1. Two rods are connected by a frictionless collar $B$. Knowing that the magnitude of the couple $M_d$ is 500 N $\cdot$ cm., determine $(a)$ the couple $M_C$ required for equilibrium, $(b)$ the corresponding components of the reaction at $C$. (25%) 

![Fig. 1](image1)

2. A slender rod $AB$, of weight $W$, is attached to blocks $A$ and $B$ which may move freely in the smooth guides shown. The constant of the spring is $k$ and the spring is unstretched when $AB$ is horizontal. $(a)$ Draw the free body diagrams of bar $AB$, blocks $A$ and $B$. $(b)$ Neglecting the weight of the blocks, derive an equation in $\theta$, $W$, $l$, and $k$ which must be satisfied when the rod is in equilibrium. (25%) 

![Fig. 2](image2)
3. A cylindrical shell $A$ of mass $m$ and radius $r$ rolls without slipping with a velocity $v_0$ on a horizontal surface just before it strikes an identical cylindrical shell $B$ that is at rest. Assume that the impact is perfectly elastic, the coefficient of kinetic friction between each cylindrical shell and the surface is $\mu_k = 0.1$, and the friction between both cylindrical shells is ignored. Determine the velocities of two cylindrical shells after the impact and they have started rolling uniformly. (25%)

![Diagram of two cylindrical shells](image)

4. The slender rod $AB$ of length 2 meter and mass 10 kg is pinned at $A$ to a vertical axle $DE$ which rotates with a constant angular velocity $\omega$. Let a 1 meter long horizontal cable $BC$ be attached to the axle and to the end $B$ of the rod. Determine the maximum angular velocity such that the tension in the cable $BC$ vanishes. (25%)