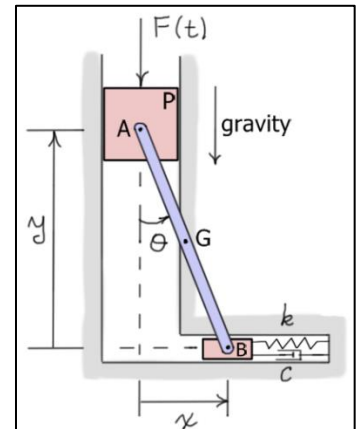


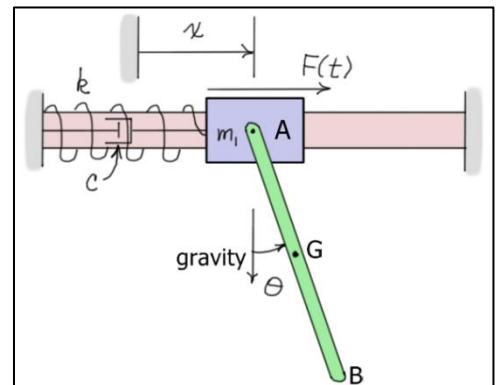
ME 6590 Multibody Dynamics

Exercises #7 – Use d'Alembert's Principle

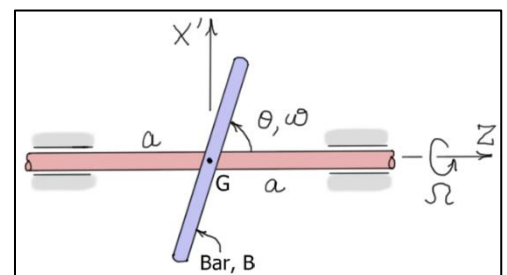
1) Find the differential equation of motion of the single degree-of-freedom system shown. The system consists of slender bar AB of mass m and length ℓ and a piston P of mass m_p . The system is driven by the force $F(t) = F_0 + F_1 \sin(\omega t)$ and gravity. A spring and damper are attached to the light slider at B . The spring is unstretched when $x = 0$. Use θ as the generalized coordinate. Neglect friction.



2) Find the differential equations of motion of the two degree-of-freedom system shown. The system consists of a mass m_1 that moves along a fixed horizontal bar and a slender bar AB that is pinned to m_1 at A . Bar AB has mass m_2 and length ℓ . Mass m_1 is attached to the fixed support by a spring of stiffness k and a viscous damper with damping coefficient c . The spring is unstretched when $x = 0$. The system is driven by gravity and the force $F(t) = F_0 \sin(\omega t)$ applied to m_1 . Use x and θ as the generalized coordinates. Neglect friction.



3) Find the differential equations of motion of the two degree-of-freedom system shown. The system consists of a slender bar B of length ℓ and mass m that is pinned through the center of a shaft of mass m_s and radius r . The rotation of the shaft about the Z -axis is described by the angle ϕ ($\dot{\phi} = \Omega$), and the rotation of the bar B about the Y' -axis axis is described by the angle θ ($\dot{\theta} = \omega$). A motor torque M_ϕ is applied to the shaft about the Z -axis, and a motor torque M_θ is applied to B about the Y' -axis. Use θ and ϕ as the generalized coordinates.



- 4) Find the differential equations of motion of the two degree-of-freedom system shown. The system consists of a disk D of mass m_d and radius R , and a slender bar B of mass m and length ℓ . The rotation of the disk about the Z -axis is described by the angle ϕ ($\dot{\phi} = \Omega$), and the rotation of the bar B about the X' -axis is described by the angle θ ($\dot{\theta} = \omega$). A rotational spring-damper is located between B and D at the pin P . The spring has stiffness k and is unstretched when $\theta = 0$. The damper has coefficient c . A motor torque M_ϕ is applied to the disk about the Z -axis, and a motor torque M_θ is applied to B about the X' -axis. Use θ and ϕ as the generalized coordinates.

