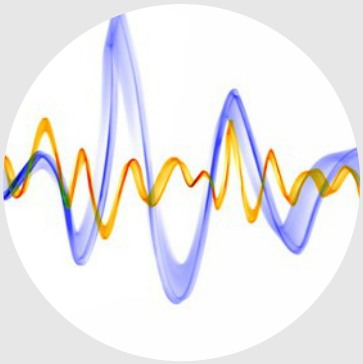

Mechanical Vibrations

MECH 411 - Fall 2021

3 Credits

Instructor Info

Masoud Masoumi

Office Hrs: Mon & Thur 11-12pm

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Course Info

Prereq: MATH 286 & ENGS 220

Mondays & Thursdays

8:00-9:15am

Leo Engineering Bldg 256

Overview

This course covers the modeling, analysis, and optimization of mechanical vibrating systems. The course starts with elements of a single degree-of-freedom (DOF) vibrating system, and continues with time and frequency response, and application of different single DOF vibrating systems. Multiple DOF system will be introduced and methods of determining their natural frequencies, mode shapes, time response, and frequency response will be covered. Vibration control techniques such as use of a vibration isolator, a vibration absorber, and suspension optimization. Newton and Lagrange methods are used throughout the course.

Learning Objectives

- Understand the fundamentals of vibration theory
- Mathematically model mechanical vibration problems.
- Study and analyze SDOF and MDOF vibrating systems as well as find their natural frequencies, time responses, and frequency responses.
- Understand and apply vibration control techniques, such as vibration isolators and vibration absorbers.

Material

Required Text

Daniel J. Inman, *Engineering Vibration*, 4th Edition, Pearson (2013)

Complementary Texts

Singiresu S. Rao, *Mechanical Vibrations*, 6th Edition, Pearson (2016)

S. Graham Kelly, *Mechanical Vibrations: Theory and Applications*, SI Edition, Cengage Learning (2012)

Other

Any handouts, required journal articles and book chapters will be provided.

Grading Scheme

10%	Homework
15%	Quizzes (every other Thursday)
40%	2 Midterm Exams (20% each)
25%	Final Exam
10%	Project

A	Grade $\geq 93\%$
A^-	$90\% \leq$ Grade $< 93\%$
B^+	$87\% \leq$ Grade $< 90\%$
B	$83\% \leq$ Grade $< 87\%$
B^-	$80\% \leq$ Grade $< 83\%$
C^+	$77\% \leq$ Grade $< 80\%$
C	$73\% \leq$ Grade $< 77\%$
C^-	$70\% \leq$ Grade $< 73\%$
D^+	$65\% \leq$ Grade $< 70\%$
D	$60\% \leq$ Grade $< 65\%$
F	Grade $< 60\%$

ABET Outcomes

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

Homework

Homework will be assigned after the completion of each topic. All problem assignments will be due the following week unless another date is specified. Completed assignments should be submitted on Moodle by the beginning of class and late work will not be accepted. Please do not email your late homework assignments to the instructor.

FAQs

What if my schedule does not allow me to attend office hours?

You are more than welcome to make an appointment whenever you have a question or concern by contacting me via email.

What is the topic for the project?

The details for the project will be announced after the second midterm. As a general guideline, you will have to analytically model a MDOF vibrating system and simulate its response using computer programming.

Is there any online resource that you suggest for this course?

There are many references and materials available for mechanical vibrations. However, a recommended resource is https://www.acs.psu.edu/drussell/demos.html.

What is your advice for performing well in this course?

Be an active listener, take good notes, and read all assigned materials. Don't just read the solutions to the problems and examples, solve them! Be organized and manage your time appropriately.

- Submitted assignments should be clean, clear and well-organized.
- Solutions should contain all steps leading to the final answer.
- Final answers must be underlined, circled, highlighted, or in some way distinguished from the rest of the problem.

