OAKLAND UNIVERSITY
School of Engineering and Computer Science

Winter 2018

ME 4300 - Mechanical Systems Design

Michael A. Latcha, PhD
Department of Mechanical Engineering
latcha@oakland.edu
(248) 370-2203

Office: 416 Engineering Center
Office Hours: 4:30 pm - 5:30 pm MW or by appointment

Text:
Shigley's Mechanical Engineering Design, 10th Edition, R.G. Budynas, J.K. Nisbett, McGraw-Hill, 2015.
ISBN: 978-0073398204

Resources: *Note - all of these resources are available at Amazon.com for very reasonable prices*
507 Mechanical Movements, Henry T. Brown
1800 Mechanical movements, Hiscox Gardner Dexter
Basic Machines and How They Work, Bureau of Naval Personnel (Dover Publications)
The Elements of Mechanical Design (Outline), James G. Skakoon, ASME Press, 2008

ME 4300 Mechanical Systems Design (4)
(4) Study of systems involving mechanical elements. Includes safety, stress, strength, deflection economic and social considerations, optimization criteria and strategies. Analysis and design of fasteners, springs, welds, bearings, power transmitting elements and complex structures subjected to static and/or dynamic loads. With project. Offered fall and winter. (Formerly ME 486)
Prerequisite(s): (ME 308 or ME 3300), (ME 372 or ME 3700),(ME 361 or ME 3250) and major standing.

Course Objectives:

- Demonstrate proficiency in the fundamentals of stress analysis: uniformly distributed stresses, elastic strain, shear and bending-moments in prismatic beams, normal and

shear stresses in bending, torsion, stresses in pressure vessels (a,e,k)
- Define and apply in design problems the concepts of deflection and stiffness, general spring rates, deflection due to bending, strain energy, Castigliano's method, Euler and Johnson columns (a,e,k)
- Design components and systems for static strength, including the use of factors of safety, failure theories and stress concentrations (a,c,e,k)
- Design components and systems against fatigue, including the use of the endurance limit, modifying factors, fluctuating stresses, torsion, combined loading, cumulative fatigue damage (a,c,e,k)
- Explain the design considerations in the use of screws, fasteners, and connections and apply them in design problems (a,c,e,k)
- Explain the design considerations of welded, brazed and bonded joints and apply them to design problems (a,c,e,k)
- Explain the design considerations of mechanical springs and apply them to design problems (a,c,e,k)
- Explain the design considerations of spur gears and apply them to design problems (a,c,e,k)
- Explain and apply the rudiments of structural optimization (a,c,e,k)
- Schedule, conduct and present, both written and orally, minor and major design projects (b,d,e,f,g,h,i,j)

Syllabus: The purpose of this class is to introduce the undergraduate student to the principles of successful and practical mechanical engineering design. The following are objectives for the major sections of the course:

- **Static Body Stresses.** Successful ME 486 students will demonstrate their ability to draw free-body diagrams (EGR 280/2800); compute forces acting on machine components (EGR 280/2800); calculate principal stresses given a biaxial state of stress (ME 361/3250); sketch shear force and bending moment diagrams (ME 322/3200) and determine maximum normal and shear stresses in prismatic beams (ME 361/3250); determine stresses and deflections in members subject to pure tension, compression or torsion (ME 361/3250); calculate the stresses in thin-walled pressure vessels (ME 361/3250) and to be familiar with the basic concepts of material science (ME 372/3700).

- **Elastic Strain, Deflection and Stability.** Successful students will be able to define general spring rates; calculate deflections due to bending by direct integration, superposition (review topics) and using singularity functions (new topic); compute the total strain energy in a system under load; apply Castigliano's Method to find the deflections of mechanical systems and analyze and design Euler and Johnson columns.

- **Failure Theories, Safety Factors, Reliability and Fatigue.** The successful student will be able to define and apply factors of safety; define and use the four main failure theories to design machine components; calculate stress concentrations for ductile materials; be able to design for alternating and fluctuating stresses under combined

loadings; be able to define and use endurance limits; be able to modify and apply endurance limits for specific applications.

- **Design of Mechanical Elements.** The successful student will be able to design and use standard machine components, including but not limited to, screws, fasteners and other connections; welded and bonded joints; mechanical springs and gear systems.

Grading: The final course grade will be determined as follows:

- **Homework**. Homework assignments will be made at the end of each lecture. Homework solutions will be discussed at the beginning of the class following the one in which they were assigned. Students must come to class prepared to present and discuss homework solutions with the class.

  SOLUTIONS:
  Chapter 3 (2, 4, 6, 8, 18, 19, 23, 34d, 38, 60, 61, 62)
  Chapter 4 (1, 2, 3, 10, 12, 56, 58, 60, 68, 99, 106)
  Chapter 5 (1, 3, 36, 39, 43 49)
  Chapter 6 (1, 2, 3, 5, 11, 13, 14, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 56)
  Chapter 8 (7, 11, 14, 29, 31, 32, 33, 37, 77)
  Chapter 9 (2, 15, 22, 29, 45, 48)
  Chapter 10 (3, 6, 7, 26, 28)
  Chapter 13 (1, 2, 3, 27, 29, 30, 31)

- **(40%) Quizzes**. Quizzes will be given at the end of every Wednesday class period with the exceptions of January 3 and April 18, 2018. Each quiz will consist of a single problem, will be strongly based on the homework and will be both closed-book and closed-notes, unless otherwise announced. Quizzes can cover any material presented from the first day of class up to, but not including, the new material presented in the preceding class. The lowest quiz grade will be dropped; there will be no make-up quizzes.
  The only resource allowed for quizzes (when appropriate) and the final exam is the Quiz and Exam Resource (rev. 4-25-2018). Each student will need to print a copy of this resource; no extra marks or notations on the pages will be allowed.
- **(20%) Design projects.** These projects may be assigned to be done individually or in design groups and will illustrate the concepts covered in class. Grades will be based on written reports.
  Design Project, Winter 2018 Project groups
- **(40%) Final exam.** A comprehensive final exam will be given on Wednesday April 25, 2018 from 7 pm to 10 pm.
- Assignments, quizzes and exams are graded on a 10-point scale. The conversion from this 10-point scale to a numerical grade is

  $$\text{Grade} = (-85P^2 + 1885P - 7550) / 700$$

  where P = points. 10 pts = 4.0; 9 pts = 3.6; 8 pts = 3.0; 7 pts = 2.1; 6 pts = 1.0

Special Considerations: Students with disabilities who may require special considerations should make an appointment with campus Disability Support Services. Students should also bring their needs to the attention of the instructor as soon as possible.

Academic Conduct: Students are expected to read, understand and comply with the Academic Conduct Policy of Oakland University, found in the Schedule of Classes and in the Undergraduate Catalog. Suspected violations will be taken before the Academic Conduct Committee. Students found responsible for academic misconduct will receive a grade of 0.0 in addition to any penalties imposed by the Academic Conduct Committee.

Program Outcomes: are a set of skills that assure the achievement of the program educational objectives. Before graduating, SECS students will demonstrate their skills in the following key areas:

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. an ability to function on multi-disciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.