Show all work for full credit! For problems involving the application of equilibrium this includes drawing a complete and correct free body diagram and showing a logical incorporation of the diagram in your analysis.

Helpful hint: Work in symbols for as long as you can, crunching numbers last!
(a) (10 Pts) A force $P$ is applied at the pins for the link with the dimensions shown below.

i. If the maximum allowable shear stress in the center of the link is $\tau_{\text{max}} = 15 \text{ MPa}$, what is the maximum value of $P$?

ii. If the maximum allowable shear stress in the pins is $\tau_{\text{max}} = 12 \text{ MPa}$, what is the maximum value of $P$? Assume the pins are in single shear.
Problem 1

(b) (12 Pts) The stress-strain curve shown was generated by testing a cylindrical aluminum specimen with a diameter of 0.50 in. and an initial length of 2.0 in.

i. How long was this specimen in the instant just prior to fracture?
   a. 0.25 in
   b. 0.50 in
   c. 2.25 in
   d. 2.50 in
   e. none of the above (give value)
   f. It is not possible to determine the answer from the information provided

ii. What is the maximum load that can be applied to this specimen?
   a. 10,800 lb
   b. 13,740 lb
   c. 54,980 lb
   d. 70,000 lb
   e. none of the above (give value)
   f. It is not possible to determine the answer from the information provided

iii. What feature(s) of this curve would change if the test were performed using a specimen with a diameter of 0.25 in. (initial length still 2.0 in.)? Circle all that apply.
   a. the peak stress would be higher
   b. the peak stress would be lower
   c. the slope in the elastic region would be higher
   d. the slope in the elastic region would be lower
   e. the strain at fracture would be higher
   f. the strain at fracture would be lower
   g. nothing about the curve would be different
Problem 2 (19 points)

The illustrated triangular frame of rigid links supports a heavy block of mass $m$ suspended by a light string. The weights of the links are negligible. The links carry axial loads only. Set up the equations needed to solve for the forces in the rigid links $AB$ and $BC$. Do not solve the equations. **Number your equations and list the unknowns.**

**Known:** $m, g, L, h$
Problem 3 (15 points)

A wall-mounted rod of length $L = 1$ m and diameter $d = 30$ cm is acted on by a compressive load $P = 27\pi \times 10^5$ N. At the same time, the rod is heated up by 100°C. The material of the rod is such that the modulus of elasticity and the coefficient of thermal expansion are 120 GPa and $10 \times 10^{-6}$ /°C, respectively. Calculate the total change in length of the rod.
Problem 4 (14 points)

Force $\vec{F}$ is applied along the line segment $BA$ and has a magnitude of 200 lb.

a) Express $\vec{F}$ as a Cartesian vector

b) Determine the angle between $\vec{F}$ and $\vec{G}$
Problem 5 (30 points)

Consider the stack of round bars shown below. Forces are applied to the rigid plates between the stacked bars as indicated in the diagram.

(a) Calculate the y-direction internal force in bar A, in bar B, and in bar C. Show all work.
(b) Find the minimum allowable diameter for bar A so that it does not yield. The yield stress of the material is $\sigma_y = 200 \text{ N/mm}^2$ and the height of the bar is 100 mm.