

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Department of Mechanical Engineering  
2.001 Mechanics and Materials I  
Fall 2006

Problem Set 8

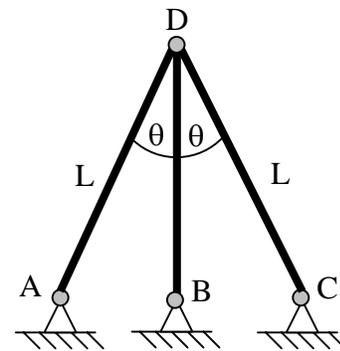
**Distributed:** Wednesday, November 8, 2006

**Due:** Monday, November 13, 2006

**Problem 1:** Hibbeler 9-70

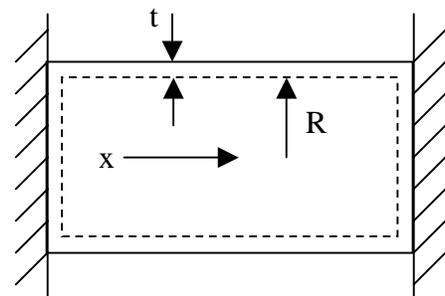
**Problem 2:** Hibbeler 9-78

**Problem 3:** A structure is composed of three bars pinned together as shown in the adjoining diagram. Each bar has a cross-sectional area of  $A$ , a Young's modulus of  $E$ , and a coefficient of thermal expansion of  $\alpha$ . The bars fit together perfectly when they are first assembled (that is, there are no stresses in the bars when the structure is first assembled). What are the forces in the bars and what is the displacement of point  $D$  when the temperature of bar  $DC$  is increased by  $\Delta T$ ?



**Problem 4:** An empty cylindrical pressure vessel is placed between two fixed walls so that it just fits. It is free to expand radially. It has a radius  $R$  and wall thickness  $t \ll R$ , and its Young's modulus, Poisson ratio, and coefficient of thermal expansion are  $E$ ,  $\nu$ , and  $\alpha$  respectively. It is then filled with an internal pressure of  $p$ .

- Find the stress in the wall of the pressure vessel, and draw Mohr's circle for the stress in this case. What is the maximum shear stress, and at what angle from the  $x$  axis does it occur?
- Find the strain in the wall of the pressure vessel, and draw Mohr's circle for the strain in this case. What is the change in radius of the pressure vessel when it is filled?



**Problem 5:** A cylindrical tank of radius  $R$ , length  $L$ , and wall thickness  $t$  is made of an isotropic linear elastic material with modulus  $E$ , Poisson's ratio  $\nu$ , and coefficient of thermal expansion  $\alpha$ . At temperature  $T_0$ , with no pressure in the tank, the tank fits without stress between a rigid wall  $W_B$  and a rigid plate  $C$ . A spring of stiffness  $K$  fits exactly between the rigid plate  $C$  and a second rigid wall  $W_A$ . The plate can only move in the horizontal direction, as indicated in the figure. The tank is free to expand radially.

- 1) The internal pressure in the tank is brought to a value  $p$ . Obtain expressions for the resulting displacement of the plate  $u_C$ , and for the change in tank wall thickness  $\delta_t$ . What is the radial strain in the tank wall? What is the circumferential strain in the tank wall?
- 2) The temperature of the wall of the pressurized tank is now increased by  $\Delta T$ . What are the new values for  $u_C$  and  $\delta_t$ ?

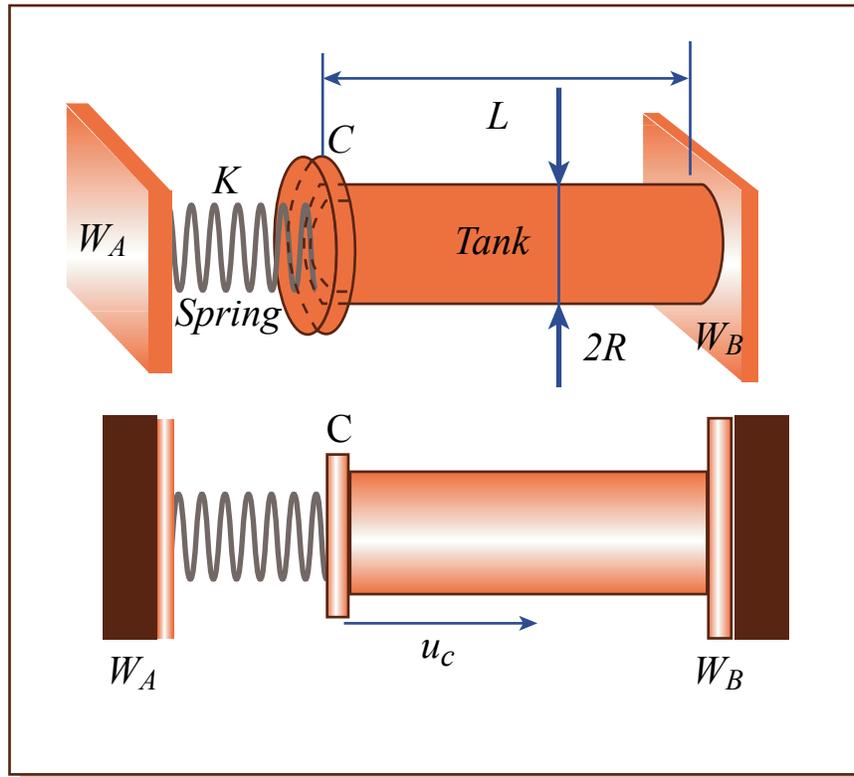


Figure by MIT OCW.