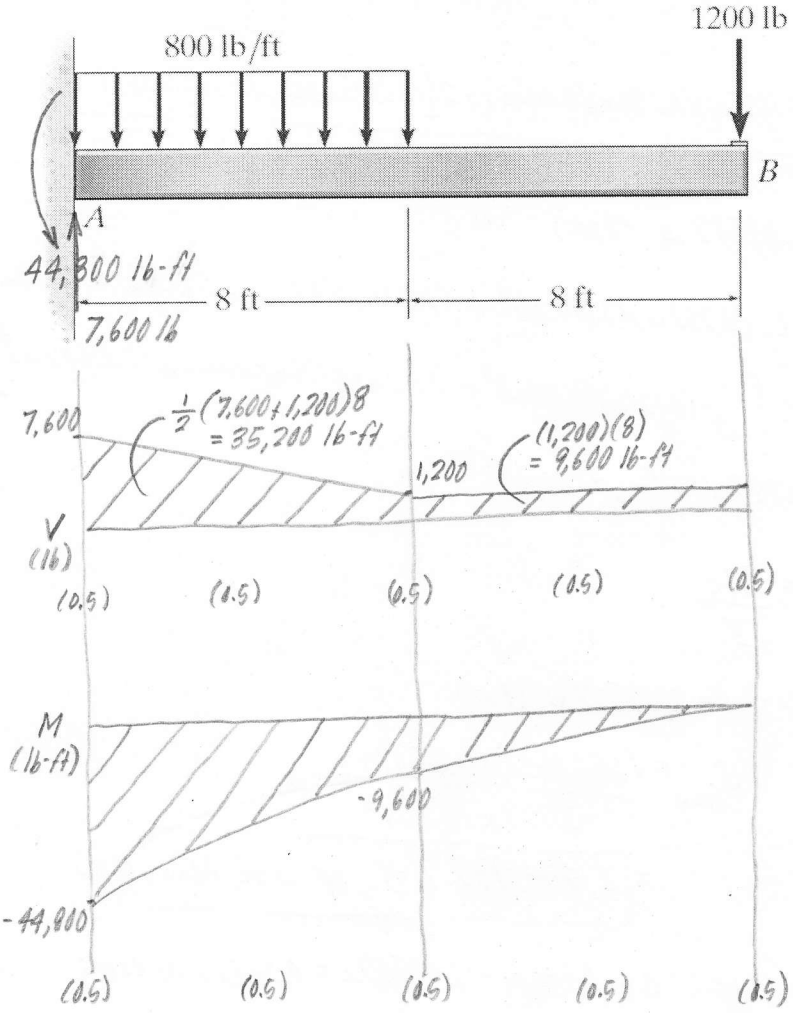
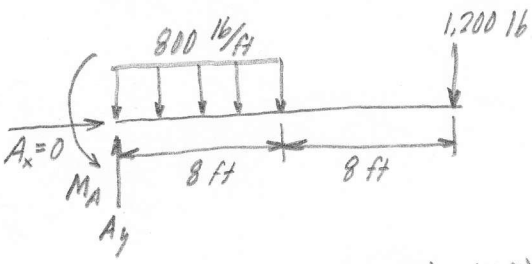
CME 260 – Mechanics of Materials
Exam #6 (03/30/2022)

Tech ID or Star ID: Grading

Do one of the two problems shown below (the second problem is on the back).
Show your work (you will not receive any credit if all you have is a final answer, right or wrong).

(1) The beam has a square cross section measuring 9 inches on a side. Determine the absolute maximum bending stress in the beam.