Class Policy & Attendance

Due to the nature of the materials covered in this course, regular attendance is highly recommended. Students are required to fulfill all course requirements as detailed in the course syllabi for their registered courses. Implicit in these requirements is completion of all course assignments and attendance in all classes. Also, if I believe that a student's failure to attend class is substantially affecting his/her course grade, I am obligated to report the situation to the dean of the school in which the student is matriculated. The dean will address the situation with the student. In case you miss a class, it is your responsibility to keep up with the class work and be informed of all announcements in class such as homework assignments, quizzes, etc. Cell phones and all other forms of electronic communication devices, if carried into the classroom, must be turned off. The use of computers and other electronic devices during class is restricted to classroom activities and course applications.

Academic Integrity

The college Community Standards & Student Code of Conduct is central to the ideals of this course. Students are expected to be independently familiar with the code and to recognize that their work in the course is to be their own original work that truthfully represents the time and effort applied. Violations of the Academic Policies of the Community Standards & Student Code of Conduct are most serious and will be handled in a manner that fully represents the extent of the Code and that befits the seriousness of its violation. See the code here https://inside.manhattan.edu/student-life/dean-of-students/code-conduct.php#academicintegrity for more information.

Diversity and Inclusivity

I consider this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, gender identities, national origins, religious affiliations, sexual orientations, ability, and other visible and non-visible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

Accommodations for Students with Special Needs

If you are a student with learning needs that require special accommodation, contact the Accommodation Administrator in Specialized Resource Center (SRC) located in Thomas Hall, Room 3.15 as soon as possible to make an appointment to discuss your special needs. Once your Academic Adjustment/ Auxiliary Form is approved, please meet with me during my office hours and bring the form. You can find more information about SRC and the procedure on their website https://inside.manhattan.edu/academic-resources/specialized-resource-center/index.php.

Class Schedule

The course will tentatively follow this schedule :

Week	Topic	Textbook	Date
Week 1	Introduction to Free Vibration	1.1	Aug 30^{th}, Sep 2^{nd}
Week 2[+]	Harmonic Motion	1.2	Sep 9^{th}
Week 3	Harmonic Motion	1.2	Sep 13^{th}
	Free Vibration with Viscous Damping	1.3	Sep 16^{th}
Week 4	Free Vibration with Viscous Damping	1.3	Sep 20^{th}
	Modeling and Energy Methods	1.4	Sep 23^{rd}
Week 5	Stiffness	1.5	Sep 27^{th}
	Measurement	1.6	Sep 30^{th}
Week 6	Coulomb Friction	1.10	Oct 4^{th}
	Exam I		Oct 7^{th}
Week 7	Harmonic Excitation of Un-damped Systems	2.1	Oct 12^{th}, Oct 14^{th}
Week 8	Harmonic Excitation of Systems with Viscous Damping	2.2	Oct 18^{th}, Oct 21^{st}
Week 9	Base Excitation	2.4	Oct 25^{th}
	Rotating Unbalance	2.5	Oct 28^{th}
Week 10	Non-Harmonic Excitation of Systems with Viscous damping	3.1 & 3.2	Nov 1^{st}
	Exam II		Nov 4^{th}
Week 11	Systems with Multi-Degree-of-Freedom	4.1 - 4.3	Nov 8^{th}, Nov 11^{th}
Week 12	Software & Project Assignment	–	Nov 15^{th}
	Systems with Multi-Degree-of-Freedom	4.1 - 4.3	Nov 18^{th}
Week 13[x]	Systems with Multi-Degree-of-Freedom	4.1 - 4.3	Nov 22^{nd}
Week 14	Lagrange Method for Systems with Multi-Degree-of-Freedom*	4.7	Nov 29^{th}
	Vibration Isolation & Absorption	5.2 & 5.3	Dec 2^{nd}
Week 15	Vibration Isolation & Absorption	5.2 & 5.3	Dec 6^{th}
	Critical Speeds of Shafts with a Disk*	5.7	Dec 9^{th}
Week 16	Final Exam		TBA

[+] Monday, September 6^{th} is Labor Day and there is no class.
[x] Thursday, November 25^{th} is Thanksgiving Day and there is no class.
[*] We will cover these topics only if time permits.