EML 3005: Mechanical Design

Mechanical & Aerospace Engineering Department
University of Florida
Spring 2024

Professor: Nagaraj K. Arakere, Office: NEB 225, Email: nagaraj@ufl.edu
Class Time: T (Periods 2-3) (8:30-10:25), R 3 (9:35-10:25) **FAC 0120**

Office Hours: T, R, Period 5 (11:45-12:35) (**on Zoom**)
Website: http://lss.at.ufl.edu (e-learning on Canvas system)

Required Textbook:

Title: SHIGLEY'S MECHANICAL ENGINEERING DESIGN
ISBN: 9780073398211
Author: BUDYNAS
Edition: 11th (or new 2020 11th edition is good too)
Copyright: 2019
Publisher: MCGRAW-HILL
Note: Avoid "International Edition" which only has SI units.

Course Description

Design process, kinematics, gear trains and standard mechanical components. (3 Credit Hours)

Course Pre-Requisites / Co-Requisites

Pre-Req: COP 2271, EML2322L and EGM 3520 with minimum grade of C.

Course Objectives

At the end of the course, the student should

- Understand how to design using the "design process"
- Be able to determine stresses in mechanical elements
- Be able to design elements to avoid failure from static and dynamic loading within some factor of safety
- Be able to design or select standard mechanical elements
- Have familiarity with the synthesis and analysis in mechanical design.

Materials and Supply Fees

None

Professional Component (ABET):

This course prepares graduates to learn how to design a mechanical component to meet certain requirements.

Relation to Program Outcomes (ABET):

Outcome	Coverage*
a. Apply knowledge of mathematics, science, and engineering	high
b. Design and conduct experiments, as well as analyze and interpret data	
c. 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	high
d. Function on multidisciplinary teams	
e. Identify, formulate, and solve engineering problems	high
f. Understand professional and ethical responsibilities	
g. Communicate effectively	medium
h. Understand the impact of engineering solutions in a global, economic, environmental, and societal context	
i. Recognize the need for and be able to engage in lifelong learning	
j. Understand contemporary issues	
k. Use the techniques, skills, and modern engineering tools necessary for engineering practice	high

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not part of the course.

Scope: This course deals with the mechanical design of machine elements, design process, conceptual design, system and component design, and selection of certain standard parts. Design of machine elements such as journal bearings, rolling-element bearings, shafts, spur and helical gears, springs, fasteners, clutches and brakes will be presented. Kinematics of certain mechanisms and gears will be presented. Background from a diverse group of subjects such as material selection, static and dynamic load determination, strength of materials (stress, strain and deflection), static failure theories, fatigue failure theories, and surface failure theories will be utilized to come up with acceptable design of a variety of machine elements.

1. Introduction to Mechanical Engineering Design-Chapter 1 (Jan 9, Lecture 1)

2. Materials (Ch. 2), Load and Stress Analysis (Ch. 3), and Deflection and Stiffness (Ch. 4) are ***prerequisites*** from EGM 3520: Mechanics of Materials. These topics will be revisited as needed but will not be repeated in detail.

3. Failure Resulting from Static Loading: Chapter 5 (**Lectures 2-8**)
    a. Yield criteria for ductile materials (5-1 to 5-5, 5-7)
    b. Failure criteria for brittle materials (5-6, 5-8, 5-9)
    c. Introduction to fracture mechanics (5-12)
4. Fatigue Failure Resulting from Variable Loading: Chapter 6 (**Lectures 9-17**)
    a. Introduction to fatigue in metals (6-1)
    b. Fatigue-life evaluation methods (6-2 to 6-6)
    c. Endurance limit, fatigue strength and modifying factors (6-7 to 6-9)
    d. Stress concentration and notch sensitivity (6-10)
    e. Effects of alternating and mean stress, combined modes, cumulative fatigue damage (6-11 to 6-17)
5. Shafts and Shaft Component Design, Chapter 7 (**Lectures 18-19**)
6. Mechanical Springs, Chapter 10 (**Lectures 20-22**)

Test 1 (Tue, Feb 27)

Design Project # 1

7. Design of Contact Elements (**Lectures 23-25**)
    a. Hertzian stresses for cylindrical and spherical contacts (3-19)
    b. Elasto-hydrodynamic lubrication of non-conformal contact

Spring Break Week (March 9-16)

8. Spur and helical Gear Design, Chapters 13 & 14, (**Lectures 25-38**)
    a. Loading, bending and contact stresses
    b. Design of spur and helical gears

Test # 2 (Tue, April 2)

Group Design project

8. Group Design Presentations (Week 15-16)

Last day of class is Tue, April 24th

Group Design Project: Design groups of 5 members (chosen randomly) will be formed. Group members must learn to work together.

There will be NO comprehensive FINAL exam.

Grading Policy:

2 Tests	= 60 %
Design Projects (30%) + Homework (10%)	= 40 %

Grading Scale:

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

Make-up Policy: Late projects or homework is not allowed. Makeup exams are not allowed. If you cannot attend an exam, you must contact the instructor prior to the exam. Arrangements will be made for students on a case-by-case basis. (Failure to contact the instructor prior to the exam will result in a zero on that exam.)

Academic Honesty: As is understood by the vast majority of students, our basic relationship is based on trust; we have rarely encountered problems in this area. Following the request of the Provost we include the following statement.

All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action.

This statement is a reminder to uphold your obligation as a student at the University of Florida and to be honest in all work submitted and exams taken in this class and all others. All students should review the University's honor code policy - you will be held to it.

Accommodation for Students with Disabilities: Students requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

UF Counseling Services: Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.

Notes on Homework Problems

Policies/Procedures:

1. Homework (HW) problems are an essential element of this course. In general, students can expect to have HW assigned every week. See the e-learning site and schedule for HW assignments. HW will be submitted via the Connect Plus web site and grading is automated to allow immediate feedback.

2. ***Students are encouraged to discuss the general principles involved in the homework sets with one another, but the detailed solution of each problem should be completed individually. Submitting a HW solution that is directly copied from another source is considered a violation of the honesty policy.***