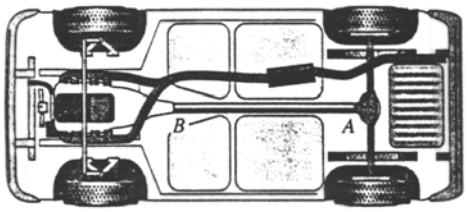
ME 313/513 STRENGTH OF MATERIALS Fall 2000
FINAL EXAMINATION November 29, 2000

STUDENT NAME _____

PROBLEM	MAX. POINTS	POINTS OBTAINED
1	50	
2	50	
3	50	
4	50	
5	50	
TOTAL	250	

1. The steel drive shaft AB of an automobile is shown. The engine delivers 150 hp when the shaft is turning at 1500 rev/min. Space limitations require that the shaft outer diameter not exceed 2.5 inches. If the allowable shear stress on the shaft is 7 ksi, determine the smallest wall thickness of a tubular shaft. How does this design compare with a solid shaft of the same material on the basis of size (i.e. outer diameter) and weight?

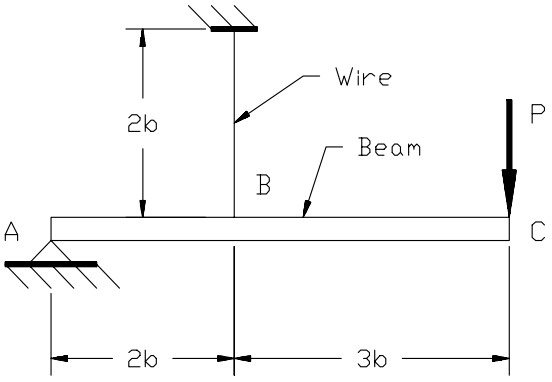


Ans
Hollow shaft d_{outer}=2.5 inch, t=0.104 inch
Solid shaft d = 1.661 inch)

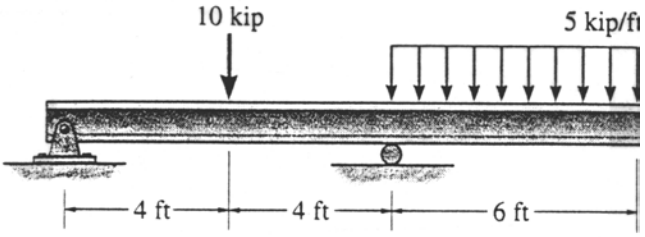
2. A steel beam ABC (moment of inertia I = 1 in^4) is simply supported at A and held by a high strength steel wire (area A = 0.01 in^2) at B. A load of P = 220 lb acts at the free end C.
   a) Draw the free-body diagram, shear-force diagram, and bending-moment diagram for the beam.
   b) Using the point A as the origin for x, write equations to describe the variation of bending moment for $0 \le x \le 2b$ and for $2b \le x \le 5b$.
   c) If b = 12 in., what is the deflection of point B.
   d) Derive equations for the elastic curve for the beam, and determine the displacement of point C.

Assume E = $30x10^6$ psi for both the wire and the beam.

Ans
$\delta_b = 4.4x10^{-2}$ *inch* ↓
$\delta_c = 0.3058$ *inch* ↓

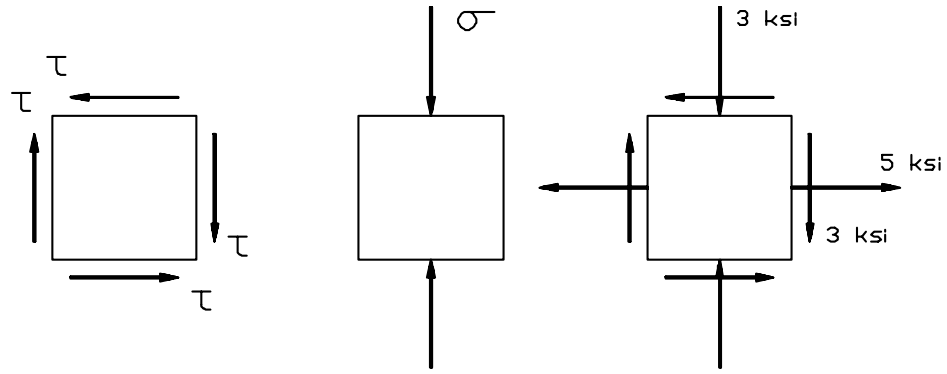


3. For the beam shown below:
   a) Draw the Free body diagram.
   b) Draw the Shear force diagram.
   c) Draw the Bending moment diagram.
   d) Select the lightest weight steel wide-flange (W) beam given the allowable bending (axial) stress $\sigma_{allow} = 24$ ksi and allowable shear stress $\tau_{allow} = 14$ ksi.

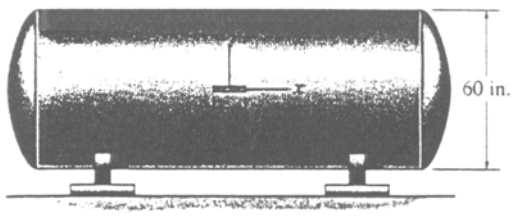


Ans:
$S_{min} = 45\ in^3$
$A_{min} = 2.14\ in^2$
W16x31

4. What are the principal stresses, the orientations of the principal planes, and the maximum in-plane shear stress for the states of stress shown. Draw the Mohr's circle for part (c) and determine the stresses on a plane inclined at an angle of 35° clock-wise from the vertical plane.



5. The strain gauge placed on the surface of a thin-walled boiler is 0.5 inch long. When the boiler is under pressure, the gauge elongates 0.2×10^{-3} inch. The wall thickness of the boiler is 0.5 inch. Determine the pressure in the boiler and the maximum in-plane shear stress. Assume the boiler is made of a material with $E = 29 \times 10^6$ psi and $\nu = 0.3$



Ans:
$p = 966.7$ psi
$\tau_{max\text{-}in\text{-}plane} = 14{,}500$ psi