ME 3220 – Mechanical Vibrations

Credits and Contact Hours: 3 Credits. Three 50 minute or two 75 minute lectures per week.

Instructors: Chengyu Cao, Eric Jordan, George Lykotrafitis, Kevin Murphy, Nejat Olgac, Jiong Tang, Bi Zhang

Textbook: *Engineering Vibrations*, by D. Inman, Prentice Hall, 2001.

Specific Course Information:

a. Catalog Description: Free and forced vibrations, with damping, of linear systems with one and two degrees of freedom. Transient vibrations. Vibration isolation. Rigid rotor balancing. Elements of Laplace transforms.

b. Prerequisites: ME 3253, MATH 2110Q, MATH 2410Q, and CE 2120

c. Required, Elective or Selected Elective: Required

Specific Goals:

a. Course Outcomes:

After completing ME 3220 students should be able to:

1. Construct the equation of motion from free-body diagrams.
2. Solve for the motion and the natural frequency of a freely vibrating single degree of freedom undamped system.
3. Solve for the motion of a freely vibrating single degree of freedom damped system under different damping ratios.
4. Solve the harmonic response of a single degree-of-freedom (undamped or damped) system, and to put together the complete solution. Analyze the frequency response.
5. Decompose any periodic excitation into a series of simple harmonic motions using Fourier analysis and obtain the corresponding response for single degree of freedom system.
6. Analyze impulse response for single degree-of-freedom system.
7. Solve the response of a single degree of freedom system subjected to arbitrary input using Duhamel integral.
8. Solve the natural frequencies and mode shapes of system with multiple degrees of freedom.

b. Relationship of Course Outcomes to Criterion 3 Student Outcomes:

a) an ability to apply knowledge of mathematics, science, and engineering: *This course requires students to apply knowledge of mathematics, science and engineering to the solution of practical linear mechanical vibration problems.*

b) an ability to design and conduct experiments, as well as analyze and interpret data: *not applicable*

c) an ability to design a system, component, or process to meet desired needs:

Students use the fundamental principles of mechanics to examine the performance of a mechanical system and redesign the system to improve its response characteristics.

d) an ability to function on multi-disciplinary teams: *not applicable*

e) an ability to identify, formulate, and solve engineering problems:
Students learn to identify, formulate and solve basic engineering problems using the fundamental principles of mechanics and mathematical approximation.

f) an understanding of professional and ethical responsibility: *not applicable*

g) an ability to communicate effectively: *not applicable*

h) the broad education necessary to understand the impact of engineering solutions in a global and societal context:
The societal implications of detrimental vibrations in everyday structures are discussed; including such critical factors as safety, cost, and design feasibility.

i) a recognition of the need for, and an ability to engage in life-long learning: *not applicable*

j) a knowledge of contemporary issues: *not applicable*

k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice:
Students learn to use numerical, mathematical and presentation tools in the solution of practical engineering problems, and have relevant software packages available for use in completing work.

Topics Covered:

- Review of 2nd order ODE's, linearity solution methods
- Single degree of freedom oscillators
- Two degrees of freedom oscillators
- Effective springs and masses
- Transient vibrations
- Impulse response
- Solutions to differential equations
- Modal analysis
- Vibration absorption
- Measurement of frequencies