Direct Dynamics: Newton–Euler Equations of Motion
Homework 13

1. A uniform rod of length $AB = L$ and mass m is supported on the smooth perpendicular planes as shown in Fig. P1. The acceleration due to gravity is g. The rod is released from rest at a position in which the angle of the rod with the vertical axis is equal to $\pi/4$ radians. Find the equation of motion and solve the equation of motion using MATLAB. Determine the reaction forces at the instant when the rod is released. Numerical application: $m = 5$ kg, $L = 1$ m, and $g = 9.81$ m/s^2.

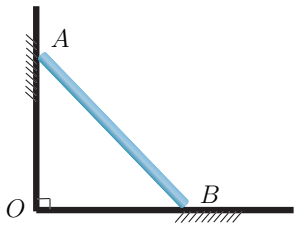

Figure P1: Problem 1

2. The slider 1 of mass m shown in Fig. P2 moves without friction on an inclined fixed link (the inclined angle is β). Determine the equation of motion and the acceleration of the slider. Find and solve the equation of motion if the slider is released from rest at O. Determine the reaction force at the instant when the sider is released. Numerical application: $m = 2$ kg, $\beta = 45°$, and $g = 9.81$ m/s^2.

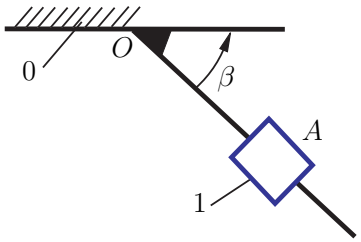

Figure P2: Problem 2

3. Two uniform hinged rods 1 and 2 of mass $m_1 = m_2 = m$ and length $AB = BC = L$ are shown in Fig. P3. The rod 1 is connnected to the ground by a pin joint at A and to the rod 2 by a pin joint at B. The end B is moving with friction along the horizontal surface. The coefficient of friction between rod 2 and the horizontal surface is μ. The acceleration due to gravity is g. The system is released from rest at a position in which the angle of the link AB with the horizontal axis is equal to $\pi/4$ radians. Find and solve the equation of motion of the system. Determine the joint reaction forces at the instant when the rods are released. Numerical application: $m = 0.5$ kg, $L = 0.5$ m, $\mu = 0.1$, and $g = 9.81$ m/s^2.

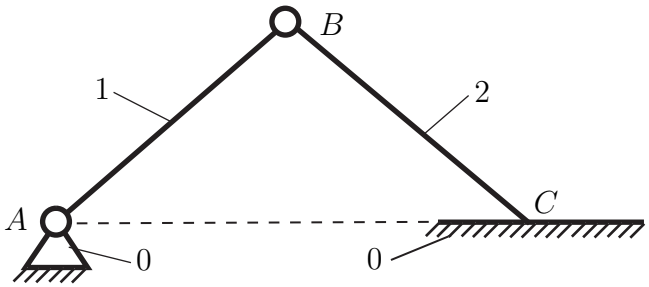

Figure P3: Problem 3

4. Figure P4 depicts two uniform rods 1 and 2 of mass $m_1 = m_2 = m$ and length $OA = AB = 2\,L$. The rod 1 is connnected to the ground by a pin joint at O and to the rod 2 by a pin joint at A. The rods are constrained to move in a vertical plane xOy. The x-axis is vertical, with the positive sense directed vertically downward. The y-axis is horizontal and is contained in the plane of motion. The rod 1 is moving and the instant angle with the vertical axis Ox is $q(t)$. The rod 2 is connnected to the ground by a pin joint at B which is confined to move in a vertical slot. The local acceleration of gravity is g. The rods are released from rest with the geometry shown in Fig. P5. Find and solve the equations of motion of the system. Determine the joint reaction forces at the instant when the rods are released. Numerical application: $m = 0.3$ kg, $L = 0.4$ m, and $g = 9.81$ m/s^2.

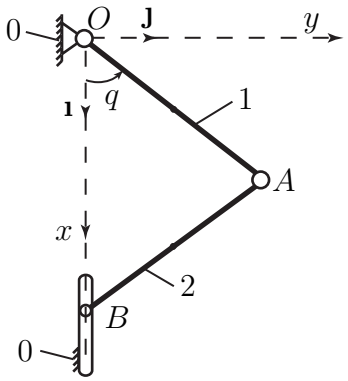

Figure P4: Problem 4

5. The uniform rod 1, in Fig. P5, has the the length $OA = L_1$ and the mass m_1, while rod 2 has the length $AB = L_2$ and the mass m_2. The rods are released from rest with the geometry shown in Fig. P5. Find and solve the Newton–Euler equations of motion. Determine the joint reaction forces at the instant when the rods are released. Numerical application: $m_1 = 1$ kg, $L_1 = 0.3$ m, $m_2 = 5$ kg, $L_2 = 0.9$ m, $a = 0.6$ m, and $g = 9.81$ m/s^2.

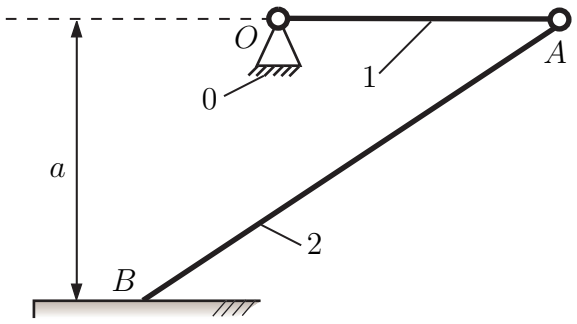

Figure P5: Problem 5