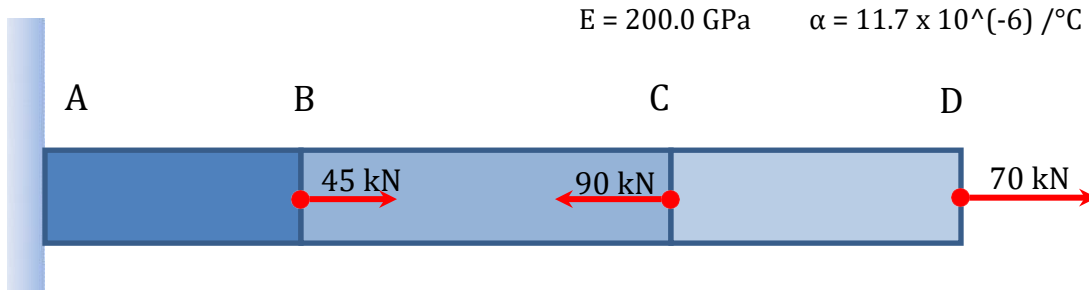Please sign and copy this Honor Statement on your Midterm pdf that you upload.  Your work will not be graded without this signed Honor Statement.

"I have neither given nor received unauthorized assistance on this Midterm."
Signature: _____

Please upload your work to Midterm #1 in the **Assignments** section of D2L.

1. (24 points) A 30mm x 30mm square steel bar is axially loaded as shown with a fixed support at A. Sections AB and CD are each 800 mm long and section BC is 1200 mm long at 28°C.
   a. Determine the magnitude of the stress in each section and state whether the section is in tension or compression.
   b. What is the net deflection of the bar at point D?
   c. If the temperature of the bar is increased to 140°C while under load, what will the net deflection of the bar be at point D?

E = 200.0 GPa        α = 11.7 x 10^(-6) /°C

A            B                        C                    D

45 kN              90 kN                    70 kN

2. (20 points)  the steel (G = 77 GPa) shaft shown below, determine the angle of twist (in degrees) of both pulleys B and C relative to A.  The shaft has a diameter of 30 mm throughout its length.

1600 N·m

900 N·m

A

B

700 N·m

C

500 mm

900 mm
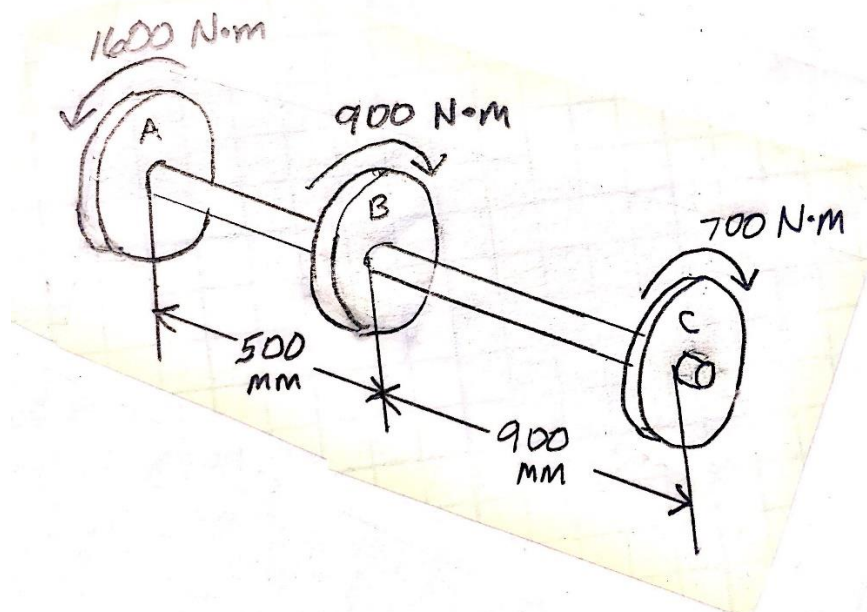
3. (15 points) Design a solid steel shaft to transmit 120 hp at a speed of 1200 rpm, if the maximum shearing stress is not to exceed 7000 ksi.

