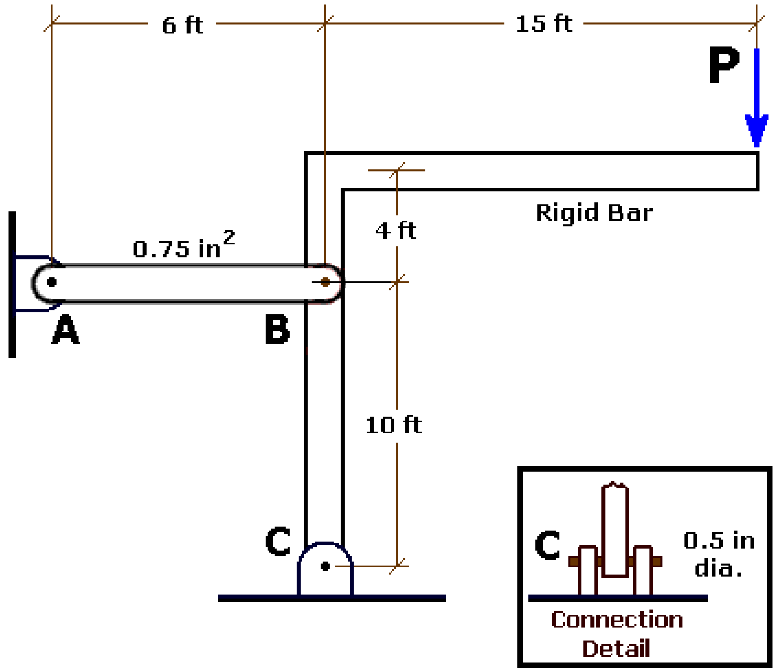
1. The simple pin-connected structure carries a concentrated load **P** as shown. The rigid bar is supported by strut AB and by a pin support at C. The strut has a cross-sectional area of 0.75 in$^2$ and an allowable normal stress of $\sigma_{allow}$ = 20 ksi. The pin diameter is 0.5 inches, and the allowable shear stress in the pin is $\tau_{allow}$ = 14 ksi.
   - Determine the maximum load **P** that can be supported without exceeding either $\sigma_{allow}$ or $\tau_{allow}$. (Note: do not consider shear stress in the pins at A and B).

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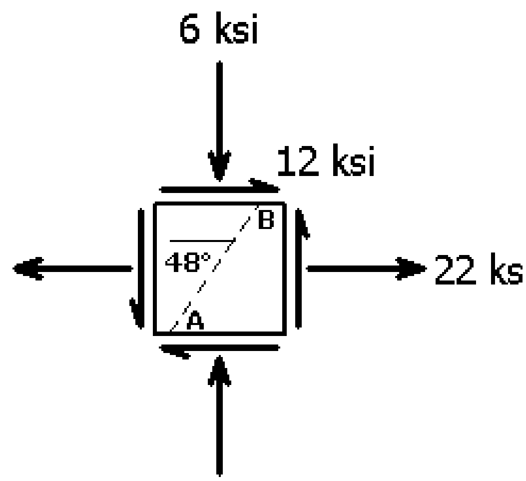
**Include proper units**
**Box-in your answers**

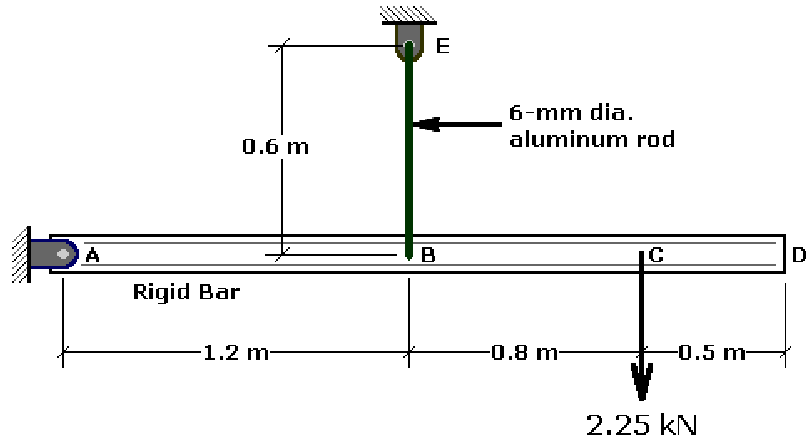
2. At a point in a structural member subjected to plane stress, there are normal and shear stresses on horizontal and vertical planes through the point, as shown on the stress element.
   - **Construct Mohr's circle** for the specified plane stress condition. (10 points)
   - Determine the principal normal stresses and **show these stresses on a properly oriented stress element.** (5 points)
   - Determine the maximum in-plane shear stress and average normal stress. **Show these stresses on a properly oriented stress element.** (5 points)
   - Compute the normal stress and shear stress on the surface AB that is inclined at 48° to the horizontal as shown. (5 points)



**Student** ______________________________

3. The rigid bar ABCD is pinned at A and supported at B by a 6-mm diameter aluminum rod as shown. When the 2.25 kN load is applied *and* the system is cooled 50°C, determine:
   - the stress in the 6-mm diameter aluminum rod, and
   - the displacement of the end of the rigid bar at D.

