

**MAT E 410 (3-0-3) Materials Engineering and Design**  
**Department of Materials Science and Engineering**  
Winter 2008  
Prof. Antonios Zavaliangos

## **COURSE DESCRIPTION**

Fracture and Fatigue. Interaction of materials, processing and design, the design-failure interface, case studies.

## **GOALS AND APPROACH**

This course has two parts:

- (a) An introduction to fracture mechanics and fatigue accompanied with selected case studies.
  - a. Historical perspective
  - b. Theoretical cohesive strength
  - c. Defects in solids
  - d. Stress concentration
  - e. Griffith crack theory
  - f. Elastic stress field around crack tips
  - g. Crack tip plasticity
  - h. Plane strain fracture toughness
  - i.  $K_{IC}$  testing
  - j. R-curve behavior
  - k. J integral (descriptive)
  - l. Cyclic Stress and Strain Fatigue
  - m. S-N curves (high and low cycle fatigue)
  - n. Paris' law and fatigue crack propagation
  - o. Creep rupture and long term ductile failure
  - p. Long term brittle failure
  - q. Data interpretation – Larson-Miller fit – accelerated tests
  - r. Environmental Stress cracking
- (b) Selected case studies will be presented and thoroughly discussed to highlight the design-materials interface. In these case studies the principles of mechanics and materials. Typical case studies may include:
  - The collapse of a molasses tank in Boston's North End (1918)
  - The explosion of 175mm Army Gun in April 1966
  - The failure of freight containers
  - The design of a PE natural gas pipeline
  - The pants belt of the instructor.

## **REFERENCE TEXTS**

- Supplementary handouts and notes
- R. W. Hertzberg, “Deformation and Fracture of Engineering Materials”
- ASM Handbook Vol. 20 Materials Selection and Design
- ASM Handbooks, Vol 9, 11, 12 (Fractography, Failure Analysis,)

All ASM Handbooks are accessible online at <http://products.asminternational.org/hbk/index.jsp> through the Drexel Network

## **OUTLINE**

Week 1 – 5: Fracture and Fatigue (topics a-n),

Week 6 – 7: Case Study I

Week 8 – 10: Case Study II: HDPE gas pipelines (topics o-r)

A third case study may be added depending on time.

## **OBJECTIVES**

At the end of this course the student should be familiar with and have a firm understanding of:

- Fundamentals of fracture and fatigue
- The relationship between materials, processing, and design
- Criteria for failure as necessary inputs to engineering design
- Laboratory test results and reference/handbook data pertaining to failure
- General approaches and techniques in a failure investigation
- The process of working systematically through a case study involving a service failure, or designing a system that will not fail in service.

## **GRADING**

Assignments : 70 % of the grade

1 Final Exam : 30 % of the grade

## **CONTACT INFO**

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