San José State University
Mechanical Engineering Department
ME 147-02: Dynamic Systems Vibration and Control, Spring 2023

Course and Contact Information

Instructor	Professor Long Lu
Email Address	Long.Lu@sjsu.edu
Office Hours and Location	Monday and Wednesday 8:00 AM-9:00 AM at ENG 303 Friday 6:00 PM-7:00 PM online via Zoom
Class Days/Time/Location	Monday and Wednesday 9:00 AM-10:15 AM at ENG 303
Prerequisites	ME 130 (with a grade of 'C-' or better)

Course Format
The course relies on lecture materials presented in class, and students are strongly encouraged to attend.

Course Materials
Course materials such as the syllabus, homework assignments, solutions,... will be available on Canvas. You are responsible for regularly checking Canvas to learn of any updates and announcements. For help with using Canvas, please see Canvas Student Resources page.

Course Description
Mathematical representation of dynamic systems. Damped and undamped free and forced vibrations of single and multi-degree of freedom systems. Vibration control and isolation. Dynamic analysis of control systems. Transient response, frequency response and the stability criteria. State-variables approach. Feedback and feed-forward compensation. Emphasis on engineering problems involving analysis and design.

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

1. model and analyze simple vibratory systems
2. calculate transient and steady-state responses for a vibratory system
3. design a vibratory system to reduce amplitude of vibration and/or transmitted forces
4. analyze multi-degree of freedom systems to determine eigenvalues and eigenvectors
5. develop a mathematical model of a control system
6. analyze a control system to determine its transfer function and characteristic equation
7. predict system stability and performance
8. design controllers to meet stability and performance goals
9. determine the relative stability gain and phase margins of a control system
10. use modern computational tools such as MATLAB for analysis and design.

Textbooks and Additional References

Required Textbook
Dynamic Systems Vibration and Control by Dr. Fred Barez which is available for order at the Spartan Bookstore, and also available for online order at <https://he.kendallhunt.com/product/dynamic-systems-vibration-and-control-0>.

Additional References (Optional)
[1] Kelly, S. G. *Fundamentals of Mechanical Vibrations*. McGraw-Hill.
[2] Rao, S. S. *Mechanical Vibrations*. Prentice Hall.
[3] Dorf, R. C. and Bishop, R. H. *Modern Control Systems*. Prentice Hall.
[4] Nise, N. S. *Control Systems Engineering*. John Wiley & Sons, Inc.
[5] Ogata, K. *Modern Control Engineering*. Pearson.

Homework Assignments
Homework assignments are individual effort assignments. Students are encouraged to have intellectual discussions about the homework problems. However, all students must prepare and submit their own solutions to the homework problems which reflect their understanding and problem-solving methodologies. Any form of cheating or plagiarism will not be tolerated. Homework is typically assigned as a set and due to Canvas in one week. No late homework submissions will be accepted. Therefore, it is crucial that students regularly check Canvas for important class announcements. Please type or scan your homework and submit it as a PDF file to Canvas by the announced deadline.

Examinations
There will be two 75-minute midterm exams and one 135-minute final exam. The final exam will be comprehensive, covering all materials and topics presented in class. Please consult the class schedule for the exam dates and times. There will be no make-ups for missed exams, except for medical or other reasons outside the student's control, and such must be documented with a written notice and proof.

Grading Information
Course grade will be out of 1000 points total.

Homework:	300 points
Midterm Exam 1:	200 points
Midterm Exam 2:	200 points
Final Exam:	300 points
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Total points:	1000 points

Determination of Letter Grades
There will be no curving of grades. Letter grades will be based on the total points and assigned as follows:

- Total points $\geq$ 970 points: A+
- 940 points $\leq$ Total points $<$ 970 points: A
- 900 points $\leq$ Total points $<$ 940 points: A-
- 850 points $\leq$ Total points $<$ 900 points: B+
- 800 points $\leq$ Total points $<$ 850 points: B
- 760 points $\leq$ Total points $<$ 800 points: B-
- 720 points $\leq$ Total points $<$ 760 points: C+
- 690 points $\leq$ Total points $<$ 720 points: C
- 650 points $\leq$ Total points $<$ 690 points: C-
- 620 points $\leq$ Total points $<$ 650 points: D+
- 590 points $\leq$ Total points $<$ 620 points: D
- 550 points $\leq$ Total points $<$ 590 points: D-
- Total points $<$ 550 points: F

University Policies
Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' Syllabus Information web page at <http://www.sjsu.edu/gup/syllabusinfo/>.

ME 147-02: Dynamic Systems Vibration and Control
Tentative Course Schedule/Outline

Week/Dates	Discussions Topics/Class Activities
Week 1 W 01/25	Welcome to ME 147, Class Orientation, Syllabus Discussion
Week 2 M 01/30 & W 02/01	Introduction to Vibration, Principles of Newtonian Mechanics, Degrees of Freedom
Week 3 M 02/06 & W 02/08	Equations of Motion, Free Vibration, Natural Circular Frequency, Period of Oscillation, Undamped Free Vibration, Energy Method
Week 4 M 02/13 & W 02/15	Damped Free Vibration, Forced Vibration
Week 5 M 02/20 & W 02/22	Undamped and Damped Forced Vibration
Week 6 M 02/27 & W 03/01	Transmissibility, Multi Degree of Freedom Systems, Eigenvalues and Eigenvectors
Week 7 M 03/06 & W 03/08	Vibration Simulation with MATLAB
Week 8 M 03/13 & **W 03/15**	Design for Vibration Control, Vibration Isolation **Review for Midterm Exam 1 on Wed 03/15**
Week 9 **M 03/20** & W 03/22	**Midterm Exam 1: 9:00 AM-10:15 AM on Mon 03/20** Vibration Absorbers, Distributed Parameter Systems, Wave Equations, Solutions to Wave Equations
Week 10 **M 03/27 & W 03/29**	**No class (Spring Recess)**
Week 11 M 04/03 & W 04/05	Flow-Induced Vibrations, Introduction to Control, Mathematical Modeling of Physical Systems, Open-Loop and Closed-Loop Systems
Week 12 M 04/10 & W 04/12	Transfer Functions, System Responses, Block Diagrams
Week 13 M 04/17 & W 04/19	Poles and Zeros, System Stability Analysis Routh-Hurwitz Criterion
Week 14 M 04/24 & **W 04/26**	Time Domain Analysis, Transient and Steady-State Responses **Review for Midterm Exam 2 on Wed 04/26**
Week 15 **M 05/01** & W 05/03	**Midterm Exam 2: 9:00 AM-10:15 AM on Mon 05/01** State-Variable Method, General Form of the State Variable Equations, Solution of State Equations, Controller Types, Controller Design
Week 16 M 05/08 & W 05/10	Frequency Analysis, Nyquist Stability Analysis, Bode Diagrams, Gain and Phase Margins, Bandwidth, Root Locus
Final Exam Week **M 05/15** **T 05/23**	**Review for Final Exam on Mon 05/15** **Final Exam: 7:15 AM-9:30 AM on Tue 05/23**