   Assume $E_{aluminum}$ = 70 GPa and $\alpha_{aluminum} = 22.5 \times 10^{-6}$ / °C.

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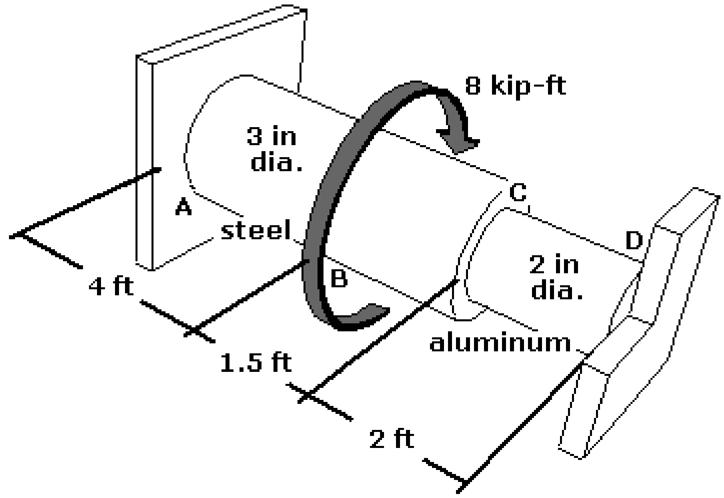
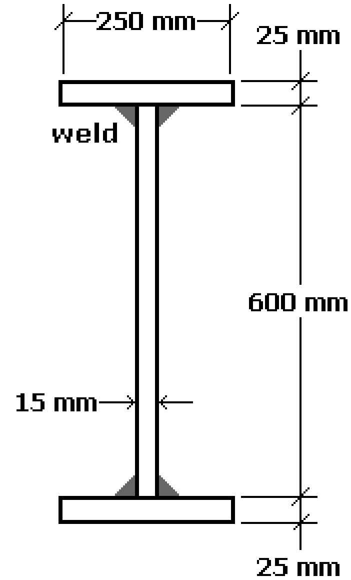



4. The composite shaft ABCD is firmly attached to rigid wall supports at ends A and D. Portion ABC is a solid 3-inch diameter steel shaft, and portion CD is a solid 2-inch diameter aluminum shaft. A concentrated torque of 8 kip-ft is applied to the shaft at B. Determine:
   - the maximum shear stress in the steel portion of the shaft,
   - the magnitude of the angle of twist at B. (report the angle in **radians** with three significant digits)

   Assume $G_{steel} = 11 \times 10^6$ psi
   and $G_{aluminum} = 4.0 \times 10^6$ psi

5. A welded steel girder is fabricated from two 250 mm × 25 mm plates welded to a 600 mm x 15 mm web plate as shown. The plates are joined by four fillet welds that run continuously for the length of the girder. Each fillet weld has an allowable shear load of 500 kN/m. Assume the girder is simply supported on a span length of L.
   - Determine the maximum shear force that the welded plate girder can support.
   - Determine the maximum load **P** that may be placed at the midspan of this girder based on the strength of the welded connection. (Hint: Draw a shear force diagram for the beam.)

