Course Information

Course Name Vibration of Complex Mechanical Systems

Course Number ENG ME 515

Semester Spring 2015

Lectures Lectures are held in EMB 105 on Tuesdays and Thursdays from 4:00 p.m.–6:00 p.m.

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. (Formerly ENG AM 515)

Prerequisites CAS MA 226 ; CAS PY 313 ; ENG ME 302 ; ENG EK 307 ; ENG ME 400; and ENG ME 307 or ENG ME 309

Required Textbook *Mechanical Vibrations*, Singiresu Rao, Fifth Edition, Pearson

Required Computer Use Matlab, blackboard and email

Instructor Professor J. Gregory McDaniel

Instructor Email `jgm@bu.edu`

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

Instructor Phone 617 353 4847

Office Hours Tuesday 10 a.m.–12 a.m. or by appointment. To arrange an appointment, email at least two suggested times and a summary of your questions.

Quizzes Quizzes will be given in class approximately once a week. You will only be allowed to use class handouts and a calculator. The lowest quiz grade will be dropped in computing your quiz average.

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

- Quiz Average: 20%
- Project: 20%
- Midterm Examination: 30%
- Final Examination: 30%

Percent Range	Letter Grade
92.5–100.0	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

Table 1: Table used to determine course letter grade.

Course Grade The letter grade for the course will be determined from the Table 1.

Midterm Examination The midterm examination is scheduled for March 19, 2015.

Final Examination The final examination date will be announced in class.

Missed Examinations Here is the policy regarding a missed examination:

- 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.

Syllabus

Instructor Professor J. Gregory McDaniel

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Semester Spring 2015

Textbook *Mechanical Vibrations*, Singiresu Rao, Fifth Edition, Pearson

Lecture	Topics	Textbook
1	Introduction to free vibration of single-degree-of-freedom systems	2.1
	Free vibration of an undamped translational system	2.2
	Free vibration of an undamped torsional system	2.3
	Response of first-order systems and time constant	2.4
2	Rayleigh's Energy Method	2.5
	Free vibration with viscous damping	2.6
3	Introduction to harmonically excited vibration	3.1
	Equation of motion	3.2
	Response of a damped system under harmonic force	3.4
	Response of a damped system under harmonic force with complex exponentials	3.5
4	Response of a damped system under harmonic motion of the base	3.6
5	Response of a damped system under rotating unbalance	3.7
6	Introduction to vibration under general forcing conditions	4.1
	Response under a general periodic force	4.2
	Response under a general periodic force of irregular form	4.3
7	Response under a non periodic force	4.4
	Convolution integral	4.5
8	Response spectrum	4.6
9	Laplace transform	4.7
10	Numerical methods	4.8
11	Introduction to two-degree-of-freedom systems	5.1
12	Equations of motion for forced vibration	5.2
	Free vibration analysis of an undamped system	5.3
13	Torsional system	5.4
	Coordinate coupling and principal coordinates	5.5
14	Forced vibration analysis	5.6
	Semi-definite systems	5.7

Lecture	Topics	Textbook
15	Introduction to multidegree-of-freedom systems Modeling of continuous systems as multidegree-of-freedom systems	6.1 6.2
16	Using Newton's Second Law to derive equations of motion Influence coefficients	6.3 6.4
17	Potential and kinetic energy expressions in matrix form Generalized coordinates and generalized force Using Lagrange's equations to derive equations of motion	6.5 6.6 6.7
18	Equations of motion of undamped systems in matrix form Eigenvalue problem Solution of the eigenvalue problem	6.8 6.9 6.10
19	Expansion theorem Unrestrained systems Free vibration of undamped systems	6.11 6.12 6.13
20	Force vibration of undamped systems using modal analysis Force vibration of viscously damped systems	6.14 6.15
21	Introduction to continuous systems Transverse vibration of a string or cable	8.1 8.2
22	Logitudinal vibration of a bar or rod Torsional vibration of a shaft or rod	8.3 8.4
23	Vibration of membranes	8.6
24	Rayleigh's Method The Rayleigh-Ritz Method	8.7 8.8
25	Introduction to vibration measurement and applications Transducers Vibration pickups	10.1 10.2 10.3
26	Fourier analysis	course notes