Ph.D. Qualifying Exam – Mechanics of Materials (Fall 2009)

Name:_____

ID #:_____

1. The state of stress of an element at *O* is represented in Fig. 1, where $\sigma_z = 0$. (*a*) Draw the *three* Mohr's circles for stresses in the *xy*, *yz*, and *zx* planes. (*b*) Determine the range of values of θ for which the normal stress $\sigma_{x'}$ in the $x'y'$ plane is equal to or less than 130 MPa. (*c*) What is the *maximum* shear stress developed in this element?

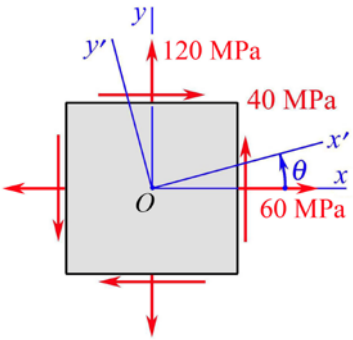

Fig. 1

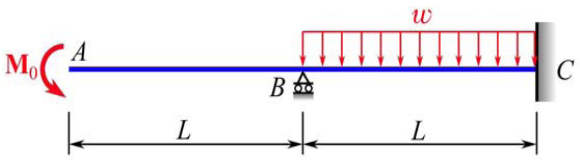

Fig. 2

2. The beam *ABC* of length 2*L* has a constant flexural rigidity *EI* and carries a moment $\mathbf{M}_0$ at *A* and a distributed load with intensity w in the segment *BC* as shown in Fig. 2, where $\mathbf{M}_0 = 1.5wL^2$ ↺. Determine (*a*) the reaction at *B*, (*b*) the deflection at *A*, (*c*) the slope at *A*.

3. A sign is supported by a pipe having outside diameter of 100 mm and inside diameter of 80 mm as shown in Fig. 3. The dimensions of the sign are 2 m × 0.75 m and its lower edge is 3 m above the support. The wind pressure against the sign is 1.5 kPa. Determine the following:

a) The internal forces and moments at the base of the pipe at section *a-a*. Draw the appropriate free-body diagram.
b) Determine the normal stress and shear stress at point *A* on the cross section at section *a-a*.
c) Determine the normal stress and shear stress at point *C* on the cross section at section *a-a*.
d) Draw the stress state at point *A* on a differential volume element located at this point.
e) Is this a statically determinate or statically indeterminate problem? Explain.

Note: Be sure to clearly show all work and state units.

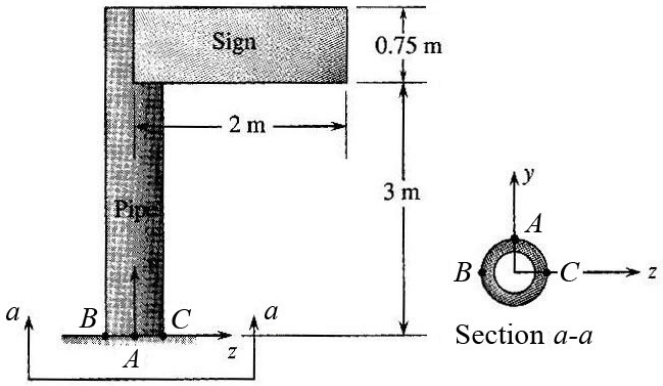

Fig. 3