ME 729 Advanced Vibrations
Fall Semester, 2020
Course Syllabus

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Class Meeting TBD
Office Hours Email the instructor for questions and Zoom meeting request.
Pre-Requisites ME 421 (Theory of Vibrations) or Graduate Standing.

Bulletin Description

The course focuses on vibration analysis of continuous systems and vibration of multi-degree-of-freedom discrete systems.

Course Description

This course introduces methods to analyze various vibrating systems, including the derivation of equation of motion using Newton's method and Lagrange's method and solution techniques for free and forced responses. The vibrating systems include discrete systems, continuous second-order models such as rods, shafts and strings, and fourth-order beam models.

Anticipated Course Outcomes

At the end of the course the student should

1. Understand fundamental concepts of vibrations, including natural frequency, mode shape, nodal point, modal damping.
2. Be able to find the free or forced response of a single degree of freedom vibrating system with or without damping.
3. Understand the concepts of eigenvalues and eigenvectors.
4. Be able to use the modal analysis method to find response of a vibrating system.
5. Be able to derive the equation of motion of a system from Lagrange's equation.
6. Be able to find the responses of continuous vibration models, including second-order models and fourth-order beam models.
7. Apply the knowledge gained in this class to analyze a real physical system's dynamical response.

Grading

Homework	30%
Three exams	30%
Project	20%
Final exam	20%
	100%

Final course grade scale

A 90 – 100 B 80 – 89 C 70 – 79 D 60 – 69 F <60

Homework Assignments

1) Homework will be submitted electronically to Blackboard. The due date and time will be given in each assignment. Homework should be neatly written and well organized. *Unlegible homework will not be graded.* Homework can be submitted in formats of Word document, PDF or picture files. Pictures must be clear.
2) Students are encouraged to discuss homework assignments with each other. However, students should not copy other's homework solutions.

Exams

There will be three exams. Make-up exams are given only in the event of illness or emergency; in case of such special event, the student should inform the instructor as soon as possible. Same as homework, exam solutions are to be submitted electronically to Blackboard.
Tentative exam schedule: Sept. 28, Oct.26 and Nov. 23. Final exam: Dec. 14.

Project

There will be a project that the students complete individually. There will be a mid-term presentation on the topic of the project, a final presentation and a final paper by the end of the semester. Project schedule and requirements will be given in a separate document.

Americans with Disabilities Act for Students with Special Needs Statement

Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the Disability Services Office (www.ndsu.edu/disabilityservices) as soon as possible.

Approved Academic Honesty Statement

The academic community is operated on the basis of honesty, integrity, and fair play. NDSU Policy 335: Code of Academic Responsibility and Conduct applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and Records. Informational resources about academic honesty for students and instructional staff members can be found at www.ndsu.edu/academichonesty.

Auditing of Graded Work

Students are welcome to discuss the grading of their work. Contact the instructor to discuss grade problems. Auditing of a work must be made within two weeks after the work has been returned to the student and no later than Friday noon of the Finals week.

Tentative Topics

Discrete Systems

1. Single degree of freedom systems (review)
    a. Free vibration
    b. Forced response; frequency response function
2. Multi-degree of freedom systems
    a. Newton-Euler method
    b. Eigenvalue problems

    c. Properties of eigenvalue problems (matrix symmetry, positive definiteness, orthogonality)
3. Modal analysis method
    a. Expansion theorem and decoupling
    b. Steady-state harmonic response
    c. Damped system response
4. Lagrange's method for discrete systems

Continuous Systems

5. Free vibration
    a. Transition from a discrete system to a continuous system
    b. Second-order models: rods, shafts, and strings; Natural frequencies and mode shapes
    c. Fourth-order models: Euler-Bernoulli, Rayleigh and Timoshenko beams; Natural frequencies and mode shapes
    d. Two-dimensional models: Membranes
6. Continuous system eigenvalue problems
    a. Properties of the eigenvalue problems
    b. Extended operators: eigenvalue problems in boundary conditions
7. Modal analysis
    a. Steady-state harmonic motion
    b. Static deformations
    c. Transformation of inhomogeneous boundary conditions

Note: The instructor reserves the right to change any of the course requirements, the topics to cover, class activities/assignments, and schedule for any reason.