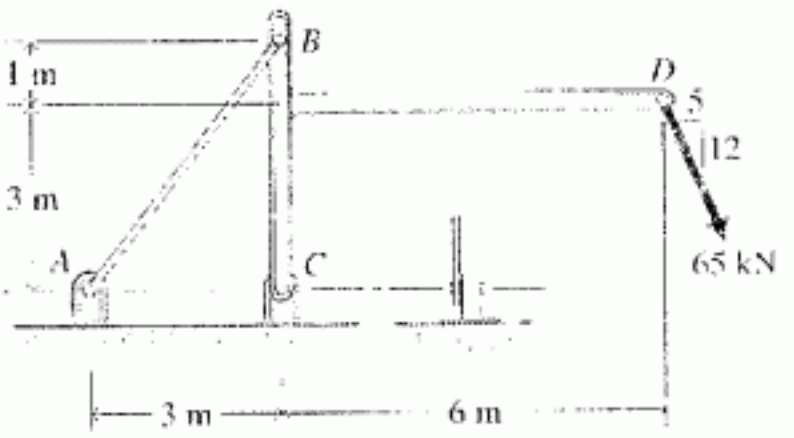
Total 100 pts

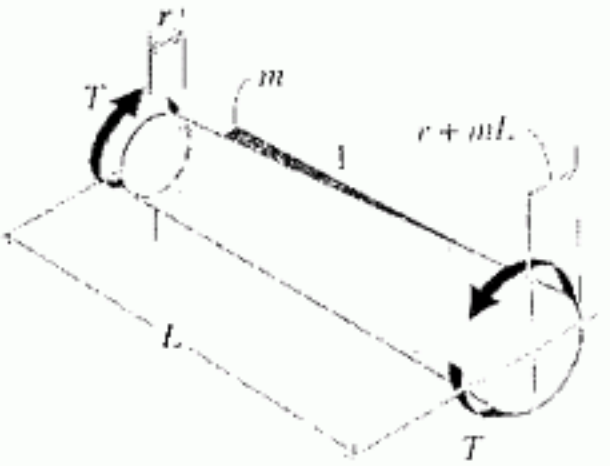
1. Please use brief statements to explain the following terms in engineering mechanics/mechanics of materials: (1) impending motion (2) Moments of inertia (3) Virtual work (4) Shear force (5) bending moment (6) Cantilever beam (7) principle stress (8) Deflection (9) coefficient of thermal expansion (10) Stress concentration (20%)

2. The tie rod *AB* has a cross-section area of 1000 mm^2. The cross-section area of pin C is 2000 mm^2. Both the tie rod and the pin are made of steel, for which the elastic strengths are 250 MPa in tension and 150 MPa in shear. The ultimate strengths are 450 MPa in tension and 270 MPa in shear. Determine:
   a. The normal stress in rod *AB*.
   b. The shearing stress in the pin at *C*.
   c. The factor of safety with respect to failure by yielding for rod *AB*.
   d. The factor of safety with respect to failure by fracture for pin *C*.

   (20%)



3. The solid circular tapered shaft is subjected to a constant torque T. Determine the angle of twist in terms of *T, L, G (shear modulus), r,* and *m*. (20%)

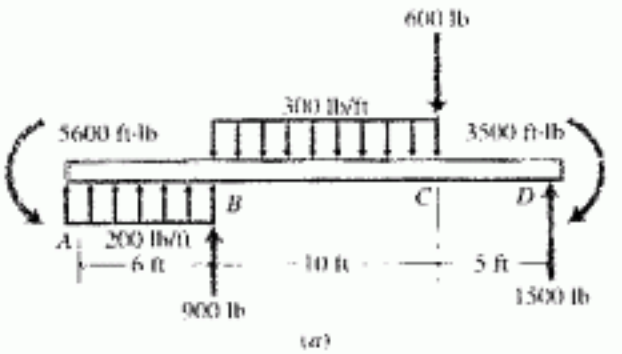


4. A timber beam is loaded and supported as shown in (a), and the cross section of the beam is shown in (b). Determine

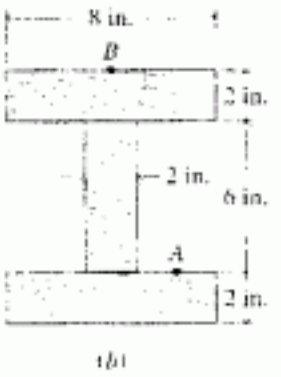
a. The flexural stresses at points A and B on a transverse cross section 1 ft from the left end of the beam.

b. The maximum tensile and compressive flexural stresses in the beam.

(20 %)



(a)



(b)

5. The uniform bar AB has a length of l ft and weighs W lb. If the attached spring is unstretched when θ=90° with a spring constant of k lb/ft. Please **use only the principle of virtual work** (other methods will not get points) to determine the angle θ for equilibrium. Note the spring always remains in the vertical position since the top end is attached to a roller which moves freely along the horizontal guide. (20 %)