Syllabus (ABET Format): Course Map/Outline
ME/AE 455 Mechanical Vibration and Control – Fall 2020

1. Course number and name
   ME/AE 455 Mechanical Vibration and Control

2. Credits and contact hours
   3 credits and two 75-minute lectures per week
   Instructor - Lectures (Zoom): Tuesday/Thursday, 10:00-11:15

3. Instructor and TA Information
   Instructor: Cetin Cetinkaya, Ph.D.
   Instructor - Office hours (Zoom): Tuesday/Thursday, 1:00-2:30 (or by appointments)

   TA: Yigitcan Coskunturk
   TA – Office Hours (Zoom): Friday, 9:00-11:00 and 3:00-5:00 (or by appointments)

4. Textbook title, author, and year
   Daniel Inman, Engineering Vibration
   Fourth Edition, 2013

   Other supplemental material: none

5. Specific course information
   a. Brief description of the content of the course (catalog description)
      The course will cover fundamental concepts on the vibration of mechanical systems including, review of systems with one degree for freedom, Lagrange's equations of motion for multiple degree of freedom systems, introduction to matrix methods (for multi-degree of freedom systems), transfer functions for harmonic response, impulse response, and step response, convolution integrals for response to arbitrary inputs, natural frequencies and modes, applications to critical speeds, measuring instruments, isolation, torsional systems, introduction to basic nonlinear problems.

   b. Prerequisites or co-requisites
      ES 223 Rigid Body Dynamics

   c. Indicate whether a required, elective, or selected elective (as per Table 5-1) course in the program
      ME 455 is a required course.

6. Specific goals for the course
   a. Specific outcomes of instruction

- The student will apply dynamics concepts to estimate the vibrational motion of mechanical systems.
- The student will predict the resonance frequencies, vibrational modes of motion, and harmonic/transient responses of mechanical systems due to initial conditions and dynamic loads.
- The student will make a mathematical model to estimate the maximum dynamic (cyclical) load and/or displacements that a mechanical system can withstand without failure.
- The student will understand key applications of vibrational analysis.

b. Criterion 3 outcomes addressed by the course
   1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

7. Brief list of topics to be covered
   a. Vibrating Elements/Types of Motion-Excitations
   b. Free Vibration of Single-DOF systems
   c. Vibration under Harmonic Excitation
   d. Vibration under General Excitation
   e. Multi-DOF Systems

Current Year Milestones - Potsdam	Fall 2020
First Day of Classes	August 19
Break Days	TBD
Midterm Grades Available	October 9
Last Day of Class	November 13
Reading Days	November 16, 17
Final Exams	November 18, 19, 20, 23, 24
Commencement (Potsdam)	November 24
Final Grades Available	December 1

Topical Course Outline:	**Chapters**	**Approx. Class Time**
1. Vibrating Elements/Types of Motion-Excitations	Chapter 1	3-4 Lectures
2. Free Vibration of Single-DOF systems	Chapter 1-2	4-5 Lectures
3. Vibration under Harmonic Excitation	Chapter 2	4-5 Lectures
4. Vibration under General Excitation	Chapter 3	7-8 Lectures
5. Multi-DOF Systems	Chapter 4	4-5 Lectures

