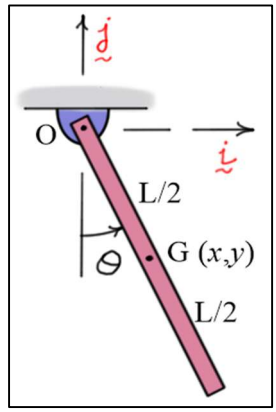
Multibody Dynamics
Exercises #6

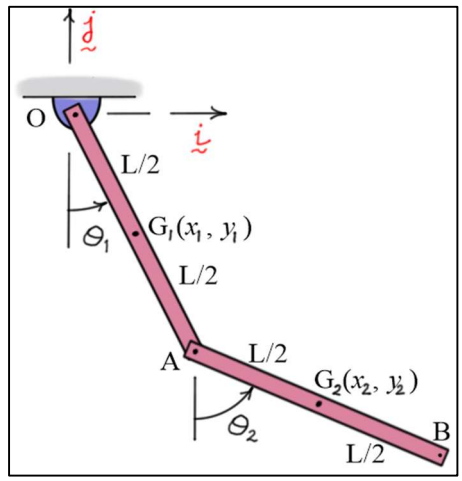
1. The figure shows a pendulum made of a single slender bar of mass m and length L. Using Lagrange's equations, complete the following.



a) Formulate the equation of motion of the pendulum using θ as the only generalized coordinate.

b) Formulate equations of motion of the pendulum using the set of dependent generalized coordinates (x, y, θ). Then differentiate the constraint equations to form second-order ordinary differential equations. There should be ***five*** equations in all.

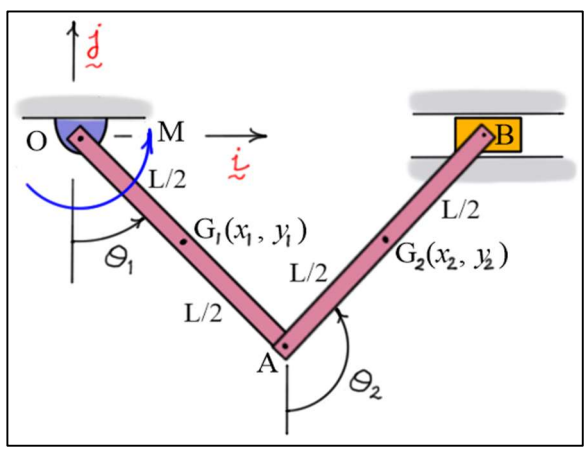
2. The figure shows a double pendulum made of two slender bars each having mass m and length L. Using Lagrange's equations, complete the following.



a) Formulate equations of motion of the pendulum using θ_1 and θ_2 as generalized coordinates.

b) Formulate equations of motion of the pendulum using the set of constrained generalized coordinates (x_1, y_1, θ_1) and (x_2, y_2, θ_2). Then differentiate the constraint equations to form second-order ordinary differential equations. There should be ***ten*** equations in all.

3. The figure shows a slider-crank mechanism driven by a motor torque M. Each slender bar has mass m and length L. Assume the mass of the slider is negligible and treat the system as a constrained double pendulum.



a) Using results from 2(a), formulate equations of motion of the slider-crank mechanism using the set of constrained generalized coordinates (θ_1, θ_2). Then differentiate the constraint equation to form a second-order ordinary differential equation. There should be ***three*** equations in all.

b) Using results from 2(b), formulate equations of motion of the slider-crank mechanism using the set of constrained generalized coordinates (x_1, y_1, θ_1) and (x_2, y_2, θ_2). Then differentiate the constraint equations to form second-order ordinary differential equations. There should be ***eleven*** equations in all.