Vibrations

EML 4220 Section 2703
Class Periods: MWF 5 (11:45am – 12:35pm)
Location: Larson 0239
Academic Term: Fall 2022

Instructor:
Dr. Patrick Musgrave
Assistant Professor, Mechanical and Aerospace Engineering Dept.
pmusgrave@ufl.edu
(352) 392-6230
Office Hours: TBD

Teaching Assistant/Peer Mentor/Supervised Teaching Student:
Please contact through the Canvas website

- Boyang Gu, guboyang@ufl.edu
  Office Hours: TBD
- Matthew Nguyen, nguyen.m@ufl.edu
  Office Hours: TBD

Course Description
Single and multiple degree of freedom systems, including application to mechanical systems with problems employing computer techniques. Credits: 3

Course Pre-Requisites / Co-Requisites
Prerequisite: EGM 3344 and EGM 3401 and EGM 3520 and MAP 2302 with minimum grades of C.

Course Objectives
This course presents the fundamental engineering science and mathematical principles required for the understanding of vibrations. Students will (a) learn the concepts needed to understand and analyze the dynamic behavior of vibrating systems and (b) will develop the skills necessary to design mechanical systems that suppress or enhance vibrations. Upon completion of this course, each student should have:

1. General understanding of vibration analysis and the ability to apply this understanding towards solving a given problem.
2. Basic understanding of free, damped, and forced vibrations in single and multiple degree of freedom systems
3. The ability to apply advanced science and engineering principles in the design and analysis of structures to suppress or enhance vibrations.

Materials and Supply Fees
None

Relation to Program Outcomes (ABET):

Outcome	**Coverage***
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
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	Low
3. An ability to communicate effectively with a range of audiences	

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	Low
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Low
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Low

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbook

- Engineering Vibration
  Daniel J. Inman
  4th Edition, 2014 (Prentice Hall, Inc.)
  ISBN-10: 0132871696
  ISBN-13: 978-0132871693

This course is participating in UF All Access program. Login at the following website and Opt-In to gain access to your required eBook. https://www.bsd.ufl.edu/G1CO/IPay1f/start.aspx?TASK=INCLUDED – UF All Access will provide you with your required materials digitally at a reduced price and the ability to pay using your student account. This option will be available starting 1 week prior to the semester starting and ending 3 weeks after the first day of class. For print purchasing options or study guides and additional course materials please visit https://www.bkstr.com/floridastore/home or the UF Bookstore located in the Reitz Union.

Recommended Reading

We will largely follow the layout of the Inman book. It is extremely useful. I suggest you read the relevant chapters, especially if you are having issues with the homework. Any edition of the book is fine for content, but homework problems will be assigned from the 4th edition of the book.

Required Software

- MATLAB Student Version
  - This will be used throughout the class and on some homework assignments.
  - You may consider using UFApps to access a number of popular software applications for "free" including Matlab at: http://info.apps.ufl.edu/
    - Not all toolboxes are included in this version.
  - Matlab is also available for purchase and download at: http://www.mathworks.com/academia/student_version/index.html

Attendance Policy, Class Expectations, and Make-Up Policy

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies: https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/

Attendance

- Regular class attendance is expected. Attendance is not explicitly included in the grade evaluation; however, there will be in-person quizzes.
- If the instructor is unable to hold a lecture in-person (due to travel), lectures will be pre-recorded and posted to Canvas. Students are expected to watch the recorded lectures before the following class.
- You are expected to take a sincere interest in learning the classroom material.
  - You are expected to show up on time for class.
  - Please silence/turn-off all cell phones prior to the start of class

- If you are a distraction in class, you will be asked to leave.
- Please do not bring food to class.

Exams

- Exam dates:
  - Mid-Terms:
    - All mid-terms will be conducted during class time
    - Exam 1 – 9/21
      - Contents: Free Vibrations (Inman – Ch 1)
    - Exam 2 – 10/26
      - Contents: Forced Vibrations/Response to Harmonic Excitation (Inman – Ch 2)
    - Exam 3 – 11/16
      - Contents: General Forced Response (Inman – Ch 3)
  - Final Exam (Cumulative):
    - 12/13 from 3:00-5:00pm (https://registrar.ufl.edu/courses/final-exam.html)
    - The final is cumulative, and any material taught in the class could be on the final (Inman Ch 1-5)
    - Emphasis will be placed on material that is not evaluated on Mid-terms 1-3:
      - Multi Degree of Freedom Systems, Vibration Suppression (Inman – Ch 4 & portions of 5).

