CE 573: Structural Dynamics

Instructor

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  - Office Hours: Regular hours to be determined, or by appointment (please email me)

Course Description

Analysis of structural members and systems subject to dynamic loads such as wind and earthquake loads; basic theory for single-degree-of-freedom and multi-degree-of-freedom analytical models of civil engineering structures; free vibration, harmonic and transient excitation, foundation motion, response spectrum, frequency domain analysis, Lagrange's equation, modal analysis, lumped parameter methods, computer methods.

Course Learning Outcomes

By the end of the course, you will be able to:

1. Model dynamic systems and describe how they respond to various loadings.
2. Determine the dynamic characteristics of a variety of linear structural systems.
3. Obtain and solve the equations of motion for a dynamic system modeled as a linear system

Prerequisites

- Able to solve differential equations
- Understanding of matrix operations and eigensolutions

Required Text and Materials

Required Text

- *Structural Dynamics: Theory and Computation* by Paz, Mario, Kim, and Young Hoon (2019). 6th edition (any edition can be used, but must check problems and units)

Additional Tools/Technologies

- Use of MATLAB/SIMULINK will be expected to complete the computer simulations assigned as part of certain homework assignments. Any version of MATLAB/SIMULINK will be suitable for these simulations. OCTAVE is allowed, although help cannot be guaranteed; MATHCAD is not acceptable for this course.
  - You can access MATLAB through the Purdue University MATLAB Portal.

Recommended Texts (Optional, use as References)

- *Dynamics of Structures* by Chopra
- *Dynamics of Structures* by Clough and Penzien
- *Structural Dynamics* by Craig

Grading

This course will be graded based on the following criteria:

Assessment Type	Description	% of Final Grade
Homework	Homework assignments will include both textbook problems and computer (MATLAB) assignments designed to support learning and assess the student's understanding of the material. Homework must be submitted to Gradescope by 11:59pm on the due date unless otherwise noted. Homework should be clear and neat; there is no requirement to use special paper. Late homework will not be accepted. 9 assignments are planned during the course.	20%
Quizzes	Short quizzes will be used to assess the student's understanding of the material. These quizzes will be comprehensive. After each quiz is graded, feedback will be provided to advise on the material that is relevant for exam preparation. Quizzes will be timed (students will typically have 1 hour for each quiz). Students will have one attempt to complete each quiz. Quizzes should be completed individually but students may reference notes, homeworks, videos, the textbook, and other reference books. 6 quizzes are planned during the course.	20%
Exam I	Exam I will assess the student's achievement of the learning objectives in Section 1 of the course, SDOF Systems.	20%
Exam II	Exam II will assess the student's achievement of the learning objectives in Section 2 of the course, MDOF Systems. Knowledge of previous material (Section 1) is expected.	20%
Exam III	Exam III will assess the student's achievement of the learning objectives in Section 3 of the course, Distributed Parameter Systems. Knowledge of previous material (Sections 1 and 2) is expected.	20%

- **Exams:** All exams are 60 min. One 8.5 x 11" sized paper with writing on both sides may be used during exams. Calculators may be used. No other materials are allowed. Cell phones and smart watches of all types must be stowed away during all exams and quizzes. At the time of the exam, you will be required to join a web conference. The date/time for each exam as well as other details about logging in to the web conference will be announced prior to the exam. Each exam section will open in Brightspace (under the corresponding Section) when it is time to take the exam. Exams will be uploaded to Gradescope for grading at the end of the period.

Grading Scale

Your course grade will be based on the following grading scale:

This class is graded according to a set curve. I am interested in seeing that you demonstrate what you have learned through your assignments, quizzes, and exams. Although these are simple quantitative measures of your learning, your participation in class will also contribute to your final grade. Final grades will be distributed through an assessment among students based on the assignments outlined above. According to these points, the following grades will be distributed as follows:

A: Demonstrates good mastery of the material in the course

B: Demonstrates strong ability to apply the material with a few small gaps

C: Demonstrates very little ability to apply the course material

D: Demonstrates very low ability to apply the course material and does not meet course requirements.

F: Demonstrates unsatisfactory ability to apply the course material and does not meet course requirements.

Estimated Effort

- 12 hours/week
- 15 weeks total

Course Content and Activities

Section	Module	Assignments
1 – Single Degree of Freedom (SDOF) Systems	1. Free Response	• **Homework:** 1. Generating and solving undamped system EOMs • **Quiz 1**
	2. Forced Response	• **Homework:** 2. Harmonic loading undamped and damped systems 3. Periodic loading, base motion and intro to MATLAB • **Quiz 2**
	3. Frequency Domain and Simulation	• **Homework:** 4. Response to general loading, response spectrum • **Quiz 3** • **Exam 1**
2 – Multi Degree of Freedom (MDOF) Systems	4. Free Response	• **Homework:** 5. Free vibration of MDOF systems • **Quiz 4**
	5. Forced Response	• **Homework:** 6. Forced vibration of MDOF systems, MDOF simulation; Lagrange's equations
	6. Frequency Domain	• **Homework:** 7. Numerical simulation, MDOF systems • **Exam 2**
3 – Distributed Parameter Systems	7. Matrix Analysis	• **Homework:** 8. Distributed parameter systems • Quiz 5
	8. Mathematical Modeling	• **Homework:** 9. Assumed modes method • Quiz 6 • **Exam 3**

Course Help

To get help with course content, comment in the Brightspace *Questions and Answers* discussion forum. By commenting in this discussion forum, the course team will be able to respond to your question more quickly.

To get help with course content, contact your course team using one of the following methods:

1. Check the discussion forum to see if your question has already been answered.
2. Comment in the discussion forums. By commenting in these discussion forums, the course team will be able to respond to your question more quickly.
3. Email the TA directly. The TA will try to respond to your email within 48 hours.
4. Email the instructor for your question. The instructor will try to respond to your email within 48 hours.

NOTE: When emailing the TAs or instructor, please start your subject line with "[CE 573]" and the topic (e.g., “CE 573 Assignment 2 Question”).

Discussion Guidelines

Please follow the Discussion Guidelines when contributing to discussions in this course. Here are a few of the key points you should remember:

- Do not use offensive language. Present ideas appropriately.
- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.
- Avoid using vernacular or slang language. This could possibly lead to misinterpretation.
- Do not hesitate to ask for feedback.
- Be concise and to the point.
- Think and edit before you push the “Send” button.

Nondiscrimination Statement

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. A hyperlink to Purdue’s full Nondiscrimination Policy Statement is included in our course Brightspace under *University Policies*.

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available in our course Brightspace under *University Policies*.

The Purdue Honor Pledge

> *"As a Boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue."*

Accessibility Support

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

Disclaimer

This syllabus is subject to change.