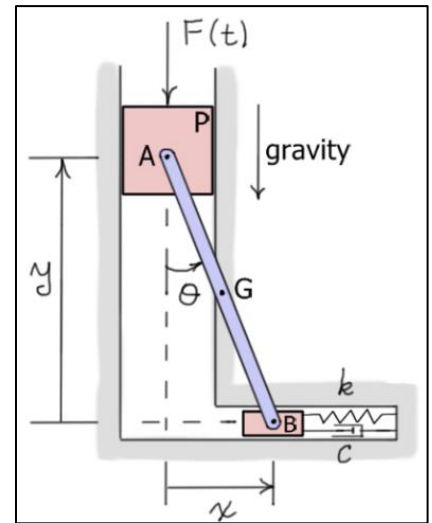


## ME 5550 Intermediate Dynamics

### Exercises #11: Lagrange's Equations with Configuration Constraints

1. In Exercises #8, the equation of motion of the system shown was found using a single generalized coordinate  $\theta$ . Using Lagrange's equations, formulate the equations of motion of the system using the set of *constrained generalized coordinates*  $(x, y, \theta)$ . Then differentiate the constraint equations to put them into the form of second-order, ordinary differential equations. There will be *five* differential equations in all. The equations will contain *five variables*: three generalized coordinates  $(x, y, \theta)$  and two Lagrange multipliers  $(\lambda_1, \lambda_2)$ .



2. In Exercises #8, the equations of motion of the system shown were found using the generalized coordinates  $\theta$  and  $x$ . Using Lagrange's equations, formulate the equations of motion of the system using the set of *constrained generalized coordinates*  $(x, x_G, y_G, \theta)$ . Here, the coordinates  $(x_G, y_G)$  represent the  $X$  and  $Y$  coordinates of  $G$  relative to point  $A$ . Then differentiate the constraint equations to put them into the form of second-order, ordinary differential equations. There will be *six differential equations* in all. The equations will contain *six variables*: four generalized coordinates  $(x, x_G, y_G, \theta)$  and two Lagrange multipliers  $(\lambda_1, \lambda_2)$ .

