1. The collar $B$ of mass $m_B = 5 \text{ kg}$ is at rest, and when it is in the position shown the spring is unstretched as $y = 1.2 \text{ m}$. If another collar $A$ of mass $m_A = 1 \text{ kg}$ strikes it so that $B$ slides a distance $x = 0.5 \text{ m}$ on the smooth rod before momentarily stopping, determine the velocity of $A$ just after impact, and the average force exerted between $A$ and $B$ during the impact if the impact occurs in time $\Delta t = 0.05 \text{ sec}$. The coefficient of restitution between $A$ and $B$ is $e = 0.8$, the spring has the stiffness $k = 0.5 \text{ kN/m}$, and the acceleration of gravity is $g = 9.81 \text{ m/s}^2$. (25%)

![Diagram of collars and spring](image)

2. The 0.5 kg disk has a radius of gyration of $k_G = 0.212 \text{ m}$ about an axis passing through its mass center $G$. Assuming that the wheel does not slip or rebound, determine the minimum velocity $V_G$ it must have to just roll over the obstruction at $A$. (25%)

![Diagram of disk and obstruction](image)
3. A hollow circular tube A (outer diameter $d_A$) fits over the end of a circular tube B (outer diameter $d_B$), as shown in the figure. The far ends of both tubes are fixed. Initially, a hole through tube B makes an angle $\beta$ with a line through two holes in tube A. Then tube B is twisted until the holes are aligned, and a pin (diameter $d_p$) is placed through the holes. When tube B is released, the system returns to equilibrium. Assume that the shear moduli of both tubes G are the same; the polar moment of inertia $I_{PA} = 2I_{PB} = I$, and $d_A = \frac{10}{\sqrt{A_B}} = d$. Find the maximum value of $\beta$ if the shear stress in the pin $\tau_p$ cannot exceed $\tau_{cr}$, and find the maximum value of $\beta$ if the magnitude of the shear stress in the tubes $\tau_z$ cannot exceed $\frac{3\sigma_{cr}}{2}$, and the magnitude of the normal stress in the tubes $\sigma_z$ cannot exceed $\sigma_{cr}$. (25%)

4. A beam of T-section is supported and loaded as shown in the figure. Determine the principal stresses and the maximum shear stress at point C which is 2.4m away from the left end of the beam. (25%)