

Days/Time	Thursday from 4:00-6:25
Location:	1220 Benedum Hall
Instructor Contract Information:	Jeff Vipperman 531 Benedum Hall 624-1643 jsv@pitt.edu http://www.pitt.edu/~jsv/courses/me2042
Instructor Biography:	http://www.engr.pitt.edu/mechanical/people/facstaff/vipperman_jeffrey.html
Course Description	This courses will present measurement and analysis techniques for dynamic systems, with particular emphasis on mechanical vibrations and acoustics. Background on vibration of lumped and continuous parameter systems, acoustics, noise and vibration control will be given. Other concepts include FFTs, windowing, calculation of input/output relationships, test methods, transducers, instrumentation, and the use of dynamic signal analyzers. Application to system identification and modal analysis will be included, as well as hardware demonstrations.
Prerequisites:	ME1020/ME2020, Mechanical Vibrations and by special permission.
Textbook and Readings:	<ul style="list-style-type: none"> • <i>Fundamentals of Noise and Vibration Analysis for Engineers, 2/e</i>, Michael Norton and Denis Karczub, Cambridge University Press, New York. ISBN 0-521-49913-5 (the paperback is much cheaper and identical on the inside). • Various Application Notes published and distributed for free by Briel & Kjaer Instruments, including ones on "Mobility Measurements" and "How to Determine the Modal Parameters of Simple Structures" (will be posted to course web page) • Various Application Notes distributed by Siglab, Inc. (will be posted to course web page)
Software Requirements:	The use of a computer and MATLAB, including the Signal Processing Toolbox, will be integral to the course. A public computing cluster with MATLAB on Windows, MacOS, and the Unix platform is available in Room 1075 Benedum Hall. You can also purchase your own copy of MATLAB from Pitt Software Licensing Services in 105 Bellefield Hall for \$10: http://technology.pitt.edu/Software.aspx?mp=2&body=Software/sls.html
Course Objectives:	<p>Time and frequency domain measurements and analysis of structural and acoustic systems will be presented. Concepts will be demonstrated with equipment in the <i>Sound, Systems, and Structures Laboratory</i>, in the Department of Mechanical Engineering.</p> <p>We will cover much of the first 5 chapters of Norton and will also study ancillary materials.</p> <p><u>Topics include:</u></p> <ul style="list-style-type: none"> • Review of single- and multiple- degree of freedom (SDOF/MDOF) vibration • Vibration of continuous systems • Acoustics in air and fluid/structure interaction • Noise and vibration control • Transducers for noise and vibration measurements, including dynamics and conditioning electronics

	<ul style="list-style-type: none"> • Digital signal analysis, including <ul style="list-style-type: none"> ○ Discrete and Fast Fourier transforms (DFT/FFT) and Hilbert Transforms (HT) ○ Aliasing ○ Time-domain windowing ○ Auto and cross spectral density functions, auto and cross correlation functions ○ Input/Output relationships for single and multi input/output systems ○ Computation of the H1 and H2 frequency response functions (FRFs) and the coherence function • Impact Testing, swept-sine analysis, and random signal analysis • Use of dynamic signal analyzers, including <ul style="list-style-type: none"> ○ Anti-alias filtering ○ Analog to digital (A/D) and digital to analog (D/A) converters ○ Triggering modes ○ Ensemble averaging ○ Overlap processing ○ Time-domain windowing ○ Dynamic Range ○ AC/DC coupling ○ Zoom Processing
Exams:	Midterm Exam: 2/28/08 Final Exam: 4/24/08 or possibly take-home
Projects:	Students will be assigned a project to write your own spectrum analyzer in MATLAB using Welch's Periodogram method. The analyzer should implement time-domain windowing and overlap processing.
Homework:	Assigned and collected weekly
A Few Important Things	

Grading:

Midterm	30%
Final Exam	30%
Project	10%
Homework	30%

Where to Find Further Information:

Math:

- ◆ Schaum's Mathematical Handbook of Formulas & Tables. Spiegel, Murray R., 1998, ISBN: 0070382034, The McGraw-Hill Companies

Modal Analysis:

- ◆ Modal Testing: Theory, Practice and Applications, D J Ewins, January 2000, Research Studies Press Limited, ISBN: 0-86380-218-4

Random Signal Analysis:

- ◆ Random Data: Analysis and Measurement Procedures, Julius S Bendat and Allan G Piersol, February 2000, Interscience, ISBN:0-471-31733-0.

Signal Processing:

- ◆ Discrete Time Signal Processing, 1, John R Buck, Alan V Oppenheim, and Schafer, December 1998, Prentice Hall PTR, ISBN: 0-13-754920-2.

System ID and Modeling:

- ◆ System Identification. Ljung, Lennart, 1998, ISBN: 0136566952, Prentice Hall

Vibrations:

- ◆ Principles and Techniques of Vibrations, Leonard Meirovitch, October 1996, Prentice Hall PTR, ISBN: 0-02-380141-7.

Acoustics:

- ◆ Fundamentals of Acoustics, Lawrence E Kinsler, Frey, Coppens, and Sanders, December 1999, John Wiley & Sons, Incorporated, ISBN: 0-471-84789-5.
- ◆ Fundamentals of Physical Acoustics, David T Blackstock, April 2000. John Wiley & Sons, Incorporated ISBN: 0-471-31979-1.

MATLAB:

- ◆ Mastering MATLAB 7 (or Mastering MATLAB 6), Hanselman, Duane C.; Littlefield, Bruce C., 2005, Pearson/Prentice Hall.