Syllabus

Course Name Vibration of Complex Mechanical Systems

Course Number ENG ME 515

Semester Spring 2022

Course Description Analysis of free and forced vibration of multidegree-of-freedom systems. Analysis of free and forced vibration of continuous systems such as strings, bars, beams, and membranes. Introduction to vibration control, vibration isolation, and vibration absorbers. Introduction to vibration sensors. Analysis of free and forced vibration of systems and structures modeled with the finite element method. Students learn computational implementation of all analyses.

Prerequisite CAS MA 226; ENG ME 302

Required Course Materials *Mechanical Vibrations*, Sixth Edition, Singiresu S. Rao.

Required Course Software Matlab

Recommended Course Equipment 0.9 mm Pentel GraphGear 500 Automatic Drafting Pencil Gray (PG529N) with 2B lead

Lectures Lectures are held in PHO 202 on Tuesdays and Thursdays, 3:30 p.m. – 5:15 p.m.

Section A1 Access to Live and Recorded Lectures You are expected to attend lectures in person. You are allowed to access 3 lectures remotely, either live or recorded or both. These are intended to support learning if you are ill or have other legitimate reasons for not attending in person. To access a live lecture on Zoom, simply join using the Zoom links on Blackboard. To access a recorded lecture, send a request by email to the instructor. You are not required to state the reason in the email. If more than 3 are necessary, please email the instructor and explain the reason.

Section D1 Access to Recorded Lectures You are expected to attend live lectures on Zoom. To access a live lecture on Zoom, simply join using the Zoom links on Blackboard. You are allowed to access 3 recorded lectures. These are intended to support learning if you are ill or have other legitimate reasons for not attending in person. To access a recorded lecture, send a request by email to the instructor. You are not required to state the reason in the email. If more than 3 are necessary, please email the instructor and explain the reason.

Instructor Professor J. Gregory McDaniel

Instructor Email `jgm@bu.edu`

Grader Luis Souza

Grader Email `luisdhvs@bu.edu`

Graduate Student Teacher Noah Li

Graduate Student Teacher Email `nuoli@bu.edu`

Office Hours By appointment. To arrange an appointment, email at least two suggested times and a summary of your questions.

Accommodations for Students with Documented Disabilities If you are a student with a disability or believe you might have a disability that requires accommodations, requests for accommodations must be made in a timely fashion to Disability & Access Services, 25 Buick St, Suite 300, Boston, MA 02215; 617-353-3658 (Voice/TTY). Students seeking academic accommodations must submit appropriate medical documentation and comply with the established policies and procedures at `http://www.bu.edu/disability/accommodations/`.

Course Average The numerical course average will be an average of 10 assignments.

Course Grade The letter grade for the course will be determined from the following chart:

Percent Range	Letter Grade
92.5–100	A
90.0–92.5	A-
87.5–90.0	B+
82.5–87.5	B
80.0–82.5	B-
77.5–80.0	C+
72.5–77.5	C
70.0–72.5	C-
60.0–70.0	D
50.0–60.0	F

Collaboration Policy on Assignments Students are allowed to discuss the assignments with each other and help each other learn. However, each student must turn in a code that they wrote. Students are not allowed to share their code in any way.

- Code may not be electronically transmitted in any format.
- Code may not be posted online.
- Code may not be printed out and given to another person.
- Code may not be visually seen by another person, either on a screen or on paper.
- Code may not be read aloud to another person.
- Code cannot be communicated in any way to another person.

No portion of any assignment may be posted online. If identical portions of codes are found, that will be considered a violation of the academic conduct code and referred to the university for investigation.

Grading Concerns All grading concerns must be reported to the professor within one week of returning the graded work.

Lecture Topics

6.1 Introduction to Multidegree-of-Freedom Systems

6.2 Modeling of Continuous Systems as Multidegree-of-Freedom Systems

6.3 Using Newton's Second Law to Derive Equations of Motion

6.5 Potential and Kinetic Energy Expressions in Matrix Form

6.6 Generalized Coordinates and Generalized Forces

6.8 Equations of Motion of Undamped Systems in Matrix Form

6.9 Eigenvalue Problem

6.10 Solution of the Eigenvalue Problem

6.11 Expansion Theorem

6.12 Unrestrained Systems

6.13 Free Vibration of Undamped Systems

6.14 Forced Vibration of Undamped Systems Using Modal Analysis

6.15 Forced Vibration of Viscously Damped Systems

8.1 Introduction to Continuous Systems

8.2 Transverse Vibration of a String or Cable

8.3 Longitudinal Vibration of a Bar or Rod

8.4 Torsional Vibration of a Shaft or Rod

8.5 Lateral Vibration of Beams

8.6 Vibration of Membranes

9.1 Introduction to Vibration Control

9.10 Vibration Isolation

9.11 Vibration Absorbers

10.1 Introduction to Vibration Measurement and Applications

10.2 Transducers

10.3 Vibration Pickups

10.8 Experimental Modal Analysis

12.1 Introduction to the Finite Element Method

12.2 Equations of Motion of an Element

12.3 Mass Matrix, Stiffness Matrix, and Force Vector

12.4 Transformation of Element Matrices and Vectors

12.5 Equations of Motion of the Complete System of Finite Elements

12.6 Incorporation of Boundary Conditions