CEE 5720/ME 5990 Structural Dynamics
Spring 2024

AY 2023-2024: CEE 5720/ME 5990 Structural Dynamics

Class Times: MWF 10:50-11:40 AM

Location: Lafayette L411

Credit: 3 semester hours

Description: Analysis of the 1-D wave equation. Time-domain and frequency-domain analysis of linear single degree of freedom (SDOF) systems subjected to initial conditions and(or) arbitrary loading. Multi-degree of freedom (MDOF) systems. The eigenvalue problem in structural dynamics. Analysis of linear multi-degree of freedom systems using modal analysis. Numerical methods for dynamic analysis of MDOF systems

Prerequisites: Senior Standing in Eng. or Physical Science, Graduate Student

Textbook: *Structural Dynamics* – Tedesco, McDougal and Ross

Other Texts: *Dynamics of Structures 2nd Edition*. A.N. Chopra, Prentice Hall 2000
An Introduction to Structural Dynamics, Kasper and Hall, 2019
Modal Analysis, J. He and Z-F Fu, Butterworth-Heinemann 2001
Fundamentals of Vibration, L. Meirovitch, McGraw Hill, 2001
Mechanical Vibrations, J.P. Den Hartog, Dover, 1985

Materials: mechanical pencil (or digital pen), calculator, engineering paper, laptop.

Instructor: Dr. Eric M. Hernandez
Office: 217 Votey Hall
E-mail: eric.hernandez@uvm.edu
Office hours: By appointment via MS Teams

Learning Objectives:

1. Develop suitable models for mechanical/structural systems subjected to vibration.
2. Solve the 1-D uniform wave equation
3. Understand concepts of degree of freedom, stiffness, mass and damping in structures
4. Compute response of SDOF systems to initial conditions, moving supports and external loads
5. Solve eigenvalue problems in MDOF systems
6. Use and understand modal analysis of MDOF linear systems

7. Code numerical methods to compute response of MDOF systems

Topics:

- Introduction to the phenomena of wave propagation and vibration
- Models of structural and mechanical systems subjected to vibration
- Deriving equations of motion. Equilibrium and energy methods
- Solution of the 1-D uniform wave equation
- Degrees of freedom, stiffness, mass and damping in structures
- SDOF vs. MDOF systems
- Compute response of SDOF linear system to initial conditions
- Compute response of SDOF linear system to harmonic loading
- Compute response of SDOF linear system to arbitrary loading using the convolution integral
- Compute response of SDOF linear system to support/base motion
- Response spectrum for SDOF linear systems
- Finite difference methods to compute response of SDOF linear systems
- Newmark methods to compute response of SDOF linear systems
- State-Space analysis of SDOF linear systems
- Frequency domain analysis of SDOF linear systems
- Stiffness, mass and damping matrices for MDOF Systems
- Eigenvalue problem in MDOF linear systems
- Modal analysis of MDOF linear systems

Grading:

• Assignments	50%
• Midterms	30%
• Final Exam	20%

Instructions for assignments and midterms (READ CAREFULLY)
All assignments must have a cover page indicating: the university, course name/number, instructor, student's name, assignment number and due date. Every problem must include the problem statement (could be a copy of the textbook problem statement). All calculations must be made by hand on engineering paper (or using a digital pen on virtual paper). All results must have units and expressed to 2 decimal places. All figures must be drawn to scale either by hand with rulers and/or set squares or using CAD software (points will be deducted for free-hand drawings that are not accurate). All pages must be numbered sequentially starting with 1 at the cover page and must have the student's name and assignment number on them. Aesthetics and organization will be part of the grade. Late assignments will not be accepted. Assignments/projects that do not comply with any of these instructions will not be graded.

Computer Usage: MATLAB, Python

ABET Outcomes

Below find a description of the 7 ABET Outcomes and how this course contributes to the fulfillment of such outcomes:

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 (Medium)

3. an ability to communicate effectively with a range of audiences (NA)

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 (NA)

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 (Medium)

6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions (NA)

7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies (High)

UVM POLICIES – Read Carefully

Student Learning Accommodations: In keeping with University policy, any student with a documented disability interested in utilizing accommodations should contact ACCESS, the office of Disability Services on campus. ACCESS works with students to create reasonable and appropriate accommodations via an accommodation letter to their professors as early as possible each semester.

Contact ACCESS: A170 Living/Learning Center; 802-656-7753; access@uvm.edu; www.uvm.edu/access

UVM's policy on disability certification and student support:
www.uvm.edu/~uvmppg/ppg/student/disability.pdf

***Religious Holidays**:* Students have the right to practice the religion of their choice. *If you need to miss class to observe a religious holiday, please submit the dates of your absence to me in writing by the end of the second full week of classes.* You will be permitted to make up work within a mutually agreed-upon time.

Academic Integrity: The policy addresses plagiarism, fabrication, collusion, and cheating. www.uvm.edu/~uvmppg/ppg/student/acadintegrity.pdf

Grade Appeals: If you would like to contest a grade, please follow the procedures outlined in this policy: www.uvm.edu/~uvmppg/ppg/student/gradeappeals.pdf

Grading: For information on grading and GPA calculation, go to www.uvm.edu/academics/catalogue and click on Policies for an A-Z listing.

Code of Student Rights and Responsibilities: www.uvm.edu/~uvmppg/ppg/student/studentcode.pdf

FERPA Rights Disclosure: The purpose of this policy is to communicate the rights of students regarding access to, and privacy of their student educational records as provided for in the Family Educational Rights and Privacy Act (FERPA) of 1974. http://www.uvm.edu/~uvmppg/ppg/student/ferpa.pdf

Final exam policy: The University final exam policy outlines expectations during final exams and explains timing and process of examination period. www.uvm.edu/academics/catalogue2010-11/?Page=allpolicies.php&SM=policymenu.html&policy=Examinations