Rate each subproblem from 1-5 based on how comfortable you felt solving the problem, where 1 is not at all comfortable, and 5 is very comfortable.

1.) Figure 1 is an engineering stress-strain curve from a real tensile test of 6061-T6 aluminum.

![Engineering Stress-Strain Curve](image)

**Figure 1: Engineering stress-strain curve from uniaxial tensile test of 6061-T6 aluminum**

a. Clearly identify the elastic and plastic ranges, and briefly explain what they are and how they differ.

b. Estimate the elastic modulus and the 0.2% offset yield point of this specimen. Show your work.

c. In your own words, explain what ultimate tensile strength is, and how it is calculated. Indicate it on the graph.
2.) A sketch of the specimen (prior to testing) from Problem 1 is shown in Figure 2. Dimensions are in inches.

![Figure 2: 6061-T6 aluminum tensile test specimen](image)

a. Calculate maximum load $P$ that was exerted on the part during the test.

b. Calculate the maximum load $P$ on the part before yielding occurred.

c. Neatly draw the stress distribution across cross section A due to this loading.
3.) Do this problem neatly on a separate page and staple it to this packet. Figure 3 shows a constrained beam under a load $P$. The beam is made of A36 steel, $S_y = 36$ ksi.

![Figure 3: Loaded I-beam](image)

Figure 3: Loaded I-beam

a. Indicate the points on the cross-section where the maximum shear and bending stresses occur, respectively, and what equations are used to calculate them. Draw shear and bending moment diagrams to scale, in terms of $P$.

b. Use the parallel axis theorem to calculate the second moment of area of the beam.

c. Calculate the maximum load $P$ before yielding occurs. Indicate on the sketch where the maximum stress occurs in the beam. Also, locate and calculate the maximum displacement due to this load.

d. Calculate the reactions and maximum shear and bending stresses at C-C.

4.) Draw the shear and bending moment diagrams for the loaded beam depicted in Figure 4. Compare the results to those found in Problem 3.

![Figure 4: Loaded I-beam](image)
5.) For the situation depicted in Figure 5 below:

a. Calculate the forces in each member. The joint at A is allowed to slide vertically, and all three joints are pinned.

b. Calculate the stress induced in each of the 3 members due to the load at B. Assume the cross-sectional area of each member is 1.5 in$^2$.

c. Assuming the members are made of A36 steel ($S_y = 36$ ksi), determine whether they constitute a safe design if the required safety factor $N_f = 3$.

P = 500 lbs

![Figure 5: Cantilevered truss](image-url)
A motor is coupled to a steel shaft mounted in ball bearings at B₁ and B₂ as shown in Figure 6. The maximum torque from the motor, $T_{in}$, is 100 ft-lbs, and loads are transmitted out of the shaft by a 5" diameter gear ($T_{out}$). Loads are not well-known, and assume you cannot get good test information on materials. Determine an appropriate material and diameter for the shaft. The shaft should be a consistent diameter over its length. Assume you can get bearings in any integer millimeter size (e.g.: 9mm, 11mm, 55mm, etc.)

Figure 6: Motor with output shaft mounted in bearings