Exam 1

September 26, 2014

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Show all work for full credit! For problems involving the application of equilibrium this includes drawing a complete and correct free body diagram and showing a logical incorporation of the diagram in your analysis.

Helpful hint: Work in symbols for as long as you can, crunching numbers last!
Problem 1—three unrelated parts (24 points total)

(a) (8 pts) For the loading shown find the shear stress in the bolt that connects these two pieces. The bolt has a circular cross section with a diameter \( d = 3.0 \) cm and passes through the pieces shown.

(b) (8 pts) A tensile test specimen, originally \( L = 3.0 \) inches long, stretches by 0.1 inches under a stress of \( \sigma = 1000 \) psi. What is Young’s Modulus (the elastic modulus) for this material?

(c) (8 pts) A piece of steel (\( E = 200 \) GPa, \( \alpha = 6 \times 10^{-6} \) 1/°F) is left outside during the winter at a temperature of \( T_{\text{out}} = -5^\circ\text{F} \). While at this temperature, the measured length is \( L = 15 \) cm. After it is brought inside where the temperature is \( T_{\text{in}} = 72^\circ\text{F} \), how long will it be?
Problem 2 (16 points)

A 30 lb force acts in the direction going from point $A$ to point $B$ in the figure below. Express the force in Cartesian vector form.
Problem 3 (40 points)

The two weights shown below are suspended by massless, inextensible ropes $AB$, $BC$, and $CD$. The tension in rope $BC$ is 200 lb. Angles $\theta$ and $\beta$ are unknown.

(a) Find the tension in rope $CD$ and the angle $\theta$.
(b) Find the tension in rope $AB$ and the angle $\beta$. 

(a) Find the tension in rope $CD$ and the angle $\theta$.
(b) Find the tension in rope $AB$ and the angle $\beta$. 

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Diagram:

- Two weights: 100 lb and 120 lb
- Ropes $AB$, $BC$, and $CD$
- Tension in $BC$ is 200 lb
- Angles $\theta$ and $\beta$ are unknown
Problem 4 (20 points)

Known loads are applied to the massless rods 1 and 2 as shown in the figure. The left end of rod 1 is fixed to the wall and both rods are connected to the rigid loading plate at B. The lengths of the rods, their cross sectional areas, and their respective moduli of elasticity (Young’s Moduli) are all known.

Set up the required equations to find the deflection of point B. You do not need to solve the equations, but you do need to number your equations and clearly label the unknowns.

Known: \(L_1, L_2, A_1, A_2, E_1, E_2\)