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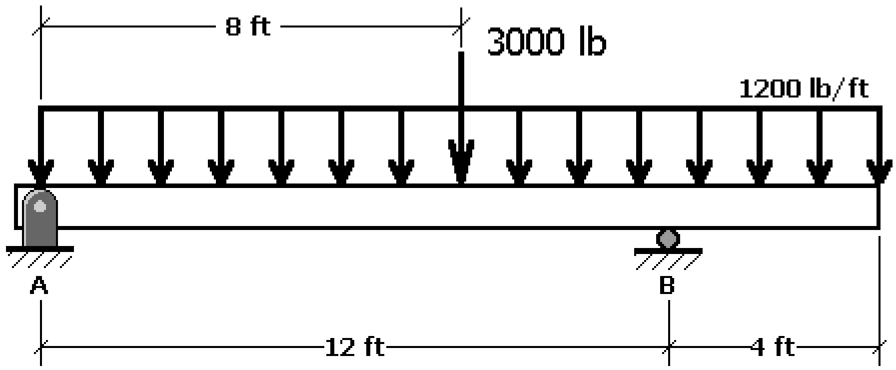
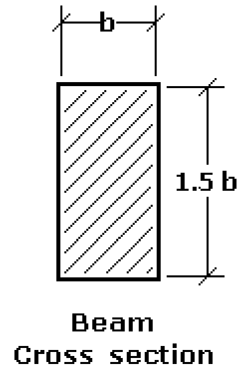
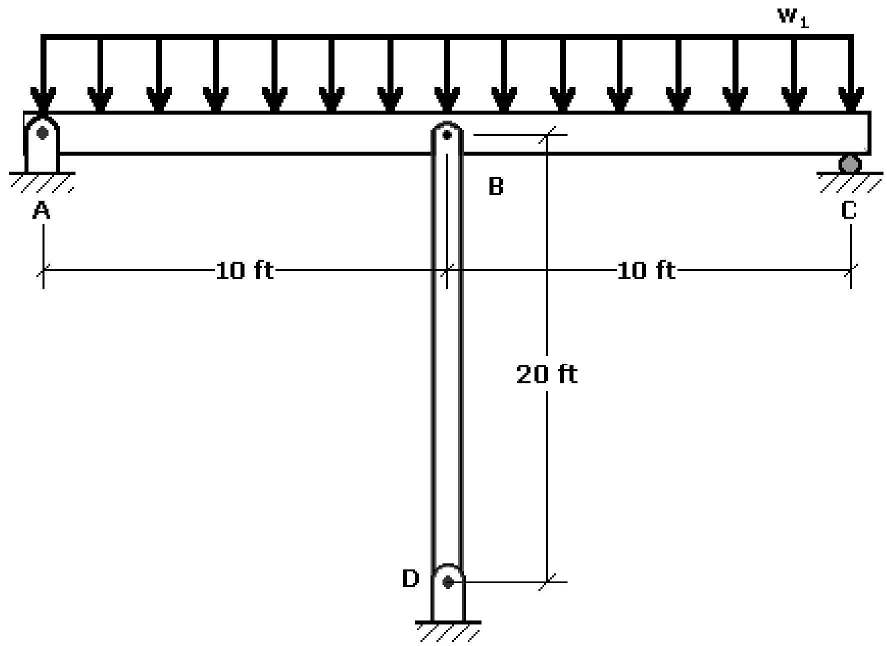
**Include proper units**
**Box-in your answers**

6. A simply-supported beam carries a uniformly distributed load of 1200 lbs/ft and a concentrated load of 3000 lbs as shown. If the allowable normal stress is $\sigma_{allowable}$ = 18 ksi and the allowable shear stress is $\tau_{allowable}$ = 11 ksi,
   - ■ Determine the minimum dimension **b** that may be used.



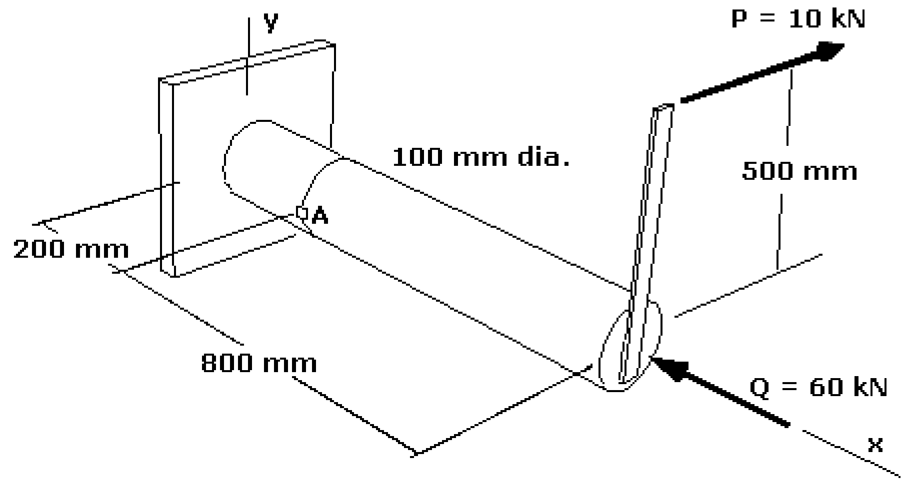
7. A steel beam ($E = 29 \times 10^6$ psi, $I = 120$ in$^4$) is loaded and supported as shown. Post BD is a 6 × 6 in. timber ($E = 1.5 \times 10^6$ psi) that is braced to prevent buckling. Assume that the post is initially unstressed. After a uniform load of $w_1 = 530$ lb/ft is applied to the beam,
   - Determine the axial load carried by post BD.

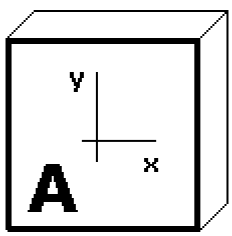


**Student** ______________________________

8. A 100-mm diameter solid steel shaft is loaded and supported as shown. At point A on the surface of the shaft, determine
   - normal stresses $\sigma_x$ and $\sigma_y$ ,
   - shear stress $\tau_{xy}$, and
   - show these stresses properly oriented on the stress element below.

(Note: do not compute principal stresses, etc.)




Stress
Element
at A

**PRINT LEGIBLY**
**Include proper units**
**Box-in your answers**