

MAE130C/SE 101C  
Mechanics III: Vibrations

**Designation:** Required Course for ME and AE

**Catalog Data:**

MAE 130C Mechanics III: Vibrations (4)

Free and forced vibrations of undamped and damped single degree of freedom systems. Harmonically excited vibrations and vibrations under general loading conditions. Vibrating systems with two or more degrees of freedom. Modal analysis with application to realistic engineering problems. Vibration of continuous systems.

**Prerequisites:** Grades of C- or better in Math 20F and MAE 130B or SE 101B.

**Textbooks, Required Materials:** Thomson, William T. and Dahleh, Marie D., Theory of Vibration with Applications, Fifth Edition Prentice-Hall, Inc., Englewood Cliffs, NJ, 1997.  
S.S. Rao, Mechanical Vibrations, 5<sup>th</sup>, Pearson Prentice Hall, 2004.

**Prerequisites by Topic:** Integral and differential calculus, differential equations, engineering dynamics.

**Class/Laboratory Schedule:** 4 lecture hours per week

**Course Topics:**

1. One degree-of-freedom transient and steady state response
2. Applications to vibration isolation and measurement
3. Response to impact and impulse excitation
4. Two degree-of-freedom undamped systems: beat frequencies, static and dynamic coupling, free vibration, and normal modes
5. Properties of n degree-of-freedom systems: matrix formulation, eigenvalues and eigenvectors, modal matrix, and reduction to normal coordinates
6. Free and forced vibration of n degree-of-freedom systems
7. Lagrange's Equations
8. Vibration of continuous systems

**Course Objectives:**

(Numbers in parentheses refer to ME and AE Program Outcomes)

Objective 1: To teach students the basic principles underlying the vibration of mechanical and structural systems (1a,5e).

Objective 2: To train students to identify, formulate and solve engineering problems in vibrations (1a,5e).

Objective 3: To introduce students to the concepts and applications of Lagrange's equations (1a,5e).

**Methods of evaluation:**

1. Homework will be regularly assigned, collected and graded.
2. Midterms and Final exam.

**Performance Criteria:**

(Numbers in parentheses refer to the methods of evaluation used to assess student performance)

Objective 1

- 1.1 Students will demonstrate an understanding of linear vibration theory and the basic formulations for  $n$  degree-of-freedom and continuous systems (1, 2).

Objective 2

- 2.1 Students will demonstrate the ability to formulate the equations of motion for multi degree-of-freedom systems (1, 2).
- 2.2 Students will demonstrate an ability to calculate the normal modes of a system (1, 2).
- 2.3 Students will demonstrate that they can determine and apply the appropriate solution method to calculate the response of the system (1, 2).

Objective 3

- 3.1 Students will demonstrate an understanding of Lagrange's equations as applied to free vibrations of single and multi- degree-of-freedom systems without dissipation (1, 2).
- 3.2 Students will demonstrate an ability to apply Lagrange's equations to forced vibrations of dissipative systems (1, 2).

**Contribution of Course to Professional Component:**

The course provides the basis for the vibration analysis of structural components in mechanical, aerospace, and civil engineering.

**Prepared by:** D. Benson, February 2000.

**Revised:** V. Lubarda and H. Murakami, April 2008 via Teaching Work Group meeting