MEEG 4104 MACHINE ELEMENT DESIGN (4 Credits)

Instructor: Zhenghui Sha (zsha@uark.edu)
Office: MEEG123
Hours: Tuesday and Thursday 1:30 – 3:30 pm and by appointment

Teaching assistant: Joshua Pennington (jspennin@email.uark.edu)
TA office: MEEG227
TA hours: 1:00 – 3:00 pm Monday; 3:00 – 5:00 pm Wednesday

Course Overview

Course textbook: Shigley's Mechanical Engineering Design, 10th edition, Budynas & Nisbett, McGraw-Hill. (We will not be using online resources from the publisher.)

Learning outcomes

1) Understand and apply static failure theory.
2) Understand and apply dynamic (fatigue) failure theory.
3) Understand and apply principles of mechanical component selection.
4) Design systems that integrate mechanical components to achieve system performance and reliability requirements.

Course Structure

Level-based scaffolding: This course is structured with 4 levels, i.e., Level 1 – statics, Level 2 – fatigue analysis, Level 3 – spring and gear design, and Level 4 – bearing and shaft design. There are 20 lectures in total. Each level covers an independent yet coherently connected content. You must not lag behind the class in order to proceed successfully to the next level.

Individual learning: Individual homework will be assigned on every Thursday's class. Your work should be uploaded in your own hand writing in pdf or word file only. The homework is due on next Wednesday 5:00pm.

Team-based learning: a) Group work. You will apply the concepts and theories you learnt in classes to textbook problems or physical systems as a team. Group work will be assigned on every Tuesday's class. The group work is due on next Monday 5:00 pm. b) Projects. There will be two projects, i.e. Project 1 – Reverse Engineering and Project 2 – Power transmission design. A projects is accomplished by a group. Weekly tasks of the projects are planned in order to help a group maintain a steady progress and ensure the final deliverable.

Lecture preview and/or review: Lecture videos made by Dr. David Jensen are available on YouTube, and the links are posted on Blackboard. Watching the lecture videos is optional but highly recommended, especially before class and/or before level tests. In addition, reading the corresponding chapters of the textbook is encouraged for lecture preview and review.

Assessment and Grading

Level tests: At the completion of each level there will be an in-class test of the concepts from that level.

Project reports and presentations: The first project is assessed in a form of final project report. Each group will submit one report. The report is due at the end of the 7th week, i.e., March 5th, 5:00 pm. The second project is assessed by presentation in a form of PPT slides and/or posters given by each group. Presentation will be performed in the final week.

Peer evaluation: Each team member will be evaluated by their peers in the same group to assess the individual performance in that group. Two peer evaluations will be performed for your performance in group work and project work, respectively.

Grading: On Blackboard there are two total scores. One represents your progress in the course all together (including zero for things yet to be done) and the other indicates grade on work submitted so far. A total of 900 points are available for the course. Point values and contribution to your final grade can be identified from the table below.

	Graded Activity	**Point Value Each**
Individual effort 500 points (~55%)	Homework	10 (10 activities)
	Level tests	100 (4 tests)
Group effort 400 points (~45%)	Group work	10 (14 activities)
	Project assessments	120 (2 assessments)
	Peer evaluation	10 (2 peer evaluations)
Total points: 900		

Policies of Grading

1) There will be NO rounding, that is, to get an “A" you must achieve a 90% or better. Other letter grades are specified in a similar fashion. Since achievement in this course is level-based all grades must be achieved. All concerns related to grading should be addressed prior to completion of the next level.
2) You must achieve a passing grade in both individual and group work in order to pass this course.
3) Late individual work will be accepted up to one week late with a penalty of 25% off the score achieved. Late group work will not be accepted.

