Syllabus

Course Name Vibration of Complex Mechanical Systems

Course Number ENG ME 515

Semester Spring 2018

Course Description Introductory course in mechanical vibrations for graduate students and for undergraduate students with substantial mastery of core undergraduate subjects in mechanics and mathematics. Course includes an elementary introduction to applicable concepts in linear algebra. Potential and kinetic energy functions of single- and multi-degree-of-freedom systems. Matrix formulations of forced vibrations of linear systems. Natural frequencies, resonance, and forced vibration response. Natural modes and mode shapes. Rayleigh's principle. Rayleigh's dissipation function, transient and forced responses of damped vibrations. Random excitation of vibrations. Impedance matrix. O'Hara-Cunniff theorem, modal masses, modal analysis. Vibrations of simple continuous systems such as strings, beams, rods, and torsional shafts. This course cannot be taken for credit in addition to ENG ME 441.

Prerequisite CAS MA 226 ; CAS PY 313 ; ENG ME 302; and ENG EK 307; ENG ME 309

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

Lectures

- Lectures are held in SAR 300 on Tuesdays and Thursdays, 3:30 p.m. – 5:15 p.m.
- Attendance will be taken and used as one indicator of your level of effort.
- You are strongly encouraged to ask questions during lecture and to offer answers to questions asked by the professor, even if you are not sure they are correct.
- Ringers on cell phones should be turned off during lecture.
- Texting during lecture is prohibited. Violations of this prohibition will result in a decreased attendance grade.

Instructor Professor J. Gregory McDaniel

Instructor Email `jgm@bu.edu`

Instructor Office Location Room 406, fourth floor of 110 Cummington Mall

Instructor Phone 617.353.4847

Office Hours Wednesdays 1 p.m. – 2 p.m. or by appointment. To arrange an appointment, email at least two suggested times and a summary of your questions.

Course Average The numerical course average will be computed using the following distribution:

- Project: 10%
- Quizzes: 30% (lowest quiz grade is dropped)
- Midterm Examination: 30%
- Final Examination: 30%

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

Midterm Examination The midterm examination is not yet scheduled.

Final Examination The final examination is not yet scheduled.

Missed Examinations

- If you know ahead of time that you will miss the examination, you must notify the instructor by email and describe your reason for missing the examination.
  - If the instructor determines that the reason is appropriate, you will be given a makeup examination.
  - If the instructor determines that the reason is not appropriate, you will receive a zero for that examination. The following reasons are not appropriate: oversleeping, working on an assignment for another course, travel for pleasure.
- If you do not know ahead of time that you will miss the examination, you must notify the instructor in writing as soon as possible after the examination and describe your reason for missing the examination.

Missed Quizzes

- If you know ahead of time that you will miss the quiz, you must notify the instructor by email and describe your reason for missing the examination.
  - If the instructor determines that the reason is appropriate, that quiz will not be included in your grade calculation and you will not be given a makeup quiz.
  - If the instructor determines that the reason is not appropriate, you will receive a zero for that quiz. The following reasons are not appropriate: oversleeping, working on an assignment for another course, travel for pleasure.
- If you do not know ahead of time that you will miss the quiz, you must notify the instructor in writing as soon as possible after the examination and describe your reason for missing the quiz.

Lecture	Section	Subject
1	Notes	Course Overview and Review
2	6.1	Introduction to Multidegree-of-Freedom Systems
	6.2	Modeling of Continuous Systems as Multidegree-of-Freedom Systems
3	6.3	Using Newton's Second Law to Derive Equations of Motion
4	6.5	Potential and Kinetic Energy Expressions in Matrix Form
	6.6	Generalized Coordinates and Generalized Forces
5	6.8	Equations of Motion of Undamped Systems in Matrix Form
6	6.9	Eigenvalue Problem
	6.10	Solution of Eigenvalue Problem
7	6.11	Expansion Theorem
	6.12	Unrestrained Systems
8	6.13	Free Vibration of Undamped Systems
	6.14	Forced Vibration of Undamped Systems Using Modal Analysis
9	6.15	Forced Vibration of Viscously Damped Systems
10	Notes	Transient Analysis of Viscously Damped Systems
11	8.1	Introduction to Continuous Systems
	8.2	Transverse Vibration of a String or Cable
12	8.3	Longitudinal Vibration of a Bar or Rod
	8.4	Torsional Vibration of a Shaft or Rod
13	8.5	Lateral Vibration of Beams
14	8.5	Lateral Vibration of Beams
15	8.6	Vibration of Membranes
16	8.7	Rayleigh's Method
	8.8	The Rayleigh-Ritz Method
17	9.1	Introduction to Vibration Control
	9.2	Vibration Nomograph and Vibration Criteria
	9.3	Reduction of Vibration at the Source
18	9.7	Control of Vibration
	9.8	Control of Natural Frequencies
	9.9	Introduction of Damping
19	9.10	Vibration Isolation
20	9.11	Vibration Absorbers
21	10.1	Introduction to Vibration Measurement and Applications
	10.2	Transducers
22	Notes	Fourier Analysis and the FFT
23	Notes	Fourier Analysis and the FFT