Course Registration Numbers: 15571

Schedule: Tuesdays and Thursdays at 10:30 – 11:45 am in 1021 ARMS

Instructor: Michael D. Sangid; Email: msangid@purdue.edu
Office: 3329 ARMS; Telephone: 494-0146
Office Hours: Wednesdays 2:30 – 3:30 pm
Immediately before or after class
Additionally available by appointment

Please note: To ensure that everyone has the same access to questions/answers, please ask questions about the HW during class or seek HW help in the scheduled office hours. Emailing questions should be avoided. Also, please do not ask general/vague questions, such as 'how do I do #X (while showing up with no prior work)?' or 'is this right?'

Prerequisites: AAE 204 / AAE 352 – No prior knowledge of materials science is needed

Required Text: "Mechanical Behaviour of Engineering Materials: Metals, Ceramics, Polymers, and Composites," Roesler, Joachim, Harders, Harald, Baeker, Martin; Springer, 2007; ISBN 978-3-540-73446-8.
Can be downloaded for Purdue students for via going through the Purdue library website and entering the title into the keyword search:
http://www.springer.com/materials/mechanics/book/978-3-540-73446-8

Recommended Text:
"Mechanical Behavior of Materials," by William F. Hosford; Cambridge; ISBN-10: 0521846706
Online book: Defects in Crystals by Helmut Foll:
http://www.tf.uni-kiel.de/matwis/amat/def_en/index.html

Supplemental Texts:
Mechanical Behavior of Materials, Thomas H. Courtney, McGraw Hill
Mechanical Behavior of Materials, Norman E. Dowling, Prentice Hall
Deformation and Fracture Mechanics of Engin. Material, Richard W. Hertzberg, Wiley
Materials Science and Engineering, An Introduction, William D. Callister, Wiley
Mechanics of Materials, James M Gere & Barry J. Goodno, Cenage Learning
Introduction to Dislocations, D Hull & DJ Bacon, Butterworth-Heinemann
Microstructural Design of Fiber Composites, Tsu-Wei Chou, Cambridge
Theory of Dislocations, Hirth & Lothe, Krieger
Crystals, Defects, and Microstructure, Rob Phillips, Cambridge

Course Website:
https://engineering.purdue.edu/AAE/Academics/Courses/aae59000_Mechaincal_Behavior_of_Materials/Spring_2015
The current schedule as well as supplementary information will be kept on the website. The HW and figures displayed in class will be found in the restricted access folder.

Course Description:

This course serves as an overview for materials behavior for students without a materials background, including seniors and entry-level graduate students. Materials are at the foundation for all of engineering, as evident by the latest products that we design, to the airplanes that we fly, to the latest smart phones. In fact breakthroughs with material research are often accompanied by rapid advancements in technology. Thus it is paramount for all engineers to have an understanding of the structure and behavior of materials.

In this class, we focus on the structure of materials, the microstructure connection to mechanical properties, and ultimately failure mechanisms. Materials play an important role in both design and manufacturing, which will be addressed in the context of components and extreme environments. Of specific interest will be defects within materials, defect formation/evolution, and their role in strengthening mechanisms.

Material anisotropy, micromechanisms, and elasto-plastic properties at the atomic, single-crystal/constituent, and polycrystal/material levels and their use in explaining the deformation and failure characteristics in metals, polymers, and ceramics; failure mechanisms and toughening in composites; structure and behavior of aerospace materials: metal alloys, ceramic-matrix composites, and fiber-reinforced polymer composites. Particular topics will also include: elastic deformation, dislocation mechanics, plastic deformation and strengthening mechanisms, creep, and failure mechanisms; design criteria; special topics. We will attempt to have minimal overlap with AAE 554 'Fatigue of Structures and Materials', therefore we will not cover fracture, fatigue, or stress concentrators.

Approach: Active learning – classes are a mixture of lecture and discussion

Students are expected to be present and prompt for class, to keep up with the materials and homework assignments, and to live up to the highest standards of honesty and integrity. Lectures will include presentation of concepts and methods and working of examples. A typical class period will include a lecture highlighting the important concepts and integrating examples. Students are encouraged and expected to be lively and participate with the lectures. The class notes will be given on the blackboard with figures shown on the overhead (the figures will be made available through the class website). It is expected that the students come to class and take notes. If a student cannot make it to class, they should arrange to get the notes from one of their classmates.

Homework: Assigned weekly on the previous Thursday (given on website) and due on the following Thursday. You are allowed to drop the lowest score out of the 11 HW assignments. You may work in teams of 1 to 3 on the HW. Please write each of your names on the HW assignment that you turn in.

The HW is for your own benefit and is necessary to properly learn the material. It is expect that each student put forward an honest effort in solving each problem. Working together is not a means to 'divide up' the work. If you turn in an assignment with more than one name on it; each person must have put forth their best effort on every problem and discussed this problem with the group. Any abuse of this policy and we will go back to individual assignments.

Grading: 3 Credit Hours – HW (24%), Midterm 1 (24%), Midterm 2 (24%), Final (24%), and In-Class Participation & Exercises (4%). In general, we will have a 90%|80%|70%|60% grade scale with +/- grades. Depending on how the class performs on its assignments and tests, the instructor reserves the right to curve the scale in the favor of the class, if necessary, based on his discretion. Grades will never be curved downward.

