San Jose State University
Mechanical Engineering Department
ME 250, Precision Machine Design, Fall 2019

Instructors:	Michel Pharand, M.S. (Lectures) Raymond J. Ellis, M.S., P.E. (Labs)
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Office Hours:	by appointment
Class Days/Time:	Monday, Wednesday from 6:00PM to 7:15PM
Classroom:	Engineering 403
Prerequisites:	BSME degree or instructor consent. Mechanics of materials, Engineering statistics, Statics and Dynamics, Linear algebra (Matrix Manipulation), basic **knowledge of Matlab/Simulink and FEA**.
Class Number:	26237

ME 250 Course Web Page

Copies of the course materials, syllabus, assignments, handouts, examples, etc., may be found on the https://drive.google.com/drive/folders/0B5dG8oVHxW18aGJscXFGMTVnOFU?usp=sharing

You are responsible for regularly checking this site for updates.
Please send me an email to cdn.precision@gmail.com

ME 250 Course Description

Principles of precision machine design. Exact kinematic constraint. Error motions of a machine. Integration of mechanical design, materials, sensors, and metrology for precision applications. Laboratory experiments are designed to give the student hands-on experience with metrology instruments and measurement techniques for precision engineering. (3 units; lecture & lab)

ME 250 Course Goals

The goals of this course are to:

1. Provide an overview of the principles and practice of precision machine design, and develop the necessary understanding and discipline to successfully design and develop precision machines and mechanisms.
2. Introduce the field of precision engineering and the body of literature in this field.
3. Provide hands on experience with metrology instruments and practice that is widely used in precision engineering
4. To sharpen research skills and written and oral communication skills.

ME 250 Student Learning Objectives

Upon successful completion of this course, students will be able to:

1. Explain in his/her own words and distinguish the meanings of accuracy, repeatability, resolution, cosine error, sine error, and Abbé 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/her own words the pros and cons of flexure design, identify where a flexure could be used to accomplish a particular design goal, and conceptually design a flexural system to achieve the desired “stiff” and “flexible” degrees of freedom.
4. Explain the fundamental concepts in geometric dimensioning and tolerancing (GD&T).
5. Select appropriate materials to design a precision component or device considering tradeoffs in performance, cost, machinability, etc.
6. Apply the concept of error budgeting to the design of an instrument.
7. Explain in his/her own words the concept of self-calibration and where it can be used.
8. Explain what is meant by, and identify, the structural and measurement loops in a precision device.
9. List some of the important actuators used in precision instruments, explain their performance characteristics, and select an appropriate one for a particular application.
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. Properly use common metrology tools and procedures for precision engineering measurements.
12. Properly document experiments with clear problem statement, procedures, analyses, and results. Accurately analyze data and present clear results.

Required Texts / Readings

Textbook

Slocum, A. H., *Precision Machine Design*, Society of Manufacturing Engineers, Dearborn, MI, 1992.

Other Readings

Smith, S. T., Chetwynd, D. G., *Foundations of Ultraprecision Mechanism Design*, CRC Press, 1994. (ISBN-10: 2884490019, ISBN-13: 978-2884490016)

Smith, S. T., *Flexures, Elements of Elastic Mechanisms*, CRC Press, 2000.

Blanding, D. L., *Exact Constraint: Machine Design Using Kinematic Principles*, ASME, New York, 1999.

Classroom Protocol

Complete reading assignments prior to class. Homework is due at the beginning of class on day indicated. Class participation is encouraged. No mobile phone calls or texting during class.

Dropping and Adding

Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Refer to the current semester's Catalog Policies section at http://info.sjsu.edu/static/catalog/policies.html. Add/drop deadlines can be found on the current academic calendar web page located at http://info.sjsu.edu/web-dbgen/narr/catalog/rec-12234.11649.html. The Late Drop Policy is available at http://www.sjsu.edu/aars/policies/latedrops/policy/. Students should be aware of the current deadlines and penalties for dropping classes.

Information about the latest changes and news is available at the Advising Hub at http://www.sjsu.edu/advising/.

Assignments and Grading Policy

Homework 10%, Midterm 25%, Lab Reports 20%, Term Project 20%, Final Exam 25%. If you get a better grade on the final than in the mid-term, I will only count the final grade. Overall grades will be determined using 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

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

Laboratory: Students in teams will work through a series of hands-on exercises to learn about common metrology instruments and practices used in precision engineering. Lab reports and/or presentations will document the content and results of the experiments. Lab reports are due one week after the lab is taken.

Term Project: The instructor will assign a term project to groups of students. The goal of the project is to put in practice basic knowledge gained from the course.

University Policies

Academic integrity

Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. The University's Academic Integrity policy, located at http://info.sjsu.edu/static/catalog/integrity.html, requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at http://www.sjsu.edu/studentconduct/.

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy S07-2 requires approval of instructors.

Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the Accessible Education Center (AEC) at http://www.sjsu.edu/aec/ to establish a record of their disability.

Time Required

Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of forty-five hours over the length of the course (normally 3 hours per unit per week with 1 of the hours used for lecture) for instruction or preparation/studying or course related activities including but not limited to internships, labs, clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus.

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Course Schedule

Course Schedule is subject to change with fair notice. For readings, assignments, and deadlines, see ME 250 high-resolution Course Schedule. Updates will be made available in class and available for download at the Precision Engineering class web site.

Week	Date	Topics
1	Aug 21	Introduction to Precision Machine Design and Review
2	Aug 26	Basic Statistics & Definitions - Repeatability, Precision, Accuracy
	Aug 28	Kinematic Design I – Exact Constraints
3	Sep 2	Labor Day (No Class)
	Sep 4	Kinematic Design II – Exact Constraints
4	Sep 9	**Term Project – Assignment and Discussion on Content and Deliverables**
	Sep 11	Metrology Rule of 10, Sine and Cosine Error
4	Sep 16	**Lab 1:** Intro to Basic Metrology Instruments & Measurements
	Sep 18	Vibrations SDOF and 2DOF, Damping, Mass Dampers
5	Sep 23	Geometric Dimensioning & Tolerancing (GD&T)
	Sep 25	**Lab 2:** Part Inspection using Metrology Tools
6	Sep 30	Error Budget, Using Homogenous Transformation Matrix
	Oct 2	Hertz Contact Stress, Stiffness (Parallel/Series), Linear Bearings
7	Oct 7	Flexure Design and Analysis part I (with FEA)
	Oct 9	Flexure Design and Analysis part II (with FEA)
8	Oct 14	Structures and Metrology Frames (with FEA)
	Oct 16	**Midterm Exam**
9	Oct 21	Reversal & Self-Calibration Part I
	Oct 23	**Lab 3:** Kinematic Repeatability / Straightness / Reversal
10	Oct 28	**Term Project – Q&A session /** Reversal & Self-Calibration PII
	Oct 30	Material Properties for Precision Engineering Design
11	Nov 4	Athermalization design
	Nov 6	Manual Actuators (Screw Type), Ball Screws and Motor Couplings
12	Nov 11	No class (campus closed)
	Nov 13	**Lab 4:** Kinematic Repeatability/Straightness /Reversal

13	Nov 18	Actuators – High Stiffness (Piezo) and Low Stiffness (Lorentz)
	Nov 20	**Lab 5:** Kinematic Repeatability/Straightness /Reversal
14	Nov 25	Air Bearings
	Nov 27	No Class
15	Dec 2	Sensors: Position, Velocity, Acceleration, and Force
	Dec 4	Term Project Presentations
16	Dec 9	Term Project Presentations
	Dec 11	**Final Exam**