ME413: Machine Design I, Midterm exam, October 20, 2006
Department of Mechanical Engineering, University of Saskatchewan
Time: 11:30 am-1:30 pm **Instructor: R. Fotouhi** **Student name/ID** .....

Open-book exam, the textbook is allowed. No other materials or computer are allowed in the exam. One **Calculator** is permitted in this test. Please **answer** all **questions**. Begin each problem on a new page in your answer book. **Show your work. Return the exam question** inside the exam booklet when you hand it in. Failing to return the **question sheet** will cost you **5 marks**.

10 mark

Q1- In a tension test of a steel specimen having a 6-mm by 25-mm rectangular net cross section, a gage length of 20 cm was used. Test data include the following observations: (1) load at the onset of yielding was 37.8 kN, (2) ultimate load was 65.4 kN, (3) total deformation in the gage length at 18 kN load was 112 μm. Determine the following.

a) Nominal yield strength
b) Nominal ultimate strength
c) Modulus of elasticity
d) From tables in chapter 3, and using the result of parts (a-c), determine (guess) the type of steel used in this tension test, indicate your reason
e) What do you think the value of shear modulus of elasticity is for this steel

20 mark

Q2- A straight, aluminium alloy bar of solid cylindrical cross section is subjected to a cyclic axial load that ranges from 5,000 pounds tension to 10,000 pounds tension. The material has an ultimate tensile strength of S_u=100,000 psi, a yield strength of S_y=80,000 psi, and an elongation of 8 percent in 2 inches.

a) If the diameter of the bar is d=0.4 inch determine the fatigue strength for N=5×10^8 life (k_N=1).
b) Design the bar (calculate the diameter) for a fatigue strength of S_N=40,000 psi at N=10^5 cycles.
c) In a linear scale of alternating stress versus mean stress draw the Goodman line and yield line for N=10^5 for part (b).
d) Draw the Goodman lines for N=10^4 and N=10^6 in the same graph as part (c).

10 mark

Q3- The machine part shown in Figure P4.46 is subjected to a completely reserved (zero mean) cyclic bending moment of ±4000 in-lb, as shown. The material is annealed 1020 steel with S_u=57,000 psi, S_y=43,000 psi, and elongation in 2 inches of 25%. The S-N curve for this material is given in Figure 2.19.

a) The 0.18"-radius fillet has been determined as the governing critical point. Do you agree with this determination, and why?
b) How many cycles of loading would you estimate could be applied before failure occurs?

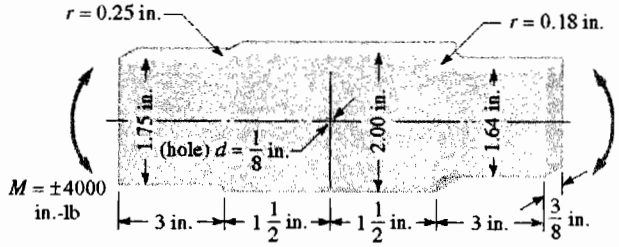

Figure P4.46
Machine part subjected to completely reversed cyclic bending moment.