

**CARLETON UNIVERSITY**  
**Department of Mechanical and Aerospace Engineering**  
**MECH 4104: Mechanical Vibrations**

**Course Outline, Winter 2011**

**MECH 4104 [0.5 credit]**

**Vibration Analysis**

Free and forced vibrations of one and two degree-of-freedom systems. Vibration measurement and isolation. Numerical methods for multi-degree-of-freedom systems. Modal analysis techniques. Dynamic vibration absorbers. Shaft whirling. Vibration of continuous systems: bars, plates, beams and shafts. Energy methods. Holzer method.

**Instructor:** Prof. F. F. Afagh, Room 2194 ME; Tel. ext. 5705; [fafagh@mae.carleton.ca](mailto:fafagh@mae.carleton.ca)

**Schedule:** M,W: 13:05-14:25; Room ME 3328

**Course Outline:**

1. Fundamental concepts: Classification of vibration problems; Basic components of vibratory systems; Modelling basic components of vibratory systems; Harmonic motions.
2. Free vibration of SDOF systems: Undamped translational systems; Undamped torsional systems; Stability considerations; Rayleigh's Energy Method; Viscously damped systems; Coulomb and Hysteretic damping.
3. Harmonically excited SDOF systems: Undamped systems; Damped systems; Harmonic motion of the base; Damped systems under rotating unbalance.
4. SDOF systems excited by general forcing functions: General periodic forcing function; Impulsive forcing function; General forcing function; Response Spectrum; Laplace Transformation.
5. 2DOF systems: Free vibration of undamped systems; Coordinate coupling and Principal coordinates; Forced vibration of damped systems; Vibration absorbers.
6. Introduction to MDOF systems: Undamped systems; Influence coefficients; Lagrange's Equations; Eigenvalue problem; Expansion Theorem; Forced undamped systems; Viscously damped forced systems.

**CARLETON UNIVERSITY**  
**Department of Mechanical and Aerospace Engineering**  
**MECH 4104: Mechanical Vibrations**

**Course Outline, Winter 2011**

7. Numerical Methods for Natural Frequencies and Mode Shapes: Dunkerley=s Method; Rayleigh=s Method; Holzer=s Method; Matrix Iteration Method; Standard Eigenvalue problem.
8. Continuous Systems: Transverse vibration of strings and cables; Longitudinal vibration of rods; Torsional vibration of rods; Lateral vibration of beams; Vibration of membranes; Rayleigh and Rayleigh-Ritz Methods.

**Text Book:** *Mechanical Vibrations* by Singiresu S. Rao; 5<sup>th</sup> Edition; Pearson/Prentice Hall 2011

**Suggested Supplemental References:**

1. Elements of Vibration Analysis; by Leonard Meirovitch; McGrawHill 1986
2. *Theory of Vibration with Applications*; by: W.T. Thomson & M.D. Dahleh, 5<sup>th</sup> Edition, Prentice Hall, 1998

**Course Notes and Assignments:**

Posted on WebCT

**Office Hours:**

Thursdays: 10:00-12:00 or by appointment  
*No technical questions related to course material will be responded to via e-mail.*

**Preliminary Evaluation:**

Midterm Examination:-----40%  
*Open Notes only*

Final Examination:-----60%  
*Open Notes only*

**Notes:**

- § To pass this course students must pass the final examination.
- § The final examination is for evaluation purposes only and will not be returned to students.
- § Assignment problems will be posted on the web but they will not be marked.

**CARLETON UNIVERSITY**  
**Department of Mechanical and Aerospace Engineering**  
**MECH 4104: Mechanical Vibrations**

**Course Outline, Winter 2011**

**Academic Accommodation**

You may need special arrangements to meet your academic obligations during the term because of disability, pregnancy, or religious obligations. Please review the course outline promptly and write to me with any request for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist.

Students with disabilities requiring academic accommodations in this course must register with the Paul Menton Centre for Students with Disabilities (PMC) for a formal evaluation of disability-related needs. Documented disabilities could include but are not limited to mobility/physical impairments, specific Learning Disabilities (LD), psychiatric/psychological disabilities, sensory disabilities, Attention Deficit Hyperactivity Disorder (ADHD), and chronic medical conditions. Registered PMC students are required to contact the PMC, 613-520-6608, every term to ensure that your Instructor receives your Letter of Accommodation, no later than two weeks before the first assignment is due or the first in-class test/midterm requiring accommodations. If you require accommodations for your formally scheduled exam(s) in this course, please submit your request for accommodations to PMC by March 11, 2011.