San Jose State University
Mechanical Engineering Department
ME 250, Precision Machine Design, Fall 2022

Instructors:	Michel Pharand, M.S.
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Office Hours:	Saturday mornings via zoom meeting 9:00AM to 10:00AM
Class Days/Time:	Tuesday, Thursday from 6:00PM to 7:15PM
Classroom:	Eng. 301
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:	TBD

ME 250 Course Web Page

Copies of the course materials, syllabus, assignments, handouts, examples, etc., will be posted 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. (3 units; lecture)

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. 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.

Course Material

Student will be required to purchase a basic list of material for Term Project 1.

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 (Zoom)

Complete reading assignments prior to class. No mobile phone calls or texting during class. Students will be required to turn on their camera during the zoom meetings.

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

Project I, 45%, Project II, 45%, Design notebook at the end of the term 10%. 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 not be collected

Term Projects: Two lectures will be dedicated to review the projects details. For project I, some knowledge of electronics is desirable. The goal of the projects are to put in practice the knowledge gained from the course.

Design Notebook: Each student needs to maintain a design notebook. This notebook will contain notes on projects and in class questions assigned at the end of each lectures. It will be collected at the end of the semester for an additional 10%.

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.

ME 250, Precision Machine Design, Spring 2021
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
	8/23/2022	Introduction to Precision Machine Design – Design process from coarse to fine. PMD historical perspective. Basics - part I
1	8/25/2022	Review free body diagrams, beam equations, combined stresses, friction, load with time dependencies
	8/30/2022	Basic Statistics & Definitions - Repeatability, Precision, Accuracy
2	9/1/2022	Kinematic Design I – Exact Constraints
	9/6/2022	**Term Project 1** – Load Cell Design/Analysis/Fabrication (Due Date 10/11/2022)
3	9/8/2022	Kinematic Design II – Exact Constraints
	9/13/2022	Metrology Rule of 10, Sine and Cosine Error
4	9/15/2022	Vibrations SDOF and 2DOF, Damping, Mass Dampers I
	9/20/2022	Vibrations SDOF and 2DOF, Damping, Mass Dampers II
5	9/22/2022	Experimental Modal Testing
	9/27/2022	Geometric Dimensioning & Tolerancing (GD&T)
6	9/29/2022	Error Budget - Using Homogenous Transformation Matrix for design and motion analysis
	10/4/2022	Stiffness (Parallel/Series), Linear rail bearings
7	10/6/2022	Flexure Design and Analysis part I (with FEA)
	10/11/2022	Flexure Design and Analysis part II (with FEA)
8	10/13/2022	**Project Presentations: Load Cell**
	10/18/2022	**Term Project 2** – Design and Analysis of a vertical lifting Stage (Due 12/1/2022)
9	10/20/2022	Material Properties for Precision Engineering Design
	10/25/2022	Reversal & Self-Calibration
10	10/27/2022	Thermal Design Part I

	11/1/2022	Thermal Design Part II
11	11/3/2022	Structures and Metrology Frames (with FEA)
	11/8/2022	Manual Actuators (Screw Type), Ball Screws and Motor Couplings
12	11/10/2022	Feedback Control Systems for Precision Machine Design; transfer function, bode plots, noise, sensitivity analysis
	11/15/2022	Actuators – High Stiffness (Piezo) and Low Stiffness (Lorentz)
13	11/17/2022	Sensors: Position, Velocity, Acceleration, and Force
	11/22/2022	Motor Design and Control Part 1
14	11/24/2022	Thanksgiving no-class
	11/29/2022	Motor Design and Control Part 2
15	12/1/2022	Review and special topics
	12/6/2022	**Term Project Presentations**