturing*, 2008, Springer.
- A. H. Slocum, *Precision Machine Design* , 1992, Prentice-Hall.
- H. Nakazawa, *Principles of Precision Engineering,* 1994, Oxford University Press.
- P. Seyfried, H. Kuntzmann, P. McKeown and M. Weck, eds., *Progress in Precision Engineering,* Springer-Verlag, 1991.
- C. Evans, *Precision Engineering; An Evolutionary View,* Cranfield Press, 1989.
- Tlusty, J., *Manufacturing Processes and Equipment*, Prentice-Hall, Upper Saddle River NJ, 2000.
- Thomas, T. *Rough Surfaces*, 2^{nd} ed., Imperial College Press, London, 1999.
- Whitehouse, D. J., *Handbook of Surface Metrology*, Institute of Physics Publishing, Philadelphia PA, 1994.

Not on reserve:

- Bhushan, B., ed., *Springer Handbook of Nanotechnology,* Springer, 2004.

Additional papers will be posted on the b-space resource section.

Academic Honesty:
All students should be familiar with the Code of Student Conduct and know that the general rules and student rights stated in that document apply to this class (see http://students.berkeley.edu/osl/osl.asp?id=928). For the purposes of homework assignments, you are allowed (and encouraged!) to *discuss* the problems and techniques with other students in this course, but each student must do his or her own work from scratch and/or write up their own solution. If you discussed your work with other students, or checked your answers against theirs, **you must describe the collaboration in your write-up and acknowledge the student(s) who assisted you or who you assisted** (all students will receive full credit in this case). Turning in someone else's work as your own (or letting someone else turn in your work as their own), on the other hand, will be treated as cheating, and will result in a grade of zero on the assignment for all students involved in the incident. Cheating on the final exam may result in a failing grade for the entire course. The final exam is take home, and collaborating with *anyone* on the exam will constitute as cheating. In all cases of cheating, your actions will also be reported to the Office of Student Conduct for administrative review.

ME 220: Schedule of Lectures (8/19/10)

#	Date	Title	Topics	Reading	HW
1	8/26	No Lecture			
2	8/31	Course Intro and History	Course overview; intro and historical perspective	1.1 - 1.2	
3	9/2	Background, cont'd	Drivers of manufacturing	1.3 - 1.5	
4	9/7	Machine Design	Background; philosophy; sources of error	2.1 - 2.3	0
5	9/9	Principles of Measurement	Measurement basics; Abbe error	3.1 - 3.3	1
6	9/14	Principles of Measurement	Metrology techniques	3.4	
7	9/16	Principles of Measurement	Metrology techniques, cont'd		
8	9/21	Principles of Measurement	Subsurface damage	3.5	2
9	9/23	Mechanical Error	Intro to mechanical error; Kinematic design	4.1-4.3	
10	9/28	Structural Compliance	Review; Macro/micro-scale compliance; Bearings and spindles	4.4-4.5	3a
11	9/30	Thermal Errors	Thermal effects; transfer parameters; specific examples; enclosures	5.1-5.8	
12	10/5	Error Mapping	Error budgets and mapping	6.1-6.3	3b
13	10/7	Compliance Errors Intro	Error mapping review; Intro to compliance errors	6.1-6.3	
14	10/12	Compliance Errors	Deformation errors; structural effects	7.1-7.4	4a
15	10/14	Vibration Errors	Vibrational errors; intro to sensors; need for sensors	7.5-7.7, 8.1-8.2	
16	10/19	Field Trip: tbd			4b
17	10/21	Sensors	Need for sensors; technology; signal processing	8.1-8.4, 8.9	
18	10/26	Sensors; Precision Processes	Applications; integration	8.10	
19	10/28	Intro. to Precision Processes	Tool/material effects; scale effects	10.1-10.3, 11.6	5
20	11/2	Machining Processes	Diamond milling/turning; Micromachining	10.4	
21	11/4	Abrasive Processes	Ultraprecision abrasive methods; CMP; non-traditional	10.5-10.6	6
22	11/9	Other Processes	Semiconductor processes; nanotechnology; MEMS; microfluidics	11.1-11.5	
23	11/11	Veteran's Day			
24	11/16	Process Planning	Process planning; capability; systems	9.1-9.6	
25	11/18	CAD/CAM	Role of CAD/CAM in precision manufacturing	Handouts	
26	11/23	Energy and Manufacturing	Metrics; measurement methods; energy consumption in processes	Handouts	
27	11/25	Thanksgiving			
28	11/30	Project Presentations	Group project presentations		
29	12/2	Course Overview	Overview and summary; course surveys		