Exam Number: ----------

Department of Mechanical Engineering

Michigan State University

Solid and Structural Mechanics
Ph.D. Qualifying Examination

January 2009

Closed Book and Notes
You may use a one page formula sheet
All Questions are weighted equally.

Prepared by

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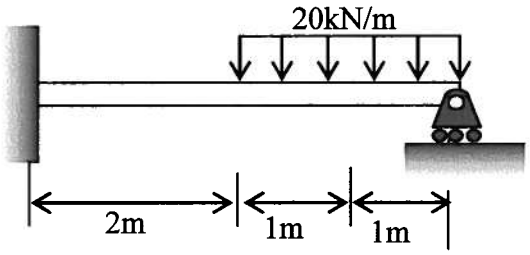
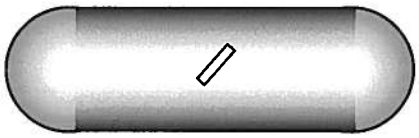
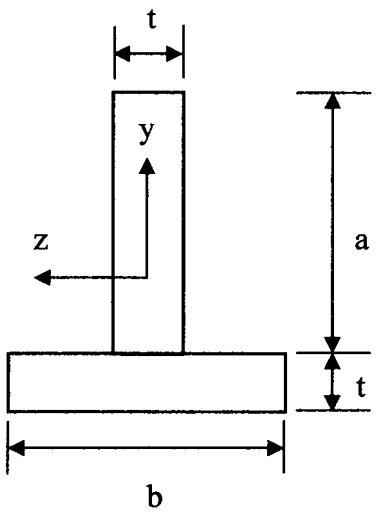
1. Determine the reaction forces and moment at the wall and the support for the beam below.



2. The radius of the pressure vessel is 20cm and the thickness of the vessel is 2cm. (a) Determine the stresses on cylindrical thin-walled pressure vessel when the pressure inside is equal to 20MPa. (b) Determine the reading on the strain gage placed at 45° as shown below when E=30GPa and v=0.3. (c) Determine the factor of safety when the yield strength of the material is 300MPa.



3. The beam below has T-shaped cross-section with the following dimensions: b = 6", a = 8" and t = 1.5". The material is assumed to be elastic perfectly plastic. A moment about the z-axis is applied, which causes the material yield stress to be reached on the entire cross-section of the beam. If the yield stress of the material is 10,000 psi in both tension and compression, what is the value of the moment?



4. Consider a thin plate of dimensions *2a* x *2b*, as shown below. The plate is subjected to the loading conditions:

at x = +b: $\sigma_x = k_1(40a^2y - 2y^3/3)$

$\tau_{xy} = k_1 b(a^2 - y^2)$

at x = -b: $\sigma_x = k_1(40a^2y - 2y^3/3)$

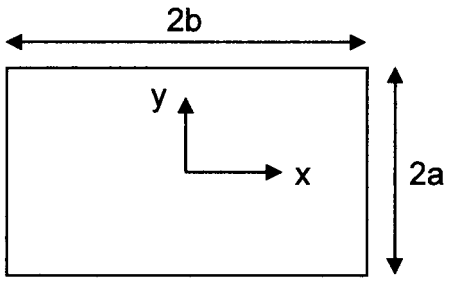
$\tau_{xy} = -k_1 b(a^2 - y^2)$

at y = +a: $\sigma_y = -Q$

$\tau_{xy} = 0$

at y = -a: $\sigma_y = 0$

$\tau_{xy} = 0$



The interior state of stress is given by:

$$[\sigma] = \begin{bmatrix} f_1(x,y) & k_1 x(a^2 - y^2) \\ k_2 f_3(x) f_4(y) & f_2(x,y) \end{bmatrix}$$

Determine the constants k_1 and k_2, and the functions f_1, f_2, f_3, and f_4.

3. The beam below has T-shaped cross-section with the following dimensions: b = 6", a = 8" and t = 1.5". The material is assumed to be elastic perfectly plastic. A moment about the z-axis is applied, which causes the material yield stress to be reached on the entire cross-section of the beam. If the yield stress of the material is 10,000 psi in both tension and compression, what is the value of the moment?