DME3051
Mid-term exam review
Instructor: Prof. Keun Ryu

Tip: Read your textbook

Problem types
- ✓ Please fill out the blank(s).
- ✓ True or false questions (Yes or No questions)
- ✓ Define A
- ✓ Compare A with B.
- ✓ etc

Chap. 1 Mechanical Engineering Design in Broad Perspective
****Mechanical Design??****
1.6 Systems of Units

lbf = (lbm)(g_c)
= (lbm)(32.17 ft/sec^2)
= 32.17 ft-lbm/sec^2
OR = (0.4536 kg)(9.8 m/sec^2)
= 4.448 N
OR = (slug)(ft/sec^2)
= slug-ft/sec^2

** Unit conversion **
- g_c= 9.81 m/sec^2 = 32.17 ft/sec^2 = 386 in/sec^2
- Pressure = Stress = Pa = N/m^2 = kg/m-s^2
- Torque = N-m
- Energy = Work = Joule = N-m = Pa-m^3 = Watt-s = kg-m^2/s^2
- Power = Watt = J/s = N-m/s = kg-m^2/s^3 = Torque × angular velocity
  - ft = 0.305 m
  - Inch = 0.0254 m
  - Mile = 1609 m
  - Yard = 0.914 m
  - 1 US gallon = 3.785 liter
  - 1 liter = 10^{-3} m^3

<u>SEE: Appendix A</u>
<u>SEE: Appendix A-2b</u>

Chap. 3 Materials
<u>SEE: Appendix C-1</u>
- Young's Modulus (E)
- Shear Modulus (G)
- Poisson's ratio
- Density
- CTE

• Toughness: Ability of a material to absorb energy per unit volume without fracture [in-lbf/in^3 or J/m^3]. **Charpy IMPACT TEST**.

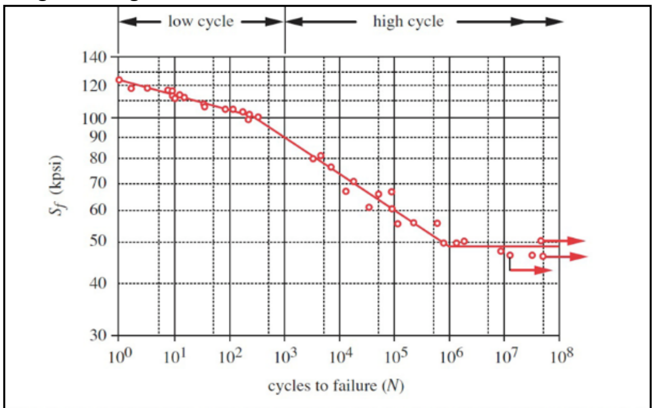
• Fracture toughness *Kc*: A material property that defines its ability to resist stress at the tip of a crack. Measured by subjecting a standardized, pre-cracked test specimen to cyclical tensile loads until it breaks.

3.2 The static tensile test
Fig. 3.1
3.3 Implications of the "Engineering" Stress-Strain Curve
Fig. 3.2

Chap. 4 Static Body Stresses
4.12 Stress Concentration Factors, K_t
4.13 Importance of Stress Concentration
- ✧ Stress concentration
- ✧ How to avoid stress concentration

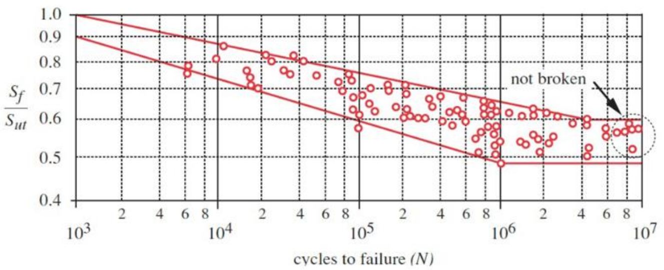
Chap. 6 Failure Theories, Safety Factors, and Reliability (MUST READ***)**
6.2 Type of Failure
6.3 Fracture Mechanics-Basic Concepts
6.4 Fracture Mechanics-Applications
<u>Sample Problems 6.1~6.2</u>
6.5 The Theory of Static Failure Theories
6.6 Max. Normal Stress Theory
6.7 Max. Shear Stress Theory
6.8 Max. Distortion Energy Theory
6.9 Mohr Theory and Modified Mohr Theory
6.10 Selection and Use of Failure Theories
<u>***Sample Problems 6.3***</u>

