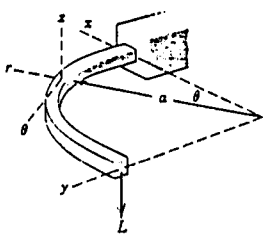
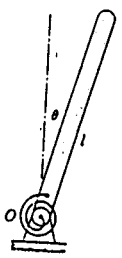
(1) Write expressions for the torsional moment T and bending moment M in the curved quarter-circular beam under the end load L. Use a notation consistent with the right-handed r-θ-z coordinate system where positive moment vectors are taken in the direction of the positive coordinates. (15%)

(2) The uniform bar of mass m is hinged about a horizontal axis through its end O and is attached ~~and is attached~~ to a torsional spring which exerts a torque $M = K\theta$ on the rod where K is the torsional stiffness of the spring in units of torque per radian and θ is the angular deflection from the vertical in radians. Determine the minimum value of K which will ensure stable equilibrium at $\theta = 0$. (15%)

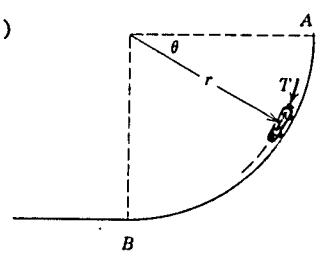


(1)

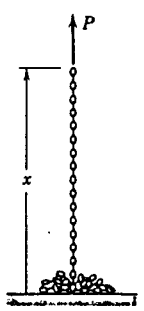


(2)

(3) A small rocket-propelled vehicle of mass m travels down the circular path of effective radius r under the action of its weight and a constant thrust T from its rocket motor. If the vehicle starts from rest at A, determine its speed v when it reaches B and the magnitude N of the force exerted by the guide on the wheels just prior to reaching B. Neglect any friction and any loss of mass of the rocket. (10%)

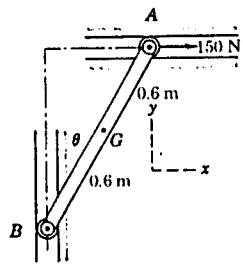


(4) The end of a chain of length L and mass ρ per unit length which is piled on a platform is lifted vertically with a constant velocity v by a variable force P. Find P as a function of the height x of the end above the platform. Also find the energy lost during the lifting of the chain. (20%)



(5) The slender 30-kg bar AB moves in the vertical plane with its ends constrained to follow the smooth horizontal and vertical guides. If the 150-N force is applied at A with the bar initially at rest in the position for which $\theta = 30°$, calculate the resulting angular acceleration of the bar and the forces on the small end rollers at A and B.

(20%)



(6) A uniform rod of length l and mass m is secured to a circular hoop of radius l as shown. The mass of the hoop is negligible. If the rod and hoop are released from rest on a horizontal surface in the position illustrated, determine the initial values of the friction force F and normal force N under the hoop if friction is sufficient to prevent slipping.

(20%)