4. (24 points) A trailer hitch assembly is shown below along with a schematic of the receiver – hitch- pin assembly (bottom drawing shows connection side-view). The receiver is made of 2-1/2" SQ {A} x 2.000" ID {B} x .250" Wall {C} Square Steel Tubing (shown in cross-section). The tube material is ductile with a tensile yield strength of 40 ksi and a yield shear strength of 21 ksi. The pin has a diameter of 5/8" and is made of a material with a shear yield strength of 30 ksi. Determine the following:
   a. Assuming a factor of safety of 5 what is the maximum allowable load for the pin?
   b. If an axial load of 7.5 kips is applied to the assembly, what is the average axial stress in the tube away from any stress concentrations?
   c. If an axial load of 7.5 kips is applied to the assembly, what is the factor of safety with regard to bearing stress of the pin acting on the receiver?
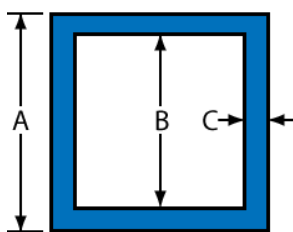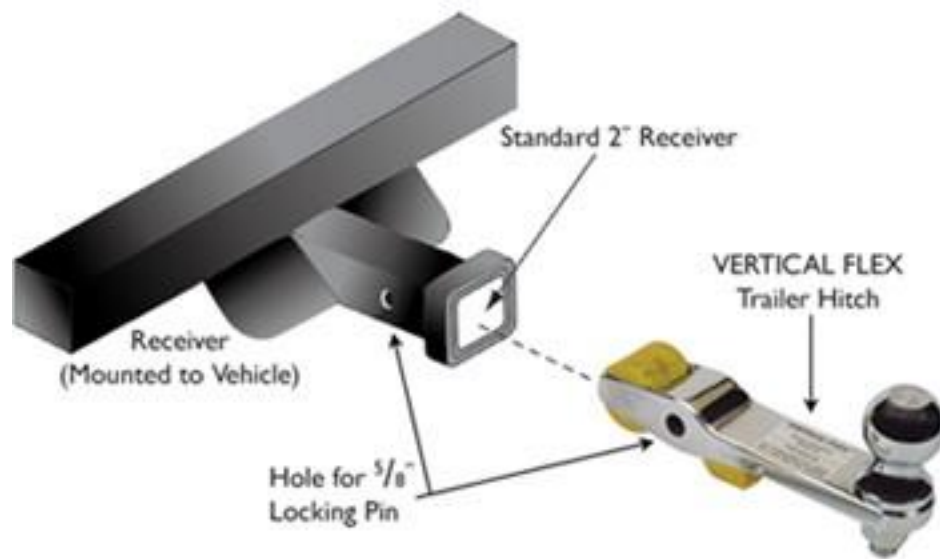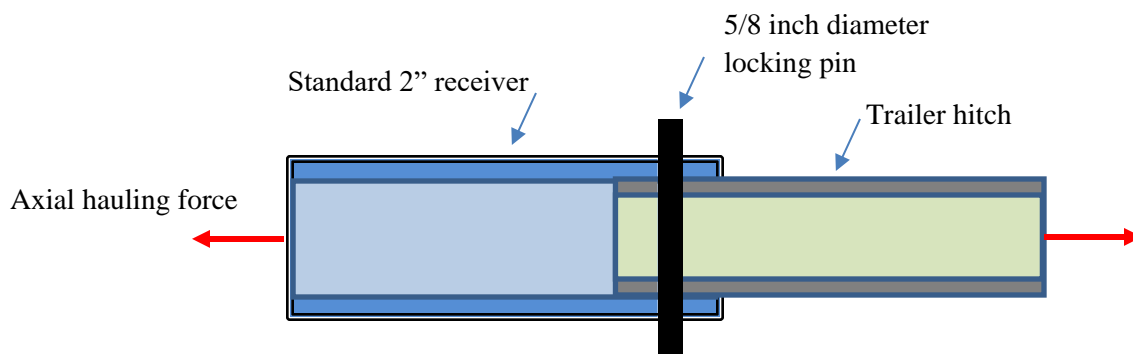


Standard 2" Receiver section dimensions
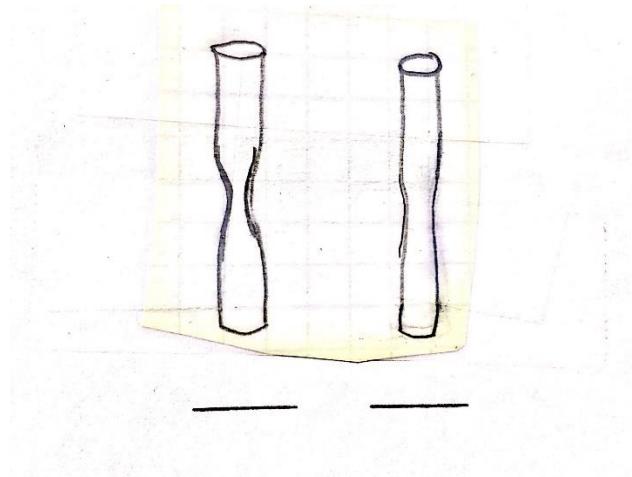
A = 2.500 inches

B = 2.000 inches

C = 0.250 inches

CONCEPTUAL RANKING QUESTIONS

**5.** (5 points) If material A has a Poisson′s ratio of 0.21 and material B has a Poisson′s ratio of 0.33, label the tensile test specimen (A or B), if both materials have a similar E and both specimens are experiencing the same stress in tension.



_____        _____

**6.** (12 points) The cross-section of 3 shafts are shown below.  Rank, from greatest to least, the amount of shear stress on the outside edge of the shaft.



GREATEST  ____    ____    ____  LEAST