INFORMATION SHEET ME443
Fall 2009 Applied Vibrations

INSTRUCTOR: Professor Sheryl M. Gracewski, Hopeman 217, X57853
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OFFICE HOURS: W 4:00-5:00, after class or by appointment

CLASS TIME: TR 4:50-6:05

PREREQUISITES: Prerequisites are basic ordinary and partial differential equations and undergraduate dynamics. Some knowledge of 1 and 2 degree-of-freedom system vibrations is assumed, but will be reviewed rapidly in the course. Knowledge of linear algebra will be useful for the solution of discrete systems, but a review of the necessary topics will be covered in class.

Objective: To obtain a deeper understanding of vibrating systems and learn a variety of numerical, analytical, and experimental techniques to obtain the dynamic characteristics and response of a system. In particular, an introduction to the numerical techniques underlying finite element computer codes will be discussed. NASTRAN will be used to obtain finite element results. Mathematica will be used for numerical calculations and to obtain plots of results. Vibration measurement techniques will be demonstrated and there will be 1 or 2 labs that include both experiments and analysis.

COURSE OUTLINE:

I. Damped One-Degree-of-Freedom Systems - free and forced vibration.
Methods for obtaining dynamic solutions to general loadings will include: direct numerical integration, Fourier series and Fourier transforms. Methods to obtain approximate solutions for nonlinear systems will be discussed.

II. Multi-Degree-of-Freedom Systems - free and forced vibration.
Lagrange's equation, Hamilton's principle, and Newton's laws will be used to derive the governing equations. Methods of obtaining natural frequencies and mode shapes for free vibration will be covered. Direct numerical integration and modal methods for obtaining forced responses will be discussed.

III. Continuous Systems - undamped free vibration of strings, longitudinal and torsional vibration of rods, and transverse vibrations of beams, membranes and plates. Both exact and approximate methods, including Rayleigh and Rayleigh-Ritz will be covered.

IV. Vibration measurement techniques – use of a shaker and an instrumented hammer to obtain frequency response functions will be demonstrated. Fundamental guidelines for using a digital signal analyzer will be discussed, with an overview of necessary concepts of discrete Fourier transforms.

GRADING:

Homework	25%
Lab	10%
Exam #1	30%
Exam #2	35%

Although you are encouraged to talk to each other (and me) about the homework assignments, ***homework must be done individually***. There are many different ways to solve most of the problems, so part of the challenge of the course is to develop your approach to new problems.

Those students who achieve a grade of A on Exam #1 and successfully complete all homework assignments will have the option of doing a project instead of taking the final exam. In this case, the student is responsible for proposing a reasonable project and the weighting will change to

Homework	25%
Lab	10%
Exam #1	40%
Project	25%

REFERENCES:

(1) S. S. RAO, Mechanical Vibrations, 4th edition, Addison Wesley, 2004.
(2) R. CRAIG, Structural Dynamics: An Introduction to Computer Methods, Wiley, 1981.
(3) A. A. SHABANA, Theory of Vibration, Volumes I and II, Springer-Verlag, 1991.
(4) L. MEIROVITCH, Analytical Methods in Vibrations, Macmillan, 1967.
(5) W. T. THOMSON, Theory of Vibration with Applications, 4th edition, Prentice Hall, 1993.
(6) A. DIMAROGONAS, Vibration for Engineers, 3rd edition, Prentice Hall.
(7) WEAVER, TIMOSHENKO, and YOUNG, Vibration Problems in Engineering, Wiley, 1990.
(8) G. STRANG, Linear Algebra and its Applications, Academic Press, 1988.
(9) R. HABERMAN, Elementary Applied Partial Differential Equations, Prentice-Hall, 1987.
(10) S. WOLFRAM, Mathematica, Addison Wesley, 1997.
(11) E. O. BRIGHAM, The Fast Fourier Transform, Prentice Hall, 1974.
(12) S.S. Rao, Vibration of continuous systems, Wiley, 2007.

The **course website** is http://www.me.rochester.edu/courses/ME443. Homework assignments, solutions, practice exams, and announcement will be posted on this website.

Prof. Clark has created a **tutorial for Mathematica** that can be obtained from the website http://www.me.rochester.edu/courses/ME201/websoft/softw.html. If you have never used Mathematica or need a refresher, then work through the tutorial.

ME COMPUTER LAB HOURS
The ME (GM and Clark) Computer Labs are in the basement of Hopeman, in rooms 05 and 06. Access is by combination lock. Mathematica is installed on computers in both rooms and most computers on campus. NASTRAN is installed on the computers in the GM Lab. The combination to the two rooms will be given in class. The hours below are the hours when the Hopeman building is open.

Monday - Thursday 6:30 – 23:00
Friday 6:30 – 18:00
Saturday 11:30 – 18:00
Sunday 11:30 – 22:00