Group Work Policies

1) Groups will be assigned in order to maximize availability and improve diversity.
2) Detailed distribution of work in a group is determined by the group itself. Individuals will not be able to skate by on their groups performance. For group submissions, each student needs to include a statement specifying their role in the group project.
3) All effort should be made to settle disputes within the group. As a next-to-last resort, the instructor will attempt to mediate to reach a solution. The final resort is that a group member may be fired by private unanimous decision among the other group members or a group member may quit. Note: no individual work will be accepted for the group projects. Ejected individuals must find another group immediately, either before quitting or within days of being fired. All behavior within the groups must be professional and respectful.

Schedule

	Week	Tuesday	Thursday	Textbook reading	Project tasks
1	17-Jan	Lecture 1 (Video Intro and 1); HW1	Lecture 2 (Videos 2 and 3); GW1	**Chapter 5:** 5.1 – 5.13	Getting familiar with the project
2	23-Jan	Lecture 3 (Videos 4 and 5); GW2	Lecture 4 (Videos 6 and 7); HW2		Stress analysis on 5 critical parts
3	30-Jan	Static summary; HW/GW Q&A; GW3	**Static Test**		Solid model and FEA analysis
4	6-Feb	Lecture 5 (Videos 8 and 9); GW4	Lecture 6 (Videos 10 and 11); HW3	**Chapter 6:** 6.1 – 6.11 & 6.14 – 6.17	Load cycle and strength
5	13-Feb	Lecture 7 (Video 12); GW5	Lecture 8 (Videos 13 and 14); HW4		Fatigue analysis
6	20-Feb	Lecture 9 (Videos 15 and 16); GW6	Lecture 10 (Video 17); HW5		FMECA table
7	27-Feb	Fatigue summary; HW/GW Q&A; GW7	**Fatigue Test**		Project 1 report due
8	6-Mar	Lecture 11 (Video 25); GW8	Lecture 12 (Videos 26); HW6	**Chapter 10:** 10.1 – 10.10 **Chapter 13:** 13.5 – 13.7 **Chapter 14:** 14.1 – 14.2	Requirement and objectives
9	13-Mar	Lecture 13 (Video 18); GW9	Lecture 14 (Video 19); HW7		Define gearing
10	20-Mar	Spring break			Spring break
11	27-Mar	Lecture 15 (Video 20); GW10	Lecture 16 (Video 21); HW8		Gearing analysis
12	3-Apr	No class; Spring and gear self-review; GW11	**Spring and Gear Test**		Define layouts and loads
13	10-Apr	Lecture 17 (Videos 22 and 23); GW12	Lecture 18 (Video 24); HW9	**Chapter 11:** 11.1 – 11.8 **Chapter 7:** 7.1 – 7.8	Bearing analysis
14	17-Apr	Lecture 19 (Video 27); GW13	Lecture 20 (Video 28); HW10		Shaft design and analysis
15	24-Apr	Bearing and shaft summary; GW14	**Bearing and shaft Test**		Solid modeling work
16	1-May	Project 2 Work Day; Project 2 Q&A	**Project Presentation**		Project presentation

*GW: Group work; HW: Homework.