Chap. 8 Fatigue
MUST READ: Chap. 8.1, 8.2
Low Cycle Fatigue vs High Cycle Fatigue
Fatigue strength & Endurance limit

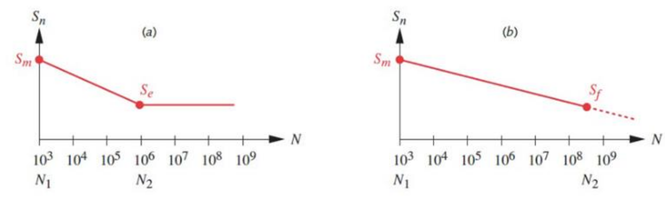


Fully Reversed Axial S-N Curve for AISI 4130 Steel, Showing Break at LCF/HCF Transition and an Endurance Limit

Chap. 8.3
R.R. Moore Rotating bearing test
MUST KNOW(**): Figs. 8.3, 8.4, 8.5, 8.9

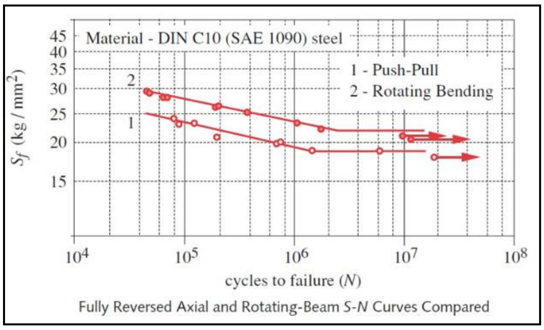


Log-Log Plot of Composite S-N Curves for Wrought Steels of S_{ut} < 200 ksi



Estimated S-N Curves for (a) Materials with Knee, (b) Materials Without Knee

Chap. 8.4
MUST KNOW: Fig. 8.11
Fully reversed bending vs Axial loading vs Torsional loading vs Rotating-beam



Fully Reversed Axial and Rotating-Beam S-N Curves Compared

Chap. 8.5

MUST KNOW: Fig. 8.12

***S_{us}=0.8S_{ut}* (for steel) & =0.7 *S_{ut}* (for other ductile metals)**

Chaps. 8.7 & 8.8

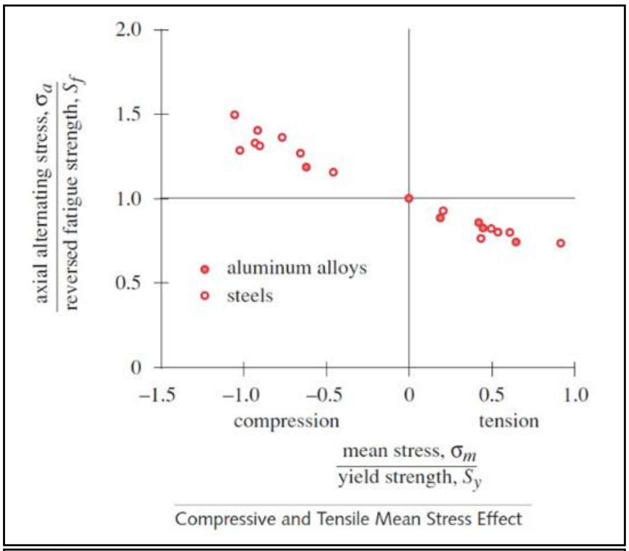
*************Table 8.1*************

********MUST READ: Chap. 8.9*********

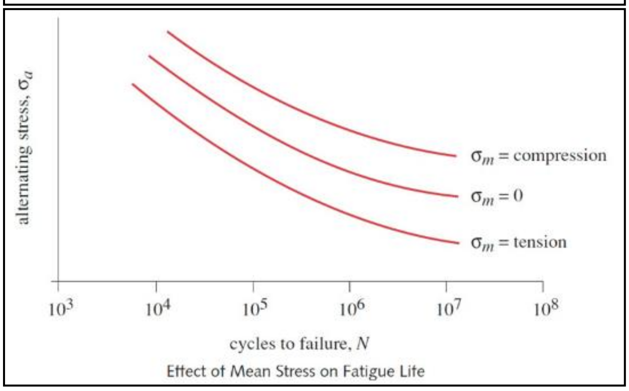
Fatigue load: Fully reversed vs Repeated vs Fluctuating

