

ME 541 FATIGUE OF MATERIALS

Winter 2006

<http://courses.washington.edu/mengr541/ramulu/541/>

Textbook: Fundamentals of Metal Fatigue Analysis, by Julie A. Bannantine, Jess, J. Comer, James L. Handrock, Prentice Hall Pub 1990

Schedule: Tuesday, Thursday
8:30-9:50 AM

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Grading:
Homework and short projects **60%**
Midterm Exam **40%**

Calendar: This indicates topics and associated reading.

Final Exam: There is no Final Exam

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EDGE Website:
<http://www.engr.washington.edu/edge/me541>

	Tuesday	Thursday
J A N U A R Y	3 Course Introduction	5 Intro & Background of failure
	10 Stress-Life approach <i>Chapt 1</i>	12 Stress-Life approach <i>Chapt 1</i>
	17 Strain -Life Analysis <i>Chapt 2</i>	19 Strain -Life Analysis <i>Chapt 2</i>
	24 Fracture Mechanics Analysis <i>Chapter 3</i>	26 Fracture Mechanics Analysis <i>Chapter 3</i>
F E B R U A R Y	31/1 Notch effects <i>Chapt 4</i>	2 Notch effects <i>Chapt 4</i>
	7 Variable Amplitude Loading <i>Chapt 5</i>	9 Midterm Examination
	14 Variable Amplitude Loading <i>Chapt 5</i>	16 Variable Amplitude Loading <i>Chapt 5</i>
	21 Applications and Comparison of Methods <i>Chapt 6</i>	23 Multiaxial Fatigue <i>Chapt 7</i>
M A R C H	28/2 Environmental effects <i>Note</i>	2 Midterm Examination
	7 Topics of Interest	9 Failure analysis <i>Notes</i>

ME541 : OVERVIEW

General Description: Fatigue of Materials (3 Credits)

Macro and micro aspects of fatigue (time dependent failure) of materials and related fatigue mechanisms. Analytical methods for fatigue and life assessment in advanced materials. Each week: Two 1.5-hr lectures

Course Goals: To give students an applied understanding of the three basic methods of fatigue analysis (stress-life, strain-life, fracture mechanics) for all classes of materials. Emphasis is placed on the engineering experience practice using practical homework problems and short projects.

Course Outline:

Introduction and brief review
Historical Overview

Macro and Micro Aspects of Fatigue

- Fracture surfaces
- Fatigue Mechanism
 - Crack nucleation
 - Crack growth
 - Fatigue failure

Stress-Life Analysis

- S-N Curves
- Mean Stress Effects (Goodman, Soderburg, Gerber)
- Modifying Factors (Marin)

Strain-Life Analysis

- Fundamental Material Behaviour
- Plasticity Relations
- Elastic and Plastic Strain Components
- Strain-Reversal Curves

Fracture Mechanics (Fatigue Crack Propagation) Analysis

- LEFM
- Fatigue Crack Growth Curves
- Relationships (Paris Power Law, Forman)
- Closure Effects, Short Cracks, Stress Raisers

Effects of Notches, Variable Loading, Multi-Axial Loading and Other Conditions

- Blunt vs Sharp Notches in Brittle and Ductile Materials
- Damage Parameters and Combined Loading (Palmgren-Miner, Rainflow)

19. Equivalent Stress and Strain

Corrosion & Fretting Fatigue

Fatigue and Failure of Joints and Structure

Methods to enhance fatigue resistance

Department of Mechanical Engineering
ME 541 --WINTER QUARTER

Fatigue of Materials
M. Ramulu

Professor

Reference Books:

1. **R.I. Stephens , A.Fatemi, R.R. Stephens and H.O. Fuchs , *Metal Fatigue in Engineering*, 2nd Edition, John Wiley, 2001.**
2. **R.W. Hertzberg, *Deformation and Fracture Mechanics of Engineering Materials*, John Wiley, 1983.**
3. **S.T. Rolfe & J.M. Barsom, *Fracture & Fatigue Control in Structures*, Prentice Hall, 1977.**
4. **N.E. Frost, K.H. Marsh, & L.P. Pook, *Metal Fatigue*, Oxford University Press, 1974.**
5. **T.R. Gurney, *Fatigue of Welded Structures*, Cambridge University Press, 1979.**
6. **R.B. Heywood, *Designing Against Fatigue of Metals*, Reinhold, New York, 1962.**
7. **J.Y. Mann, *Fatigue of Materials*, Melbourne University Press, Australia, 1967.**
8. **M. Klesnil & P. Lukas, *Fatigue of Metallic Materials*, Elsevier, 1980.**
9. **P.J.E. Forsyth, *The Physical Basis of Metal Fatigue*, Blackie & Son, Ltd., 1969.**
10. **R.W. Hertzberg & J.A. Manson, *Fatigue of Engineering Plastics*, Academic Press, 1980.**
11. **J.T. Fong, Ed., *Fatigue Mechanisms*, ASTM STP 675, 1979.**
12. **Lankford, et al., Ed., *Fatigue Mechanisms*, ASMT STP 811, 1983.**
13. **L.P. Pook, *The Role of Crack Growth in Metal Fatigue*, Metal Society, London, 1983.**
14. **SAE Fatigue Conference P-109, 1982.**

15. D. Broek, *Elementary Engineering Fracture Mechanics*, Nordhoff Int. Pub., 1983.
16. S. Kocanda, *Fatigue Failure of Metals*, Sijthoff and Noordhoff Pub., 1978.
17. Taylor, *Fatigue Thresholds*, Butterworth, 1990.
18. SAE Fatigue Committee: *Fatigue Design Handbook*, AE10, SAE Pub., 1988.
19. S. Suresh, *Fatigue of Materials*, Cambridge University Press, 1991.
20. J.Schijve, *Fatigue of Structures and Materials*, Kluwer Academic publ. 2001

Suggested Additional Reading:

Annual Book of ASTM Standards, American Society for Testing and Materials

Deformation and Fracture Mechanics of Engineering Materials, Richard Hertzberg

Elementary Engineering Fracture Mechanics, David Broek

Engineering Materials and Their Applications, Richard Flinn and Paul Trojan

Engineering Materials 1 and 2, Michael Ashby and David Jones

Mechanical Behavior of Materials, Thomas Courtney

Mechanical Engineering Design, Joseph Shigley and Larry Mitchell

Mechanical Metallurgy George Dieter

Mechanics of Materials, Russel Hibbeler

Mechanics of Materials, David Roylance

Stress, Strain, and Strength, Robert Juvinall

Highlighted books are the major references

TECHNICAL JOURNALS IN FRACTURE MECHANICS

	Title
Primary Interest	International Journal of Fatigue
	Fatigue and Fracture of Engineering Materials and Structures
	International Journal of Fracture
	Engineering Fracture Mechanics
	Journal of Failure Analysis
	Journal of Failure Analysis and Prevention
Secondary Interest	Theoretical and Applied Fracture Mechanics
	Experimental Mechanics
	Journal of Engineering Materials and Technology
	Journal of Pressure Vessel Technology
	International Journal of Pressure Vessels and Piping
	International Journal of Engineering Science
	International Journal of Mechanical Sciences
	International Journal of Solids and Structures
	Journal of Materials Science
	Journal of Composite Materials
Journal of Mechanics and Physics of Solids	
Nuclear Engineering and Design	