AME 521 Engineering Vibrations II

Fall 2010
Department of Mechanical Engineering
University of Southern California

Description:	3 units. Multi-degree of freedom systems; modal analysis; Rayleigh's quotient; continuous systems; modal analysis; beams, rods, membranes; Galerkin, Rayleigh Ritz methods; finite elements.
Prerequisite:	AME 420

Instructor	Professor Ben Yang Office: OHE 430; Phone: (213) 740-7082; Email: bingen@usc.edu
Meeting	Thursday 6:30-9:10 pm, RTH109
Office Hour	Wednesday 10:00 am -12 noon, Thursday 4-6 pm

Text Book: Leonard Meirovitch, 2002, *Fundamentals of Vibrations*, McGraw-Hill.
ISBN-13: 978-0072881806

References: [1] S. Graham Kelly, 2006, Advanced Vibration Analysis, CRC.
ISBN-13: 978-0849334191

[2] William J. Bottega, 2006, Engineering Vibrations, CRC.
ISBN-13: 978-0849334207

Grading:

Midterm Exam	20%
Homework	30%
Project	10%
Final Exam	40%
Total	100 %

Homework: Weekly homework assigned, and due the following week.
Late homework receives **NO** credits.

Project: A project requesting software MATLAB will be assigned.
A final report will be due at the end of the semester.

Topics and Reading Assignments:

- Review of single-degree-of-freedom systems (Chapter 3 of the textbook) – 1 week
- Establishment of equations of motion (Chapter 2) – 1 week
  - Newton's laws
  - Lagrange's equations
  - Small oscillation and linearization (two methods)
- Multi-degree-of-freedom systems (Chapter 3 and handouts) – 4 weeks
  - Spring-mass-damper systems
  - Methods of influence coefficients for linear systems
  - Natural modes of vibration
  - Eigenvalue problems and solutions
  - Rayleigh's quotient
  - Steady-state response to harmonic excitations
  - Vibration absorbers
  - Transient response via modal analysis
  - Damping in vibrating systems
  - Gyroscopic systems
  - Use of MATLAB in vibration analysis
- State equations and transfer function formulation (Handouts) – 1 week
  - State equations and solution via eigenvector expansion and numerical integration
  - Transfer function formulation and convolution integral
  - Transient response via inverse Laplace transform for general mechanical systems described by $M\ddot{x} + (D+G)\dot{x} + Kx = f$.
- Distributed vibrating systems (Chapter 7) – 4 weeks
  - Boundary-initial value problems of strings, rods, shafts and beams
  - Hamilton's principles and equations of motion
  - Solution of eigenvalue problems
  - Natural normal modes and eigenfunction expansion
  - Systems with lumped end masses
  - Damping in distributed systems
  - Self-adjoint and non-self-adjoint systems
  - Green's function formulation
  - Vibration of membranes
- Approximate methods for distributed systems (Chapters 5 and 8) – 2 weeks
  - Rayleigh's quotient
  - Galerkin's method
  - Rayleigh Ritz method
  - Finite element method