MAT314 – Mechanical Properties of Materials

Objective

This course is intended to bridge the introductory materials science knowledge to mechanical behavior of various crystalline and amorphous systems. It covers the influence of microstructure on the mechanical behavior of materials including metallic alloys, polymers and ceramics. The main objective of the course is to explain the fundamentals laws of elasticity followed by plastic behavior and deformation. In the meantime, the ways in which microstructure and defects are exploited to fabricate high-performance materials that are applied to today's technologies ranging from aerospace to toughened ceramics will be described. The content includes and is not limited to stress-strain relations, elastic and plastic deformation, dislocations, dislocation interactions, work hardening, vacancies, interaction of precipitates with defects, glass transition in polymers, creep in materials, brittle fracture and ductile fracture, viscoelastic behavior and case studies that span a wide variety of phenomena including fatigue.

Teaching Staff

Instructor:		
	Hatice S. Sas	
Office	IMC – 1A033 and FENS G022	
Phone	[+90] 216 300 1355	
E-mail	haticesas@sabanciuniv.edu	
Office hours	Wednesdays 3.40pm-4.30pm*	*also appointment via email

Teaching Assistants:		
	Mert Gürtan	Ceren Yıldırım
Office	IMC	IMC
Phone	[+90] 216 300 1300	[+90] 216 300 1300
E-mail	mertgurtan@sabanciuniv.edu	yildirimceren@sabanciuniv.edu
Office hours	Appointment via email	Appointment via email

Course Schedule

- Monday at 2.40 pm – 4.30 am in FENS G025
- Wednesday at 2.40 am – 3.30 am in FENS L048

Textbook and Reference Materials

I will use my own lecture notes compiled from different resources. Related reference sources are tabulated in the below tentative outline section.

Exams

You will have two midterm and a final examination. For each exam, the instructions will be shared. You will be responsible to follow the instructions.

Design Project

This semester you will propose a design solution for a selected application which will include:
i. analysis of the loading configuration
ii. selection of a metallic material for the loading and the environmental conditions
iii. propose a new design to decrease the weight and cost
You will work in a group of two. You will be assigned your project in two weeks, and you will present a midterm report and a final report with a presentation to the jury members. Jury

members will be professors from different departments related to your design problem and approach.

Assignments

- There will be 6 homework assignments.
- Assignments should be written clearly. Diagrams or graphs should be given when necessary. They should be clearly labeled and contain enough information so that they can stand-alone.

Quizzes

- There will be pop-up quizzes during the class hour.
- The content of the quizzes will cover the material specifically in that class.

Grading

Following is the list of items that will contribute to your final grade. Percentages are up to change and will be finalized at the end of the semester.

- Midterm 1 - 2 20% - 20%
- Final 30%
- Design Project 12.5%
- Assignment 12.5%
- Quiz 5 %

Course Policies

- Class attendance (physically or online) is required for your own benefit. It is imperative that you review the coverage of previous weeks prior to coming to class to increase your understanding of the materials to be covered in the class.
- Latecomers are welcomed to join the class without disturbing us.
- Working with others to learn the material is strongly encouraged. However, it is strictly forbidden to copy answers from one another without putting your efforts to solve them. All graded materials (assignments and exams) are intended to be solved or prepared individually. Any instance of giving or receiving aid on these issues will be viewed as a serious offence, which may result in a failing grade for the course and/or referral to the University disciplinary system
- Plagiarism
    - Definition: the practice of taking someone else's work or ideas and passing them off as one's own.
    - Proper citing is suggested to avoid plagiarism

Tentative Outline

Week 1 Oct.3rd – Oct.4th	▪ Course Introduction ▪ Mechanical Properties of Materials (Hibbeler – Ch 1,3, Meyers & Chawla – Ch2)	
Week 2 Oct.10th – Oct.12th	▪ Survey of materials, Isotropic vs anisotropic materials (Callister & Rethwisch – Ch1.4, Meyers & Chawla – Ch2.9)	▪ HW-1 assignment ▪ Project draft assignment

Week 3 Oct.17th – Oct.19th	▪ Stress Distribution: Axial loading, Torsion, Bending, Transverse shear (Hibbeler – Ch4,5,6,7)	
Week 4* Oct.24th – Oct.26th *This week courses will be rescheduled	▪ Elasticity (Jones & Ashby Ch – 3,4,6, Hosford - Ch10,15, Meyers & Chawla – Ch2.13 ▪ Stress Transformations: Mohr's Circle (Bedford & Liechti – Ch7)	▪ HW-2 assignment
Week 5 Oct.31th – Nov.2nd	▪ Midterm I ▪ Deformation & Plasticity (Hosford – Ch5, Callister & Rethwisch – Ch8)	
Week 6 - 8 Nov.7th – Nov.9th Nov.14th – Nov.16th Nov.21st – Nov.23rd	▪ Project midterm report ▪ Deformation & Plasticity (Hosford – Ch5, Callister & Rethwisch – Ch8)	▪ HW-3 assignment ▪ HW-4 assignment
Week 9 Nov.28th– Nov.30th	▪ Failure mechanisms: Fracture (Callister & Rethwisch – Ch9)	
Week 10 Dec.5th– Dec.7th	▪ Midterm II ▪ Failure mechanisms: Fatigue (Callister & Rethwisch – Ch9)	▪ HW-5 assignment
Week 11 Dec.12th– Dec.14th	▪ Failure mechanisms: Fatigue (Callister & Rethwisch – Ch9)	
Week 12 - 13 Dec.19th– Dec.21th, Dec.26th– Dec.28th	▪ Failure mechanisms: Creep (Callister & Rethwisch – Ch9)	▪ HW-6 assignment
Week 14 Jan.2nd– Jan. 4th	▪ Special cases: Composite materials ▪ Project final report and presentation	

References:

- Hibbeler: Hibbeler, R. C. Mechanics of Materials. 6th ed. Upper Saddle River, NJ: Prentice Hall, 2004. ISBN: 9780131913455.
- Meyers & Chawla: Meyers, M. A., and K. K. Chawla. Mechanical Behavior of Materials. Upper Saddle River, NJ: Prentice Hall, 1998. ISBN: 9780132628174
- Callister & Rethwisch: Callister, W. D. Fundamentals of Materials Science and Engineering. 2nd ed. New York, NY: Webster's New World, 2004. ISBN: 9780471470144.
- Hosford: Hosford, W. F. Mechanical Behavior of Materials. New York, NY: Cambridge University Press, 2005. ISBN: 9780521846707.
- Bedford & Liechti: Bedford, A., and K. M. Liechti. Mechanics of Materials. Upper Saddle River, NJ: Prentice Hall, 2000. ISBN: 9780201895520.