

ME-5514 Vibrations of Mechanical Systems

M W 2:30 pm – 3:45 pm Goodwin 145

Instructor:

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Course description: This course continues the study of the dynamics of mechanical systems started in the required undergraduate course ME 3504 (Vibrations) or equivalent (or a controls course). This course will *review* the vibration of single-degree-of-freedom systems. The thrust of the course will investigate multiple degree-of-freedom and continuous systems. Eigenvalue-vector/function problems, steady-state, and transient response will be treated. We will review single-degree-of-freedom systems, and then study multiple-degree-of-freedom (or lumped mass) systems and distributed parameter systems. We will end with an introduction to dynamic finite element methods in vibration analysis and give a brief introduction to modal testing methods.

Text: *Engineering Vibration 4rd Edition*, D. J. Inman, Pearson, 2014.

There are many excellent texts by other authors. If you have difficulty understanding a lecture or the assigned text, you are encouraged to look at other vibrations text in your library including the Schaum's Outline which has lots of worked problems. See Appendix D of the text for a list of other texts and reference material. Working lots of problems is a good way to learn this material. In addition (if we get the chance) we will look into the current literature a little in an attempt to transition your thoughts from learning vibrations and working on problems to doing research in the vibration area. The class project will aid in this transition and is discussed in a separate document. Several of these texts are in the library:

- 1) *Principles and Techniques of Vibrations*, by L. Meirovitch, Prentice Hall, 1997
- 2) *Analytical Methods in Vibration*, by L. Meirovitch, MacMillan, 1967
- 3) *Formulas for Natural Frequencies and Mode Shapes*, R.D. Blevins, Krieger Press, 1987
- 4) *Vibration and Control*, by D. J. Inman, Wiley, 2006
- 5) *Theory of Vibration with Applications*, by Thomson, Dahleh, 5th ed, 1997

Content: This is a first course at the graduate level vibrations. It is intended to give you an introduction to basic skills. Some of you will have had an introductory course as undergraduates and others will have not. We will study single-degree-of-freedom systems, multiple-degree-of-freedom (or lumped mass) systems and distributed parameter systems. We will end with an introduction to dynamic finite element methods in vibration analysis and give a brief introduction to modal testing methods. You are expected to have

access to and a working knowledge of MATLAB (preferred). Mathcad or Mathematica can also be used, but I will be of less help to you with these codes.

The topics that we will cover will depend somewhat on how fast we go through the material, which depends somewhat on your previous background and how quick you grasp the material. Our focus will be to start out with a quick over view (but complete with problems) of undergraduate vibrations. Referring to the assigned text, the undergraduate course normally covers Chapters 1, 2, 3 and parts of 4 and 5. The graduate course will review parts of Chapters 1, 2 and 3 and cover all of Chapters 4, 5 and 6, parts of 7, and 8. In addition we will focus a little more on nonlinear vibration than is typically done in the undergraduate course (sections 1.10, 2.9, 3.10). Towards the end of the course we hope to be reading out of the current literature in vibrations.

Course Management:

- 30% - Two small take home assignments
- 25% - Midterm
- 45% - Final Project

I also reserve the right to change **your grade +/- 10%** based on my opinion of you as a vibrations' engineer. Your homework is *required* to be a printed (and stapled), word-processed document, as this is what will be expected of you when you go to work. If you do not know how to use an equation editor, and/or MATLAB, it is time to learn how, as these will be invaluable tools for you once you graduate.

Office Hours: By appointment made through email.

Honor System: Please be aware that as a Virginia Tech student you are subject to the honor system. I suggest you read up on this at:
Undergraduate: <http://www.honorsystem.vt.edu/>
Graduate: <http://ghs.grads.vt.edu/>