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Module #	Module Objectives	Instructional Materials	Activities (Include Module Objective # each activity aligns with)
Module 1: **Week 1 (08/19)** 1.1 Introduction to Vibration 1.2 Harmonic Motion 1.3 Viscous Damping	• Learn the nature and extent of vibration problems in engineering • Learn harmonic motion of single degree-of-freedom systems • Learn how viscous damping affect vibrational motions	Text book – Section 1.1-1.3	Lectures Problem Solution Session Hmw#01: due 08/28, 5:00pm Problems: 1.5, 1.18, 1.21, 1.62
Module 2: **Week 2 (08/26)** 1.4 Modelling and Energy Methods 1.5 Stiffness 1.6 Measurements 1.8 Stability	• Learn the basics of vibrational modelling and energy methods for developing equations of motion • Learn the concept of stiffness and its role in mechanical systems • Learn basics of measurement techniques used in vibration analysis • Learn stability concepts	Text book – Section 1.4-1.8	Lectures Problem Solution Session Hmw#02: due 09/4, 5:00pm Problems: 1.67, 1.91, 1.94, 1.111
Module 3: **Week 3 (09/2)** 2.1 Harmonic Excitation of Undamped Systems 2.2 Harmonic Excitation of Damped Systems	• Learn harmonic excitation of un-damped vibrational/mechanical systems. • Learn the responses of damped systems under harmonic excitation	Text book – Section 2.1-2.2	Lectures Problem Solution Session Hmw#03: due 09/11, 5:00pm Problems: 2.9, 2.10, 2.33, 2.35
Module 4: **Week 4 (09/9)** 2.3 Alternative Representations 2.4 Base Excitation	• Learn various ways to represent harmonic and vibrational motions • Learn the dynamics of systems excited by base motion (excitation)	Text book – Section 2.3-2.4	Lectures Problem Solution Session Hmw#04: due 09/18, 5:00pm Problems: 2.41, 2.42, 2.47, 2.50

Module 5: **Week 5 (09/16)** 2.5 Rotating Unbalance 2.6 Measurement Devices 2.7 Other (Various) Forms of Damping	• Learn the effects of rotating unbalances (masses) on mechanical system vibration • Learn the types of measurement devices for quantifying vibrational motions and characterization of units (mass, spring, dashpot…) • Learn about various types of damping effects	Text book – Section 2.5-2.7	Lectures Problem Solution Session Hmw#05: due 10/2, 5:00pm Problems: 2.63, 2.67, 2.69, 2.79
Module 6: **Week 6 (09/23)** Review Session **Test 01**	• Review materials for Modules 1-5 • Be assessed for the level and extent of Modules 1-5 materials (Test 01)	Materials covered in Modules 1-5	Lecture (Review Session) Problem Solution Session **Test 01** (9/24) Cumulative Time: TBA No homework
Module 7: **Week 7 (09/30)** 3.1 Impulse Response Function 3.2 Response to an Arbitrary Input	• Learn the response of a mechanical system to impulsive loads • Learn the response of a mechanical system to arbitrary (not random) loads	Text book – Section 3.1	Lectures Problem Solution Session Hmw#06: due 10/9, 5:00pm Problems: 3.4, 3.12, 3.13, 3.21
Module 8: **Week 8 (10/7)** 3.2 Response to an Arbitrary Input (con't) 3.3 Response to an Arbitrary Periodic Input	• Learn the response of a mechanical system to arbitrary (not random) loads • Learn the response of a mechanical system to periodic loads	Text book – Section 3.2-3.3	Lectures Problem Solution Session Hmw#07: due 10/16, 5:00pm Problems: 3.22, 3.24, 3.31, 3.32
Module 9 **Week 9 (10/14)** 3.3 Response to an Arbitrary Periodic Input 3.4 Transform Methods	• Learn the response of a mechanical system to periodic loads (continued) • Learn basics of (frequency domain) transform techniques (not solving	Text book – Section 3.3-3.4	Lectures Problem Solution Session Hmw#08: due 10/23, 5:00pm Problems: 3.20, 3.33, 3.35, 3.36

