

CARLETON UNIVERSITY
Department of Mechanical & Aerospace Engineering
Tentative Course Outline – MAAE 4102
Engineering Materials: Strength and Fracture

Hours Per Week: 3 h. lectures, Lecturer: A. Artemev; office 3230 B ME;
office hours: TBD
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Lecture Plan (approx. hours)

- 1-3 Introduction. Why Study Strength & Fracture? Fracture as a Failure Criteria, Defects, Imperfections & Strength. Fracture and failure mechanisms. Fractography, Effect of Stress State on Fracture, Transition Temperature.
- 4-7 Ductile Failure.
- 8-15 Introduction to Linear-Elastic Fracture Mechanics. Griffith Crack Theory, Energy Analysis of Fracture, Stress Analysis of Cracking, Critical Stress Intensity, The Size of the Crack Tip Plastic Zone, Thickness Effect.
- 16-17 Influence of Microstructure on Fracture Toughness. Toughening methods and Mechanisms. Fracture Mechanics in Structural Design.
- 18-22 Fatigue. Fatigue Crack Initiation and Growth. Fatigue Testing. Surface treatments and Design Against Fatigue.
- 23-27 Environment Assisted Cracking. Stress Corrosion Cracking. Hydrogen Embrittlement. Environmentally Enhanced Fatigue Crack Growth.
- 28-32 Creep. Creep Curve. Mechanisms of Creep Deformation. Temperature-Stress-Strain Rate Relationships. Microstructural Design for Creep Resistance.
- 33-36 Non-Destructive Evaluation, NDE & Fracture Mechanics, Ultrasonic Techniques, Liquid Penetrants, Eddy Current, Radiographic Methods.

Learning objectives:

After completing this course you should be able to:

- understand main mechanisms of failure processes;
- understand the relationship between the fracture surface and the type of the fracture process;
- analyze the ductile failure in the common types of structural components;
- use linear-elastic fracture mechanics for the analysis of brittle fracture conditions and design of structural components;
- evaluate the fatigue life and use main approaches to design that can be applied to prevent fatigue failure;
- understand the relationships between the material structure and fracture properties;
- understand main factors determining the character of the fracture process;
- understand main types of environment assisted cracking processes;
- analyze the development of the stress corrosion cracking;
- solve the problems of creep deformation for different types of creep processes;

- understand main approaches to the microstructural design for creep resistance;
- understand the main types of experimental techniques for testing the properties of materials;
- understand main techniques of the non-destructive evaluation.

Textbooks: Lecture notes and example problems (will be posted on CULearn).

Additional Readings:

Fracture Mechanics (electronic resources available through the Carleton Library):

Wei, Robert Peh-ying, Fracture mechanics: integration of mechanics, materials science, and chemistry. Cambridge University Press, 2010.

Dietmar Gross, Thomas Seelig, Fracture mechanics: with an introduction to micromechanics. Springer, c2006.

Gdoutos, E. E., Fracture mechanics an introduction. Springer, 2005.

A. Shukla, Practical fracture mechanics in design. Marcel Dekker, 2005.

Fractography:

http://www.georgevandervoort.com/images/Failure-Analysis/Fractography_Vol12.pdf

http://www.tech.plymouth.ac.uk/sme/Interactive_Resources/tutorials/FailureAnalysis/Fractography/Fractography_Resource.htm

<http://www.lbl.gov/ritchie/Teaching/MSE212/FCP07.pdf>

Marking Scheme: Mid-Term Exam	30%
Final Exam ¹	70%

A. Artemev

August 2016

Academic Accommodation

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: <http://www2.carleton.ca/equity/>

¹ Final examination is for evaluation purposes only and will not be returned to the students.

Religious obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: <http://www2.carleton.ca/equity/>

Academic Accommodations for Students with Disabilities: The **Paul Menton Centre** for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your **Letter of Accommodation** at the beginning of the term, and **no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable)**. After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable) at <http://www2.carleton.ca/pmc/new-and-current-students/dates-and-deadlines/>

You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at <http://www2.carleton.ca/equity/>

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