- A formula sheet will be allowed during exams (one page, two sided). Otherwise, exams will be closed-book and closed-notes.
- Cell phones and physical calculators are NOT allowed during exams.
- Exam problems may be taken directly from the homework problems or from lecture discussions with some modifications. Thus, in addition to the weight placed on homework in the final grade, it is to your advantage to understand as many of the homework problems as possible. The emphasis of the exams will be to test your understanding, not on formulaic repetition, so expect the exam problems to be challenging and to test your grasp of the methods taught in the class.
- It is the students' responsibility to communicate their knowledge on the exams. In order to be able to grade your work, it must be neat, legible, and follow in logical steps with all work shown. Partial credit may be given for work which can be followed and the nature and magnitude of the mistake identified. No credit will be given for incorrect answers with insufficient indication of how they were obtained.
- The lowest mid-term exam grade will be dropped. A missed mid-term will count as your dropped exam.
- Make-up exams will not be given since a student's lowest mid-term exam grade will be dropped.
  - Makeup exams are only allowed for students with extreme, documented circumstances. Students must contact the instructor as soon as possible to provide documentation and request a make-up exam. Excused absences must be consistent with university policies in the undergraduate catalog and require appropriate documentation (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx).
- If you do not agree with the grading of a particular exam problem, you will have one week from the date the exam is returned to submit a written argument of why you think the grade should be higher. However, the final decision will remain the instructor's.

Quizzes

- Quizzes will take place during class time and will typically last 10-15min
- Tentative dates for the quizzes are given in the attached schedule and will take place sometime during the scheduled class period
- A computer or cell phone is required to record your answers in Canvas
- The quizzes will typically cover concept type questions that test your fundamental understanding
- The lowest quiz grade will be dropped. A missed quiz will count as your drop.
- Make-up quizzes will not be given since the lowest will be dropped

- Makeup exams are only allowed for students with extreme, documented circumstances. https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

Homework

- HW will be posted on Canvas along with its due date (typically due on Sundays at 11:59pm)
- HW will be turned in on Canvas.
- All assigned problems will be graded for completion, some or all will be graded for accuracy.
- Homework will be submitted online and must be in .pdf format. If submitting handwritten assignments, **the submission should be a scanned version.** Do not take a picture of your homework, as this results in unnecessarily large files. Scanner apps are available for free for mobile devices (e.g. Adobe Scan).
- Late HW policy:
  - HW submitted after the deadline will have a 25% deduction.
  - Late HW will not be accepted 24 hours after the due date.
  - Hardship cases will be considered on an individual basis and only if the instructor has been contacted before the due date of the assignment. Students with hardship cases (e.g., due to medical problems) will be referred to the Dean of Students office, which will perform a background investigation to determine if the hardship is legitimate.
- If you do not agree with the grading of a HW problem, you will have one week from the date the HW is returned to submit a written argument of why you think the grade should be higher. However, the final decision will remain the instructor's.

E-learning course web site (Canvas)

- E-Learning/Canvas system (https://elearning.ufl.edu) – all documents, homework, grades, etc. will be posted on this system.
  - Students are expected to check Canvas on a regular basis for up-to-date course information. This may include changes to the syllabus, homework assignment due dates, and exam schedules.
- Slack will be used as a discussion forum for this course.
  - Click here to join. Link is valid until 9/16/2022. Email the instructor or TA after this date to join
  - This channel is a good way for students to discuss topics amongst each other, and it is a good way to ask the Instructor and/or TA questions outside of office hours.
  - Any information about HW assignments, due dates, etc. will be posted to Canvas

Evaluation of Grades

Assignment	**Percentage of Final Grade**
Midterm Exams *(Drop Lowest)*	40%
Final Exam	35%
Quizzes *(Drop Lowest)*	15%
Homework	10%
Total	100%

