# ENES 220 – Mechanics of Materials

# Spring 2001

# March 9, 2001

# EXAM #1

## Grading:

Problem 1: _____ / 30

Problem 2: _____ / 35

Problem 3: _____ / 35

Total: _____ / 100

## Policies:

1. Write your name and section number on all sheets.
2. Use only the paper provided. Ask for additional sheets, if required.
3. Place only one problem on each sheet (front and back).
4. Draw a box around answers for numerical problems.
5. Give all answers to 3 or 4 significant figures.
6. Include free body diagrams (FBD's) for all equilibrium problems.
7. Closed book / closed notes; formula sheet permitted.
8. **SHOW ALL WORK USED TO ARRIVE AT YOUR ANSWER.**

**Problem #1** (30 points):  Two steel members of uniform rectangular cross section (a = 1 in, b = 0.5 in) are welded together at an angle $\alpha = 60°$.  The maximum stresses for the weld metal are $\sigma_{YS} = 50$ ksi and $\tau_{YS} = 35$ ksi.  For an applied load P = 25 kip, determine the factor of safety with respect to yielding for the joint.
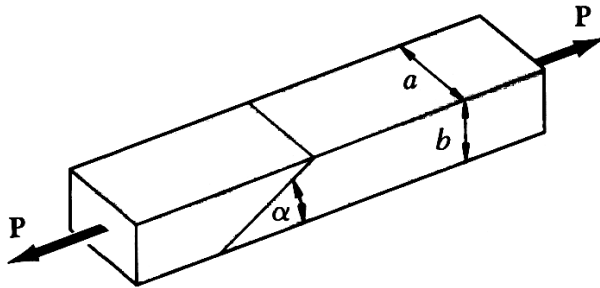
**Problem #2** (35 points): The rigid beam ABC is suspended from two rods AD and CE and is initially horizontal when the structure is unloaded at ambient temperature ($T_o = 25°C$). Rod AD is made of aluminum ($E = 70$ GPa, $\alpha = 23.6$ x $10^{-6}$ /°C, $\sigma_{YS} = 300$ MPa) and rod CE is made of steel ($E = 200$ GPa, $\alpha = 11.7$ x $10^{-6}$ /°C, $\sigma_{YS} = 250$ MPa). A load Q is then imposed at point B, and the temperature of all members is raised to $T_f = 50°C$. Calculate:
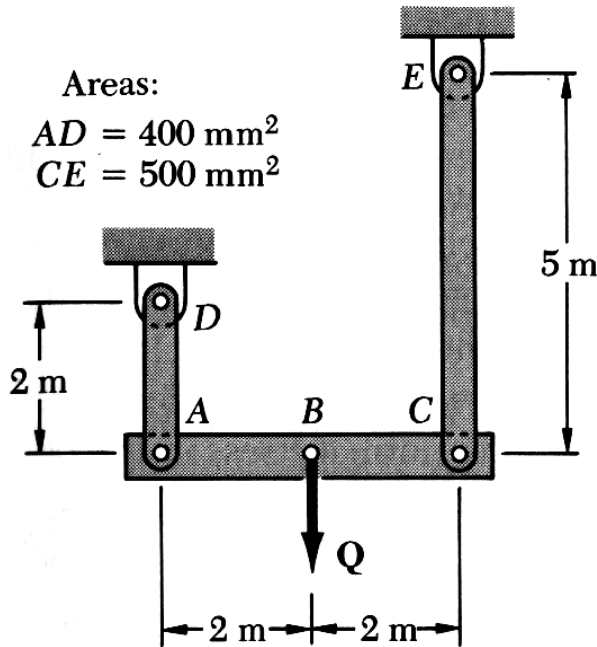
(a) The maximum load Q to avoid yielding.

(b) The total deflection of point B.

**Areas:**

$AD = 400$ mm$^2$
$CE = 500$ mm$^2$

5 m

2 m

A    B    C

Q

|← 2 m →|← 2 m →|

**Problem #3** (35 points):  The stepped shaft ABCD, composed of two solid, uniform cylinders joined at B, is fixed to the wall at points A and D.  Section AB is made of steel (G = 75 GPa) with a diameter of 30 mm.  Section BCD is made of brass (G = 39 GPa) with a diameter of 50 mm.  A torque of 500 N-m is imposed at point C.  Determine:
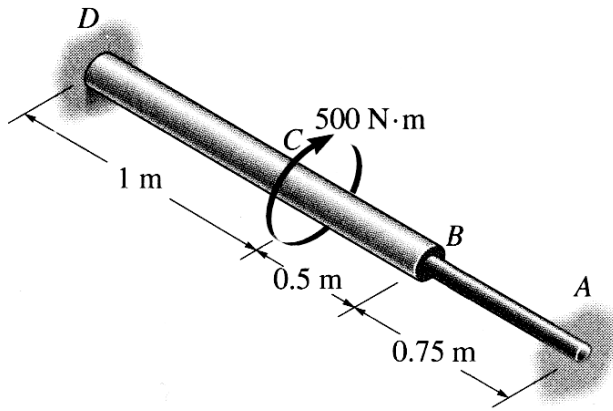
(a) The reactions at A and D.

(b) The maximum shear stress in the steel and in the brass.