Instructor: Dr. Fardad Azarmi, Dolve Hall – Office 111D
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Office hours: Tuesdays 11:00 AM –12:00 PM or by appointment

Lecture: Tuesday and Thursday 12:30-1:45 PM, Dolve 202

Textbook: Mechanical Behavior of Materials, Second Edition, M.A. Meyers & K.K. Chawla, ISBN: 9780521866750, Cambridge University Press, 2009.

Suggested Reading:
- Mechanical Behavior of Materials, W.F. Hosford, Cambridge University Press, 2005.
- Mechanical Behavior of Materials, N.E. Dowling, Prentice Hall, 1999.
- Mechanical Metallurgy, 3rd Edition, G.E. Dieter, McGraw Hill, 1986.
- Mechanical Behavior of Materials, T.H. Courtney, McGraw Hill, 1990.

Prerequisites: ME 331, basic Materials Science course, or approval of the instructor

Course Description:

Fundamental concepts of elastic, viscoelastic, and plastic deformation of materials; emphasizing atomic and microstructure-mechanical property relationships. Theory of static and dynamic dislocations; fracture, fatigue, and creep as well as strengthening mechanisms in materials.

Course Objectives/Outcomes:

1) Predict elastic and viscoelastic deformations in isotropic, anisotropic, and composite materials
2) Predict yielding failure of engineering materials and components under multiaxial stress states
3) Explain the effect of microstructural features and deformation mechanisms on flow of materials
4) Analyze crack growth behavior of engineering materials
5) Predict the fatigue life of engineering components subjected to cyclic loading
6) Predict creep deformation and rupture life of engineering materials and components

Topics Covered:

1) Materials, Structure, Properties, and Performance
   Crystal Structures
   Review different class of materials; Metals, Ceramics, Polymers

2) Elastic Deformation in Materials
   Stress-strain, compliance, and stiffness tensors
   Isotropic & anisotropic stress-strain relations
   Elastic properties of materials
   Transformation of stresses and strains
   Elastic behavior of anisotropic materials

3) Plastic Deformation in Materials
- Uniaxial stress-strain behavior, true stress-stain
- Introduction to strain Hardening
- Strain rate sensitivity in materials
- Constitutive yield, flow, and failure criteria
- Viscoelasticity
- Voigt Approach
- Non-symmetrical mechanical response of materials
- Bauschinger effect
- Dislocation back stress
- Plastic deformation of polymers
- Hardness
- Deformation of single crystals

4) Imperfections in Materials
- Point defects
  - Equilibrium
  - Production
  - Effect on mechanical properties
- Line defects
  - Behavior of dislocations
  - Stress field around dislocations
  - Energy of dislocations
  - Dislocation pileup
  - Motion of dislocations (Orowan's equation)
  - Peierls-Nabarro stress
- Grain boundaries
- Twinning and twin boundaries
- Role of grain boundaries in plastic deformation
- Other internal obstacles

5) Geometry of Deformation and Work-Hardening
- Geometry of deformation
  - Stress required for slip
  - Shear deformation
  - Slip systems
  - Independent slip systems in polycrystals
- Work-hardening
- Softening mechanisms
- Texture strengthening

6) Brief Introduction to Fracture, Fatigue, and Creep in Materials
- Microstructural and Microscopic Aspects of Failure
- Principal of Fracture
- Fatigue parameters and S-N curves
- Fundamental mechanisms responsible for creep

Grading:

Homework:	15%
In Class Quizzes (4)	10%
Term Test	25%
Term Paper and Presentation:	20%
Final Exam	30%

Contract Grades:	≥90%	A
	≥80%	B
	≥70%	C
	≥60%	D
	<60%	F

Homework Assignments:

Homework assignments will be given based on the lecture covered. Late homework: 25% penalty (1–2 days late), 50% penalty (3-4 days late), and no credit (after 5 days).

Examinations:

Term tests and Quizzes will be a combination of True/False, Complete the Sentence, Multiple Choice, Short Essay, and Work-Out Problems. If a student must miss an examination because of serious illness, family death, etc., notify the instructor or the ME Department office (231-8671) as soon as possible. Accommodations will be made for urgent and acceptable excuses.

Term Paper and Presentation:

The term paper will consist of an exhaustive review of a sub-area in the study of mechanical behavior of materials assigned by the instructor. The paper must be typed in two columns (standard for journal papers). Diagrams, flow charts, figures, and tables should be used wherever appropriate for presentation and illustration of the concepts and ideas reviewed. A 5-10 min PowerPoint presentation covering the term paper content will be given at the end of the semester by each student.

Academic Responsibility:

All work in this course must be completed in a manner consistent with NDSU University Senate Policy, Section 335: Code of Academic Responsibility and Conduct. http://www.ndsu.nodak.edu/policy/335.htm and the CEA Honor System available at http://www.ndsu.edu/cea/ug-honor-code.php.

Veterans Statement:

Veterans and student soldiers with special circumstances or who are activated are encouraged to notify the instructor in advance.

Special Needs:

Any student needing special accommodations in this course (lectures, laboratories, and exam) is invited to share these concerns or requests with the instructor as soon as possible, see NDSU policy # 606 (www.ndsu.nodak.edu/policy/606.htm).

Changes to this course outline may be made if necessary, and will be posted on Blackboard

Health and Safety Expectations:

While masks are not required as we begin the 2022 fall semester, NDSU administration has determined that faculty may request mask use in their classroom. To help maintain a healthy campus NDSU is asking all students and employees to do their part by following CDC risk reduction practices below:

- Get vaccinated
- Stay home if you have a cough or fever.
- Students should check their temperature each day before coming to campus and stay home if they have a fever. Normal temperature should be less than 100.4 degrees Fahrenheit.
- Practice social distancing.
- Wash your hands often with soap and water for at least 20 seconds.
- Limit unnecessary contact, including hugs and handshakes.
- Cover coughs and sneezes with a tissue or sleeve.

Please **do not come to class** if

- you are feeling ill, particularly if you are experiencing COVID-19 symptoms, or
- you are infected during your five-day isolation period.

You will still need to complete the assignments, exams, reading, etc. necessary to meet class learning objectives. You can complete missed work by [*Arrangement by the course & lab instructor*].