	ODEs with transform techniques)		
Module 10 **Week 10 (10/21)** 3.7 Measurement via Transfer Functions 3.8 Stability	• Learn to characterization a system's inertia (mass), damping (dashpot), and elasticity (spring). • Learn basics of system stability	Text book – Section 3.7-3.8	Lectures Problem Solution Session Hmw#09: due 11/6, 5:00pm Problems: 3.52, 3.58, 3.63, 3.64
Module 11 **Week 11 (10/28)** Review Session **Test 02**	• Review the materials for Modules 1-11 • Be assessed for the level and extent of Modules 1-11 materials (Test 02)	Materials covered in Modules 1-11	Lecture (Review Session) **Test 02 (**10/29) Cumulative No homework
Module 12 Week 12 (11/4) 4.1 Two-Degree-of-Freedom Models (Un-damped) 4.2 Eigenvalues and Natural Frequencies	• Learn the modeling and analysis two degree-of-freedom systems • Learn basics of eigen-systems (eigen-value problems) • Learn modal solutions to the dynamics of two DoF systems.	Text book – Section 4.1-4.2	Lectures Problem Solution Session Hmw#10: due 11/13, 5:00pm Problems: 4.1, 4.2, 4.13, 4.30
Module 13 Week 13 (11/11) 4.3 Modal Analysis 4.4 More Than Two Degrees-of-Freedom Systems	• Learn modal solutions to the dynamics of two DoF systems. • Learn the modelling and analysis multi-degree-of-freedom systems	Text book – Section 4.3-4.4	Lectures Problem Solution Session Hmw#11: due 11/24, 5:00pm Problems: 4.39, 4.40, 4.44, 4.45
Module 14 **Final Exam** (11/18-11/24)	• Be assessed for the level and extent of Modules 1-13 materials (Final Exam)		**Final Exam** Date/Time: TBA Cumulative

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Grading:

Activity Type	%	Dates
Test 1	15	9/24
Test 2	25	10/29
Homework Assignments	15	Weekly
Final Exam	45	TBA (11/18-11/24)
Total Grade (Points)	100%	

Rubric:

Letter Grade	Total Grade (Points) Range
A+ (4.0)	96-100
A (4.0)	93-95
A- (3.667)	90-93
B+ (3.334)	87-90
B (3.0)	83-87
B- (2.667)	80-83
C+ (2.334)	75-80
C (2.0)	70-75
D (1.0)	60-70
F (0)	0-60

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IMPORTANT NOTES

- **Changes:** This syllabus may be subjected to changes. If there is a planned change (e.g. exams time/place), it will be announced in advance.

- **Grad students:** Grad students may take this course if they have not taken an undergraduate level vibration course before.

- **Homework Assignments:** Homework problems will be assigned after completing relevant lectures. Assignments will normally be submitted in PDF format to the course Moodle site by 5:00pm **Fridays**, except announced otherwise (due to holidays, breaks, special considerations, etc. – see the Schedule above). Answers to some of the homework problems are listed in the textbook (starting at page 692). Solutions will be posted on the class webpage and the Moodle site. Graded homework papers will be returned by the TA (a return method: TBD). **No late homework assignment will be accepted.**

- ***Examination and Homework Policy***
  All exams are cumulative. All examinations are closed-books. **No make-up tests will be given except for serious professional, medical and family emergencies (explained in a letter from the office of the Dean of Students within five working days of the student's return to Campus).**

  Exam papers will be submitted in PDF format to the course Moodle site by a date/time announced by the instructor. **No late exam submissions will be accepted.**

  Final grades will be determined on the basis of the rubric given above. Grade review requests for exam and homework grades may only be made within five working days from the grade announcements date/time.

  The student can prepare and use a formula sheet (8.5×11 in., both sides, only formulas, no other information (no text, plots, figures, drawings, problem solutions/outlines, pictures, etc.) along with her/him in each examination. A formula sheet is attached and submitted with the exam package. No hand-held computers and/or no networkable devices (e.g. cell phones, smart phones, tablets, laptops, etc.) are allowed in exam rooms.

  A calculator can be used in exams, however no class related data/programs/formulas are to be stored in the calculator. During examinations, no exchange of calculators is allowed.

- **Other Policies:**
  Ethics: No form of academic dishonesty will be tolerated.
  Attendance Policy: Students are required to attend the scheduled sessions.

Prepared by: *C. Cetinkaya*

Date: 08/13/2020 (rev. draft)