Definition of Academic Dishonesty: Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty" (*University Regulations*, Part 5, Section III, B, 2, a). Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest" (University Senate Document 72-18, December 15, 1972).

Academic Integrity: "Purdue University values intellectual integrity and the highest standards of academic conduct. To be prepared to meet societal needs as leaders and role models, students must be educated in an ethical learning environment that promotes a high standard of honor in scholastic work. Academic dishonesty undermines institutional integrity and threatens the academic fabric of Purdue University. Dishonesty is not an acceptable avenue to success. It diminishes the quality of a Purdue education which is valued because of Purdue's high academic standards" (S. Akers, *Academic Integrity, A Guide for Students*, 1995, revised 1999). Also, see PURDUE UNIVERSITY CODE OF HONOR

Honors Credit: It is possible to take AAE590 for honors credit with approval from the instructor. The idea of extra projects involving teaching others (in some form of outreach) what you've learned in the class has always been appealing. Wikipedia is a very powerful tool for this, although a lot of resources already exist for mechanical behavior of materials. An honors class project for AAE 590 will consist of creating/modifying a Wikipedia page with concepts, applications, and/or examples from aerospace structural analysis (with your choice of topics from class). The topic is due on Thursday, March 12, 2015. Please include a printout of the original page that you intend to modify or the search result containing no wiki found for that topic. The project is due Thursday, April 23, 2015. Please email me a URL link to your Wikipedia website and turn in a printout of the page.

Students with Disabilities: Students with disabilities requiring additional assistance should make themselves known to the instructor.

Campus Emergency: In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control.

Additional Information: This class will uphold Purdue University's policies on 'Attendance and Grief Absence', 'Adverse Weather', 'Campus Emergency', etc. Please consult purdue.edu for more information.

			Topic	Reading	HW Due Dates
	Week	**1**			
1	Tues	13-Jan	Into and Mechanics Prelim	Ch 1; App. A	
2	Thur	15-Jan	Crystallography	App. B; 6.2.4	
	Week	**2**			
3	Tues	20-Jan	Elasticity - physical basis and link to crystallography	Ch 2	
4	Thur	22-Jan	Elasticity - anisotropy; stress-strain relationship		1
	Week	**3**			
5	Tues	27-Jan	States of Stress and Yielding, Ex of Rotation	3.1-3.3.3;3.5	
6	Thur	29-Jan	Dislocation Mechanics - Basics & Elastic. Prop	6.1-6.2	2
	Week	**4**			
7	Tues	3-Feb	Dislocation Mechanics - Basics & Elastic. Prop	6.2	
8	Thur	5-Feb	Dislocation Mechanics - Energy and Forces	6.3	3
	Week	**5**			
9	Tues	10-Feb	Dislocation Mechanics - Obstacles	6.2	
10	Thur	12-Feb	Dislocations - Partials and Stacking faults	6.3	4
	Week	**6**			
11	Tues	17-Feb	Review and Catch-up (Exam Covers Lectures 1-10)		
12	Thur	19-Feb	Plastic Deformation - single crystal	6.5	
	Week	**7**			
	Mon	***23-Feb***	***Midterm Exam I - 6:30-7:30 pm in 1252 HAMP***		
13	Tues	24-Feb	Plastic Deformation polycrystal	6.4	
14	Thur	26-Feb	Twinning and Shape Memory	6.4	5
	Week	**8**			
15	Tues	3-Mar	Strength. Mech. - Solid Solution; Precip. Strengh.	7.1-7.2;7.5	
16	Thur	5-Mar	Strength. Mech. - Strain Hardening; Grain Boundary	7.3	6
	Week	**9**			
17	Tues	10-Mar	Creep - Overview, Phenomenon, and Larson Miller	11.1	
18	Thur	12-Mar	*Two bar and residual stress problems*		7

			Topic	Reading	HW Due Dates
	Week	**10**			
	Tues	17-Mar	*No class - Spring Break*		
	Thur	19-Mar	*No class - Spring Break*		
	Week	**11**			
19	Tues	24-Mar	Impact and Contact Mechanics		
20	Thur	26-Mar	Review and Catch-up (Exam Covers Lectures 12-19)		
	Week	**12**			
21	Tues	31-Mar	Ceramics and Weibull Statistics		
	Wed	***1-Apr***	***Midterm Exam II - 6:30-7:30 pm in 1252 HAMP***		
22	Thur	2-Apr	Statistics; Probability of Failure; Property Variability		
	Week	**13**			
23	Tues	7-Apr	Polymer Structure	8.1;8.3;8.5-7	8
24	Thur	9-Apr	Polymer Time Dependency and Visco-Elasticity	8.2	
	Week	**14**			
25	Tues	14-Apr	Polymer Mechanical Behavior and Failure	8.4; 8.8	9
26	Thur	16-Apr	Composites Behavior-I	9.1-9.3	
	Week	**15**			
27	Tues	21-Apr	Composites Behavior-II	9.4	10
28	Thur	23-Apr	Machining, post-processing, and surface finishing		
	Week	**16**			
29	Tues	28-Apr	High Temp Materials: Superalloys and CMCs		11
30	Thur	30-Apr	Review and Catch-up (Exam Covers Lectures 21-29)		
			Final Exam (TBD during week of 5/4/15 to 5/9/15)		