

ME 370-1: Vibration of Mechanical Systems Course Syllabus – Spring 2008

- Instructor:** Dr. Qian Wang
325 Leonhard Bldg.
Phone: 865-8281
Email: quw6@psu.edu
- Class Schedule:** MWF, 2:30 – 3:20pm, 135 Reber Bldg.
- Office Hours:** Mon 1:10 pm – 2:10 pm, Wed 11:00 am – 12:00 pm
- Teaching Assistant:** Lloyd Scarborough, lhs123@psu.edu,
Office: TBD
Office Hour: TBD
- Prerequisites:** EMCH 212, CMPSC 201 or CMPSC 202, MATH 220, MATH 251
- Text:** Mechanical Vibrations by S. S. Rao, 4th Edition, Prentice Hall, 2003.
- Grading:**
- | | |
|-------------------|-----|
| Homework | 35% |
| Exam 1 (in class) | 15% |
| Exam 2 (evening) | 15% |
| Exam 3 (in class) | 15% |
| Final exam | 25% |
| Computer Project | 10% |
- The exam with the lowest grade from the Exams 1-3 will be dropped in the calculation of the final grade. The final exam must be taken.
 - Attendance is required.
 - **No late assignments will be accepted. Grading complaints or concerns must be submitted in writing.**
 - Consulting/studying in teams is encouraged. However, each student should complete and submit his/her own individual work

Course Description

This course studies vibration characteristics of mechanical systems and vibration control. It is divided into four main topics. Fundamental aspects of mechanical vibrations are studied first. Types and causes of various vibratory motions are described. The concepts of mathematical modeling of the vibratory systems are presented. Model elements including mass/inertia, spring and damper elements and their corresponding describing equations are studied. Single degree-of-freedom vibrations are modeled and analyzed. Equations describing free vibrations of undamped and damped systems are derived. Natural frequency and damping ratio are defined and their physical significance discussed. Harmonically excited vibrations are studied with many practical application problems; resonance and its physical significance are emphasized. The theoretical aspects of general periodic vibrations and non-periodic vibrations are formulated by means of Fourier analysis and convolution integral. Vibrations of multiple degrees-of-freedom systems are studied. Mathematical models governing free vibrations are formulated. Equations determining the natural frequencies and mode shapes of the system are derived with relation to eigenvalue problems. Harmonically excited vibrations are analyzed with practical applications. Vibration control in relation to engineering design is the last topic studied. Various vibration control concepts and techniques are presented including vibration isolation, vibration absorption and balancing to reduce the intensity of the source of excitation.

Course Objectives:

After completing this course, students should be able to:

- 1) Use Newton's Second Law and free body diagram approach to model vibratory systems
- 2) Solve differential equations and eigenvalue problems for determining the dynamic response (with correct units) of vibratory systems
- 3) Understand the physical and mathematical significance of natural frequencies and mode shapes, free and forced response, resonance, damping, superposition, lumped parameter and continuous systems, linear and nonlinear systems
- 4) Use appropriate analytical, numerical and computational tools
- 5) Understand experimental and data analysis techniques
- 6) Design mechanical systems with prescribed vibratory performance

Lecture Calendar

This is a tentative schedule and it should be used only as a guideline. This schedule may be changed and it is the students' responsibility to keep track of any changes announced in the class.

Week		Date	Topic	Reading
1	M	1/14	Introduction	1.1-6
	W	1/16	Elements of vibratory sys	1.7-10

	F	1/18	EOM, Newton's Laws	2.1-2
2	W	1/23	Energy methods	
	F	1/25	Differential eqns review	
3	M	1/28	Free vibration of undamped SDOF's	2.3-4
	W	1/30	Free vibration of undamped SDOF's	2.5
	F	2/1	Free vibration of damped SDOF's	2.6-7
4	M	2/4	Free vibration of damped SDOF's	
	W	2/6	Free vibration of damped SDOF's	
	F	2/8	Exam 1	
5	M	2/11	Forced vibration of undamped SDOF's	3.1-3
	W	2/13	Forced vibration of undamped SDOF's	
	F	2/15	Forced vibration of undamped SDOF's	
6	M	2/18	Forced vibration of damped SDOF's	3.4-5
	W	2/20	Forced vibration of damped SDOF's	
	F	2/22	Fourier analysis	4.1-3
7	M	2/25	Fourier analysis	
	W	2/27	Fourier analysis	
	F	2/29	Convolution Integral	4.4-5
8	M	3/3	Examples	
	W	3/5	Laplace Transformation, Exam 2, 6-7 pm	4.7
	F	3/7	Examples	
9	M	3/17	Free vibration of MDOF's	5.1-3
	W	3/19	Free vibration of MDOF's	
	F	3/21	Matrix review	
10	M	3/24	Eigenvalue problem	5.3
	W	3/26	Forced vibration of MDOF's	5.4
	F	3/28	Forced vibration of MDOF's	

11	M	3/31	Forced vibration of MDOF's	
	W	4/2	Forced vibration of MDOF's	
	F	4/4	Forced vibration of MDOF's	
12	M	4/7	Exam 3	
	T	4/9	Vibration absorbers	
	F	4/11	Vibration absorbers	
14	M	4/14	Examples	
	W	4/16	Matlab overview (hand out computer project)	
	F	4/18	Matlab examples	
15	M	4/21	Matlab examples	
	W	4/23	Continuous systems, wave equation	8.1-2
	F	4/25	Vibrating strings	8.3-4
16	M	4/28	Transverse vibration of beams	8.5
	W	4/30	Review	
	F	5/2	Review	

Important to Know

- 1) Hw and computer project will be posted on Angel website, and I will post announcements and send out class emails via Angel.
- 2) If you would like to contact me, send emails directly to my email account: quw6@psu.edu, **DO NOT** send me emails via Angel – I do not check emails from Angel.
- 3) I **DO NOT** discuss hw assignments and computer project through email communication unless the answer can be given within one sentence. If you have any questions regarding the hw and computer project, come to my office hour or the TA's office hour.
- 4) You are expected to know concepts that were taught in the prerequisites, and it is your responsibility to catch up the knowledge covered in the prerequisites, which I may review but would never re-teach.
- 5) I use the chalk board to write equations and plot important figures, and it is your responsibility to record the discussions and observations behind the equations and figures.
- 6) I would like to know everyone's name but may have difficulty doing this for a big class like this, and I expect you to introduce yourself to me (e.g., in/out class or during my office hour).

Disabilities Policy

In compliance with the Americans with Disabilities Act (ADA), all qualified students enrolled in this course are entitled to “reasonable accommodations.” Please notify me during the first week of class of any accommodations needed for the course. Also, you must contact a staff member for Disabled Student Services.

Academic Integrity

Information pertaining to Penn State’s policy on academic integrity can be found at <http://www.engr.psu.edu/CurrentStudents/acadinteg.asp>. In this course, students are permitted to work together on homework assignments, but each student is required to submit his or her own original work. Students are required to work together on class projects and should submit reports completed by the group. Students may not work together or cheat in any way on exams.