$\Sigma M_A = 0, \quad -(4\,ft)(6{,}400\,lb) - (16\,ft)(1{,}200\,lb) + M_A = 0$

$M_A = 44{,}800\ lb\text{-}ft$ (1 pt)

$\Sigma F_y = 0, \quad A_y - 6{,}400\,lb - 1{,}200\,lb = 0$

$A_y = 7{,}600\ lb$ (1 pt)

$$\sigma_{max} = \frac{Mc}{I}$$

$M_{max} = -44{,}800\ lb\text{-}ft$

$c = 4.5\ in$ (1 pt)

$$I = \frac{1}{12}bh^3 = \frac{1}{12}(9\,in)(9\,in)^3$$

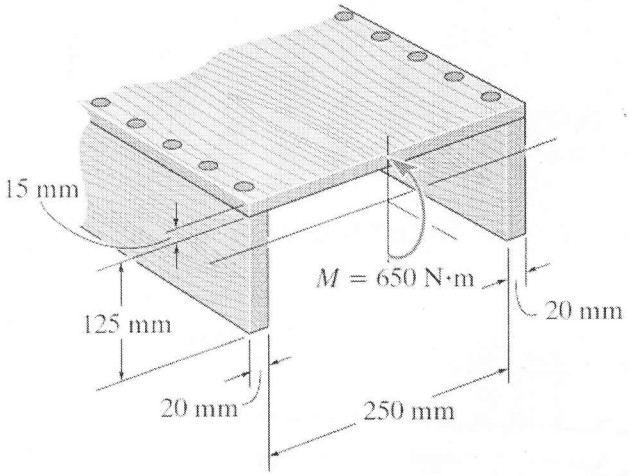
$= 546.75\ in^4$ (1 pt)

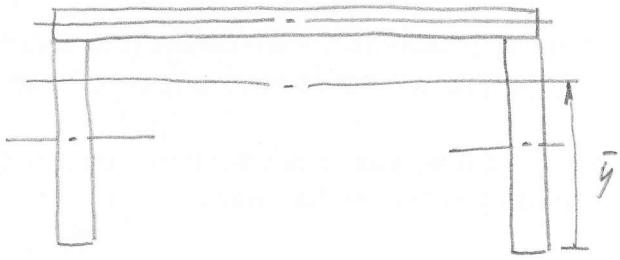
$$\sigma_{max} = \frac{(44{,}800\ lb\text{-}ft)\left(\frac{12\,in}{1\,ft}\right)(4.5\,in)}{546.75\ in^4}$$

$$= \boxed{4{,}424.7\ \frac{lb}{in^2} \text{ or } 4.42\ ksi}$$

(1 pt)

(2) The beam is made of three boards assembled as shown and is subjected to a moment of 650 N-m. Determine the maximum tensile and compressive stresses in the beam.





$$\bar{y} = \frac{(0.1325\,m)(0.290\,m)(0.015\,m) + 2[(0.0625\,m)(0.020\,m)(0.125\,m)]}{(0.290\,m)(0.015\,m) + 2(0.020\,m)(0.125\,m)}$$

$\bar{y} = 0.09507\,m$ (3 pts)

$$I = \frac{1}{12}(0.290\,m)(0.015\,m)^3 + (0.290\,m)(0.015\,m)(0.1325\,m - 0.09507\,m)^2 + 2\left[\frac{1}{12}(0.020\,m)(0.125\,m)^3 + (0.020\,m)(0.125\,m)(0.0625\,m - 0.09507\,m)^2\right]$$

$= 1.799 \times 10^{-5}\,m^4$ (3 pts)

$$\sigma_{max} = \frac{Mc}{I}$$

tensile: $c = 0.09507\,m$ (1 pt)

$$\sigma_{max} = \frac{(650\,N\text{-}m)(0.09507\,m)}{1.799 \times 10^{-5}\,m^4}$$

$= \boxed{3,434,999.7\ \frac{N}{m^2} \text{ or } 3.43\ MPa}$ (1 pt)

compressive: $c = 0.140\,m - 0.09507\,m = 0.04493\,m$ (1 pt)

$$\sigma_{max} = \frac{(650\,N\text{-}m)(0.04493\,m)}{1.799 \times 10^{-5}\,m^4}$$

$= \boxed{1,623,374.1\ \frac{N}{m^2} \text{ or } 1.62\ MPa}$ (1 pt)