Grading Policy

Percent	**Grade**	**Grade Points**
93.4 – 100	A	4.00
90.0 – 93.3	A-	3.67
86.7 – 89.9	B+	3.33
83.4 – 86.6	B	3.00
80.0 – 83.3	B-	2.67

76.7 – 79.9	C+	2.33
73.4 – 76.6	C	2.00
70.0 – 73.3	C-	1.67
66.7 – 69.9	D+	1.33
63.3 – 66.6	D	1.00
60.0 – 63.3	D-	0.67
0 – 59.9	E	0.00

More information on UF grading policy may be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Students Requiring Accommodations
Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

In-Class Recording
Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session. Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

Course Schedule

Week	Date	Day	Lecture #	Comment	Quiz	Chapter	Content
1	8/24	W	1			1	Introduction
	8/26	F	2			1	DOFs and Springs
2	8/29	M	3			1	Free Vibrations
	8/31	W	4		Q1	1	Free Vibrations
	9/2	F	5			1	Damping
3	**9/5**	**M**	**No Class**	**Labor Day**			
	9/7	W	6		Q2	1	Damping
	9/9	F	7	Online/Pre-recorded		1	Energy Methods
4	9/12	M	8	Online/Pre-recorded		1	Energy Methods
	9/14	W	9	Online/Pre-recorded		1	Energy Methods
	9/16	F	10		Q3	1	Design Considerations
5	9/19	M	11			1	Exam Review (TBD)
	9/21	W	12			1	**Exam 1 - Free Vibrations**
	9/23	F	13	Online/Pre-recorded		2	Harmonic Forcing
6	9/26	M	14	Online/Pre-recorded		2	Harmonic Forcing
	9/28	W	15	Online/Pre-recorded		2	Harmonic Forcing
	9/30	F	16	Online/Pre-recorded		2	Harmonic Forcing
7	10/3	M	17			2	Harmonic Forcing
	10/5	W	18		Q4	2	Base Excitation
	10/7	**F**	**No Class**	**Homecoming**			
8	10/10	M	19			2	Base Excitation
	10/12	W	20		Q5	2	Base Excitation
	10/14	F	21			2	Rotating Unbalance
9	10/17	M	22	Online/Pre-recorded		3	General Vibration Response
	10/19	W	23	Online/Pre-recorded		3	General Vibration Response
	10/21	F	24		Q6	3	General Vibration Response
10	10/24	M	25			2	Exam Review (TBD)
	10/26	W	26			2	**Exam 2 - Harmonic Forcing**
	10/28	F	27			3	Arbitrary Forcing
11	10/31	M	28			3	Periodic Forcing
	11/2	W	29		Q7	3	Periodic Forcing
	11/4	F	30			3	Laplace Transforms
12	11/7	M	31			3	Laplace Transforms
	11/9	W	32		Q8	4	MDOF Systems
	11/11	**F**	**No Class**	**Veterans Day**			
13	11/14	M	33			3	Exam Review (TBD)
	11/16	W	34			3	**Exam 3 - General Vibration Response**
	11/18	F	35			4	MDOF Systems
14	11/21	M	36	Online/Pre-recorded		4	MDOF Systems
	11/23	**W**	**No Class**	**Thanksgiving**			
	11/25	**F**	**No Class**	**Thanksgiving**			
15	11/28	M	37			4	Modal Analysis
	11/30	W	38		Q9	4	Modal Analysis
	12/2	F	39			5	Vibration Isolation
16	12/5	M	40		Q10	5	Vibration Isolation
	12/7	W	41			1-5	Exam Review
17	12/13	Tu	-	3-5pm, Larson 239		1-5	**Final Exam**

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Cheating at the University of Florida is unacceptable and will not be tolerated. While learning together and collaboration in the interest of learning are welcome, cheating and plagiarism are not. You are welcome to work with others to learn, but your work must be your own. If you need help with a problem, do not search for someone else's solution on Chegg. Using solutions such as those on Chegg is an Honor Code violation. Instead, **come to office hours to get help from the TAs or myself!** We are the most direct and Honor Code-approved method of getting help in the class. *Use us!*

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

On-Line Students Complaints*: https://distance.ufl.edu/state-authorization-status/#student-complaint*.