Lecture Videos

Intro Video: https://youtu.be/P2meRBV9Igk

LEVEL 1

Video 1: Principle Stress - https://youtu.be/CBVlYibdF3M

Video 2: Avoiding Failure by Deflection - https://youtu.be/AGRd5gPorwQ

Video 3: Intro to Static Failure Theories - https://youtu.be/4sCybAlyDQg

Video 4: Ductile Failure Theory - https://youtu.be/T0Oqzt9CMmw

Video 5: Brittle Failure Theory - https://youtu.be/rVes5x0AZ5g

Video 6: Distortion Theory - https://youtu.be/bFbgvgL_mEU

Video 7: Basic Uncertainty Analysis - https://youtu.be/p9mEzgv5g70

LEVEL 2

Video 8: Intro to Fatigue Failure Analysis - https://youtu.be/iJKwiU-GzIo

Video 9: Endurance Strength - https://youtu.be/skPHOeHhfXs

Video 10: Marin Factors - https://youtu.be/Age9mYeph3s

Video 11: Fatigue Stress Concentrations - https://youtu.be/qW3KvfUn0Cg

Video 12: Finite Life Estimation - https://youtu.be/70XlfG3PwmU

Video 13: Stress from Fluctuating Loads - https://youtu.be/k8rZ6wD8LjA

Video 14: Fluctuating Load Example - https://youtu.be/EGLg33u-sH8

Video 15: Combine Loading for Fatigue - https://youtu.be/Ne_6hoiPdHQ

Video 16: Example of Combined Fatigue Loading - https://youtu.be/NXtrrn43Vb4

Lecture 17: Miner's Method - https://youtu.be/LeURX0BG6Jw

LEVEL 3

Video 25: Spring Specification – https://youtu.be/_Mqc4dpSqkQ

Video 26: Sprig Design Guidelines - https://youtu.be/wqxL_AV5jGU

Video 18: Intro to Gear Design - https://youtu.be/stArIuvSAaQ

Video 19: Spur Gear Force Analysis - https://youtu.be/efLRsQIpO3Y

Video 20: Helical Gear Force Analysis - https://youtu.be/KqQYBIgx-Go

Video 21: Bending Stress on Gear Teeth - https://youtu.be/h3-h0c2AJgA

LEVEL 4

Video 22: Intro to Bearing Selection - https://youtu.be/hHZjW34G3oQ

Video 23: Stochastic Approach to Bearing Selection - https://youtu.be/wzYG9h5KH0E

Video 24: Thrust and Radial Loads on Bearings - https://youtu.be/tBfqnF05hMg

Video 27: Intro to Shaft Design – https://youtu.be/SL-hZP2UPa8

Video 28: Special Considerations for Shafts - https://youtu.be/zPFjUe_5LOA

University Related Policies

Academic Honesty
As a core part of its mission, the University of Arkansas provides students with the opportunity to further their educational goals through programs of study and research in an environment that promotes freedom of inquiry and academic responsibility. Accomplishing this mission is only possible when intellectual honesty and individual integrity prevail.

Each University of Arkansas student is required to be familiar with and abide by the University's Academic Integrity Policy which may be found at http://provost.uark.edu/. Students with questions about how these policies apply to a particular course or assignment should immediately contact their instructor.

Accommodation Policy
University of Arkansas Academic Policy Series 1520.10 requires that students with disabilities are provided reasonable accommodations to ensure their equal access to course content. If you have a documented disability and require accommodations, please contact me privately at the beginning of the semester to make arrangements for necessary classroom adjustments. Please note, you must first verify your eligibility for these through the Center for Educational Access (contact 4795753104 or visit http://cea.uark.edu for more information on registration procedures).

Emergency Procedure
Many types of emergencies can occur on campus; instructions for specific emergencies such as severe weather, active shooter, or fire can be found at http://emergency.uark.edu

- Severe Weather (Tornado Warning):
  - ✓ Follow the directions of the instructor or emergency personnel
  - ✓ Seek shelter in the basement or interior room or hallway on the lowest floor, putting as many walls as possible between you and the outside
  - ✓ If you are in a multi-story building, and you cannot get to the lowest floor, pick a hallway in the center of the building
  - ✓ Stay in the center of the room, away from exterior walls, windows, and doors
- Violence / Active Shooter (CADD):
  - ✓ CALL- 9-1-1
  - ✓ AVOID- If possible, self-evacuate to a safe area outside the building. Follow directions of police officers.
  - ✓ DENY- Barricade the door with desk, chairs, bookcases or any items. Move to a place inside the room where you are not visible. Turn off the lights and remain quiet. Remain there until told by police it's safe.
  - ✓ DEFEND- Use chairs, desks, cell phones or whatever is immediately available to distract and/or defend yourself and others from attack.

Other Policies
Discrimination and harassment of any kind will not be tolerated in this course. See University Discrimination and Harassment Policy for more information.

Always consider your own safety when assessing class attendance and be aware of University closures due to weather.