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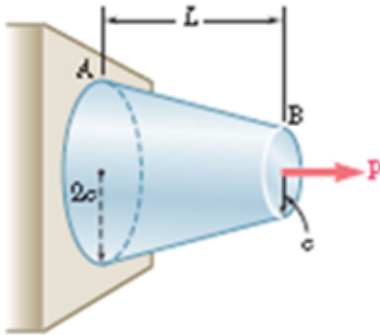
Exam 1

MEE 320 (Spring 2018)

Strength of Materials

February 26<sup>th</sup>, 2018

**Problem 1 (5% Bonus):** Find the total elongation of the truncated cone (of length  $L$ , modulus of elasticity  $E$ , big base radius  $2c$ , small base radius  $c$ ) under the effect of load  $P$  (**Fig. 1**).



**Fig. 1**

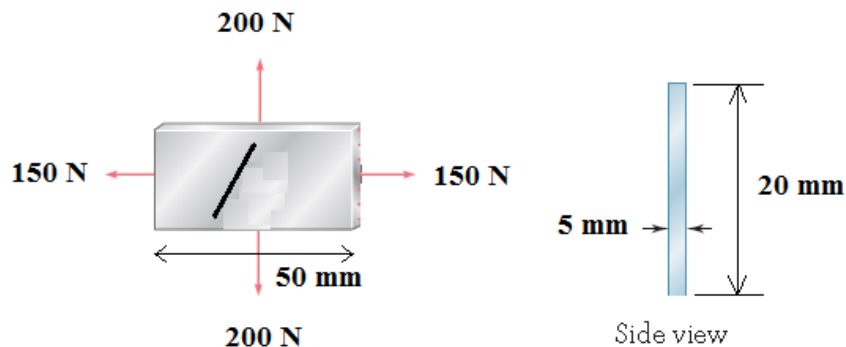


**Fig. 2**

**Problem 2 (20%):** The unstressed assembly shown (**Fig. 2**) consists of an aluminum shell ( $E_a = 70$  GPa,  $\alpha_a = 23.6 \times 10^{-6}/^\circ\text{C}$ ) of 60 mm outer diameter fully bonded to a brass core ( $E_b = 105$  GPa,  $\alpha_b = 20.9 \times 10^{-6}/^\circ\text{C}$ ) of 25 mm. Determine (a) the largest allowable change in temperature if the ultimate stress in the aluminum shell is 280 MPa and a safety factor of 2 is desired, (b) the corresponding change in length of the brass core.

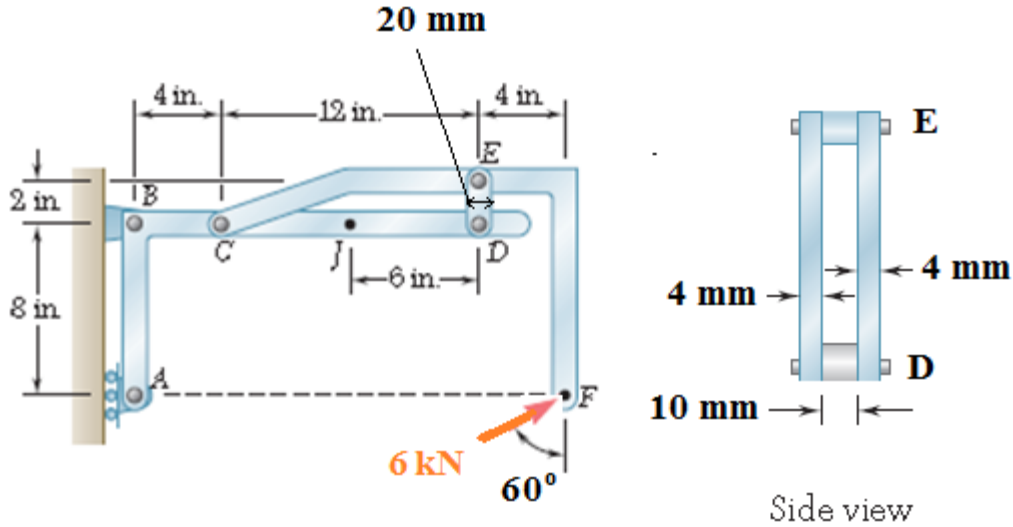
**Problem 3 (20%):** An aluminum plate ( $E = 74$  GPa,  $\nu = 0.33$ ) is subjected to a centric axial load as shown in the figure below.

- Knowing that, before loading, the drawn line on the plate was doing an angle of  $45^\circ$  with the horizontal direction, determine the value of this angle when the plate is loaded.
- Find the thickness of the plate under load



**Problem 4 (30%):**

- Determine the safety factor if the ultimate normal stress is 100 MPa and the ultimate shear stress is 70 MPa.
- Determine the minimum diameter of bolt D if the allowable bearing stress is 200 MPa, and the allowable shearing stress is 150 MPa.



**Problem 5 (30%):** The torques shown are exerted on pulleys B, C, and D. Knowing that part AC is made of aluminum ( $G = 27$  GPa), and part CE is made of brass ( $G = 39$  GPa) with a hollow of inner diameter equal to 20 mm between F and G (midpoints of CD and DE respectively), determine (a) The reaction torques at A and E; (b) the relative angle of twist of D with respect to B; (c) The maximum shear stress in the shaft

