Fall 2019

ME 433-001: Vibration Analysis

Stephen Tricamo

<table>
<tr><td>COURSE NUMBER</td><td>ME 433</td></tr>
<tr><td>COURSE TITLE</td><td>Vibration Analysis</td></tr>
<tr><td>COURSE STRUCTURE</td><td>(3-0-3) (lecture hr/wk - lab hr/wk – course credits)</td></tr>
<tr><td>COURSE INSTRUCTOR</td><td>S. Tricamo</td></tr>
<tr><td>COURSE DESCRIPTION</td><td>This course introduces the student to the fundamental theory of mechanical vibrations. Undamped and damped systems with single and multiple degrees of freedom, transient vibration, vibrations of continuous media, and analog and numerical methods.</td></tr>
<tr><td>PREREQUISITE(S)</td><td>Mech 236 – Dynamics and Math 222 – Differential Equations</td></tr>
<tr><td>COREQUISITE(S)</td><td>None</td></tr>
<tr><td>REQUIRED, ELECTIVE OR SELECTIVE ELECTIVE</td><td>Selective</td></tr>
<tr><td>REQUIRED MATERIALS</td><td>1. William J. Palm, Mechanical Vibration, 1st Ed., J. Wiley, 2007.
1. Software: MATLAB, Math Works, Inc.</td></tr>
<tr><td>Other supplemental materials (not Required)</td><td>2. William T. Thomson, Theory of Vibration with Applications, 4th Ed., Nelson Thornes Ltd., 2003.</td></tr>
<tr><td>COMPUTER USAGE</td><td>MATLAB, Math Works, Inc. and/or other TBD.</td></tr>
<tr><td>COURSE LEARNING OUTCOMES/ EXPECTED PERFORMANCE CRITERIA:</td><td>
<table>
<tr><th>Course Learning Outcomes</th><th>SOs*</th><th>Expected Performance Criteria</th></tr>
<tr><td>1 develop models of spring elements and damping elements and apply least square methods.</td><td>1</td><td>Exam Question (80% of the students will earn a grade of 70% or better on this question)</td></tr>
<tr><td>2. apply work energy methods for problems involving force, displacement, and velocity. using software to solve some exercises, individually and in teams</td><td>1,2</td><td>Exam Question (80% of the students will earn a grade of 70% or better on this question)</td></tr>
<tr><td>3. demonstrate how to properly apply the mechanical energy equation to a variety of physical systems.</td><td>1,2,5</td><td>Exam Question (80% of the students will earn a grade of 70% or better on this question)</td></tr>
<tr><td>4. compute the damped, natural frequencies, the logarithmic decrement, the time constant, and the damping factor, and determine</td><td>1,5</td><td>Exam Question (80% of the students will earn a grade of 70% or better on this question)</td></tr>
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	whether or not the system is stable.		
	5. **determine** the resonance frequency and peak response	1,2,5	**Exam Question** (80% of the students will earn a grade of 70% or better on this question)
	6. **analyze** the displacement and transmitted force of system having base excitation, rotating unbalance, or rotor shaft vibration	1,2,5	**Exam Question** (80% of the students will earn a grade of 70% or better on this question)
	7. **use** the Fourier series method and the Laplace transformation method to obtain the response of a linear system. Also, expressed in matrix form	1,2,5	**Exam Question** (80% of the students will earn a grade of 70% or better on this question)
	8. **identify** the modes of a system and compute its natural frequencies.	1,2,5	**Exam Question** (80% of the students will earn a grade of 70% or better on this question)
	9. **determine** ways to reduce unwanted vibration and the equipment used for collecting response data	1,2	**Exam Question** (80% of the students will earn a grade of 70% or better on this question)

CLASS TOPICS

1. Introduction to basic vibration terminology and the concepts of stiffness and damping (least squares method).
2. Differential equation of motion derived directly from Newton's laws.
3. Free response of damped and undamped systems having single degree of freedom.
4. Harmonic response of systems having one degree of freedom including resonance.
5. Single DOF systems response to non-harmonic forcing functions.
6. Design systems to eliminate or reduce the effects of unwanted vibration.
7. Use Matrix methods for analysis for equations of motion and analysis.
8. Vibration measurement and testing, hardware and measurement of response.
9. Vibration of systems that cannot be described adequately with lumped-parameter
10. Applications of MATLAB to finite element analysis.

STUDENT OUTCOMES (SCALE: 1-3)

1	2	3	4	5	6	7
3	3	2	2	1	1	2

3 – Strongly supported 2 – Supported 1 – Minimally supported

* Student Outcomes