

Solid Mechanics

August 2006

Exam Number: -----

Department of Mechanical Engineering

Michigan State University

Solid Mechanics  
Ph.D. Qualifying Examination

August 2006

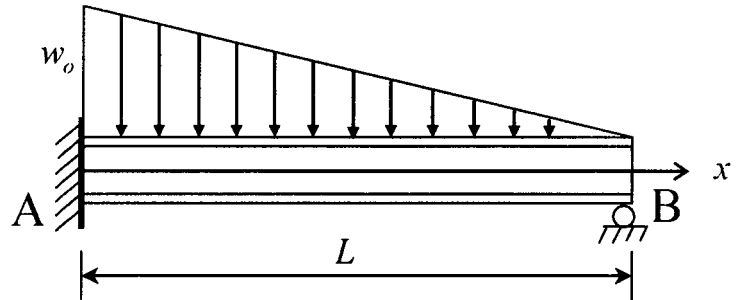
Open Book Open Notes  
All Questions are weighted equally.

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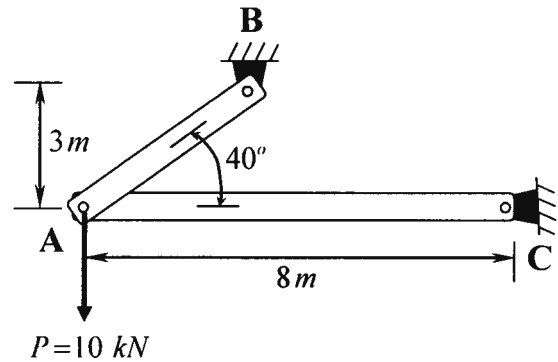
1. The I-beam is loaded as shown:

- Calculate the reaction forces,  $R_A$ ,  $R_B$ , and bending moment,  $M_A$ , as a function of  $L$  and  $w_o$ .
- Calculate  $M_A$ , assuming  $L = 1.8 \text{ m}$  and  $w_o = 10 \text{ kN/m}$ .

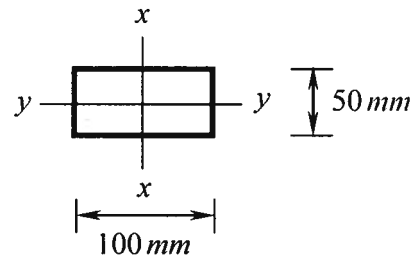


2. The pin-jointed steel frame with the following properties  
 (  $E = 200 \text{ GPa}$ ,  $\sigma_{all} = 3.6 \text{ MPa}$  ) is loaded as shown:

- Calculate the safety factor  $m = \frac{P_{cr}}{F}$  for the member buckling about the y-y axis.
- Calculate the safety factor  $n = \frac{\sigma_{all}}{\sigma}$  for the member failing in tension.



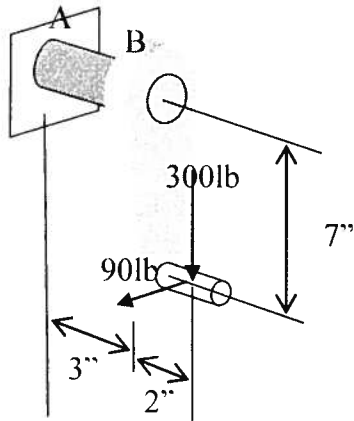
Cross Section for AB and AC:



3. You are assigned to determine if the diameter of the shaft AB designed at 0.6" is safe based on the maximum stress at the cross-section A. The material is a ferrous alloy whose yield strength is 120ksi. Assume the load on the pedal is 300lb with the frictional load of 90lb.

(a) Determine the reaction loads and moments at the cross-section A

(b) Determine the location and magnitude of the maximum stress



4. (a) Determine the 3-D Mohr circle for stress for the body which is loaded with 10MPa on a frictionless surface. (b) If the yield strength is 12MPa, will this body yield? You have to show your work to get any credit. (c) Determine the 3-D Mohr circle for strain given that  $E=20\text{GPa}$  and  $\nu=0.2$ . (d) If you have the strain rosette ( $0^\circ/45^\circ/90^\circ$ ) on the front face of the body, what are the readings on each of the strain gauges?