Fig. 8.15: Stress range, Alternating stress, Mean stress, Stress ratio, Amplitude ratio

Combined σ_m and σ_a

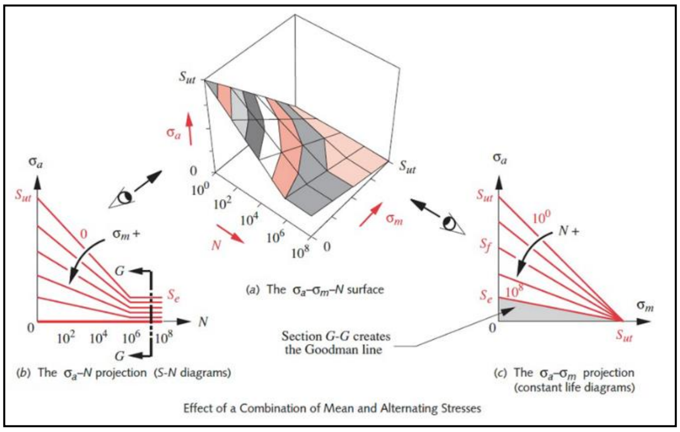


Compressive and Tensile Mean Stress Effect

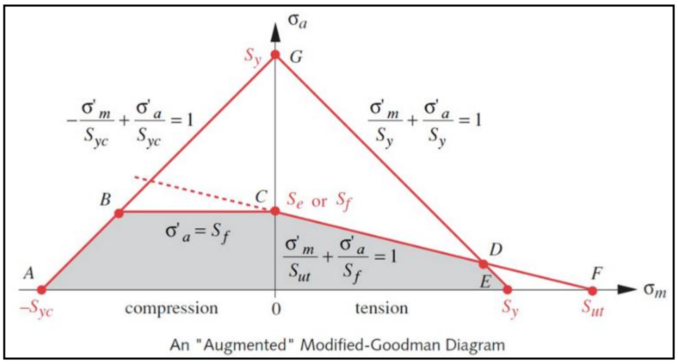


Effect of Mean Stress on Fatigue Life

MUST KNOW(**): Table 8.2, Figs. 8.16, 8.20



Effect of a Combination of Mean and Alternating Stresses



An "Augmented" Modified-Goodman Diagram

Sample Problems: 8.1 & 8.2

MUST READ: Chap. 8.11

Sample Problems: 8.3 & 8.4

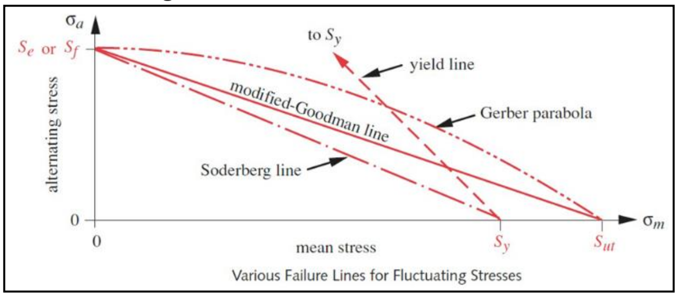
MUST READ: Chap. 8.16

MUST KNOW: Fig. 8. 34

Sample Problem: 8.7

MUST READ: Chap. 8.17

MUST KNOW: Fig. 8. 36



Various Failure Lines for Fluctuating Stresses

Chap. 9 Surface Damage

****MUST READ: Chaps. 9.8, 9.9, 9.10, 9.11, 9.14, 9.15****

Wear
- Adhesive wear
- Abrasive wear
- Corrosion wear
- Surface fatigue (or contact-stress fatigue)