1. A wheel weighs 200N with a diameter of 0.5m as shown in Figure 1.

(a) Determine the minimum moment required for the wheel to roll over a height of 5cm obstacle. (10%)

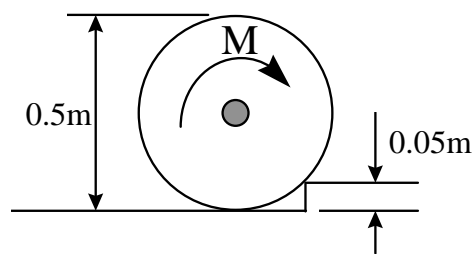(b) What is the minimum coefficient of friction between the wheel and the obstacle to avoid slippage? (10%)

Figure 1.

2. Rod AB can slide freely along the floor and the inclined plane (Figure 2). Denoting by v_A the velocity of point A, derive expressions for

(a) the angular velocity of the rod. (10%)

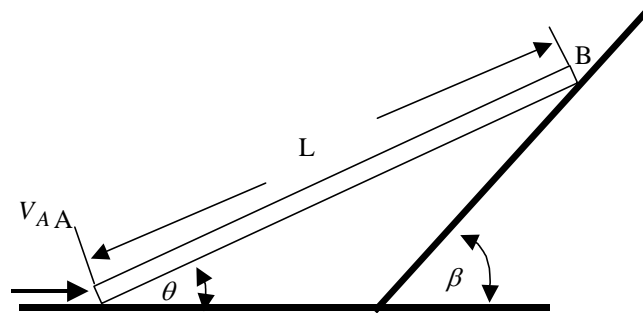(b) the velocity of end B. (10%)

Figure 2.

3. A 240-mm-radius cylinder of mass 8 kg rests on a 3 kg carriage (Figure 3). When the system is at rest, a force P of magnitude 10N is applied as shown for 1.2 seconds. Assume the gravity of acceleration is $g = 10 \, m/s^2$. Knowing that the cylinder rolls without sliding on the carriage and neglecting the mass of the wheels of the carriage,

(a) determine the resulting velocity of the carriage. (10%)

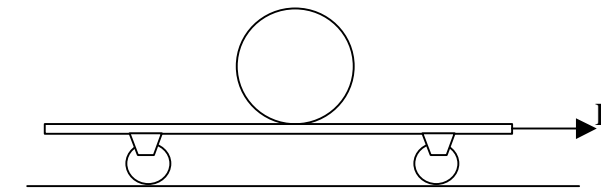(b) determine the resulting velocity of the center of the cylinder. (10%)

Figure 3.

4. A prismatic bar with cross-sectional area A is subject to a tension P and A solid circular bar with a diameter d is subject to a torque T (see Figure 4a and Figure 4b respectively). Determine and show the normal and shear stress at $=45°$ on sketches of the stress element for Figure 4a and Figure 4b, respectively. (20%)
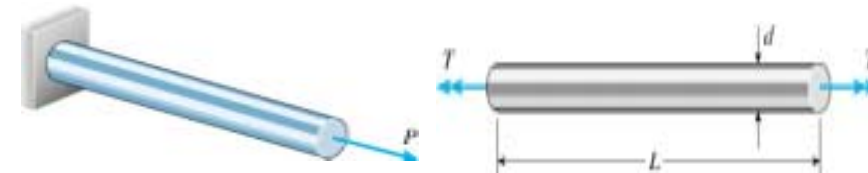
Figure 4a   Figure 4b

5. Find the angle of rotation $_c$ and deflection δ_c at the free end C for a cantilever beam ABC that supporting a uniform load of intensity q acting over the right-hand half of the beam (Figure 5). The length of the beam is 2L and with two different flexural rigidity 3EI and EI in the left and right part of the beam. (20%)
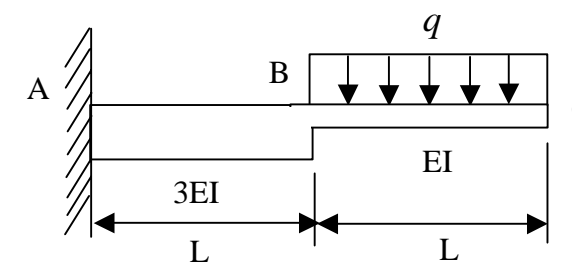
Figure 5