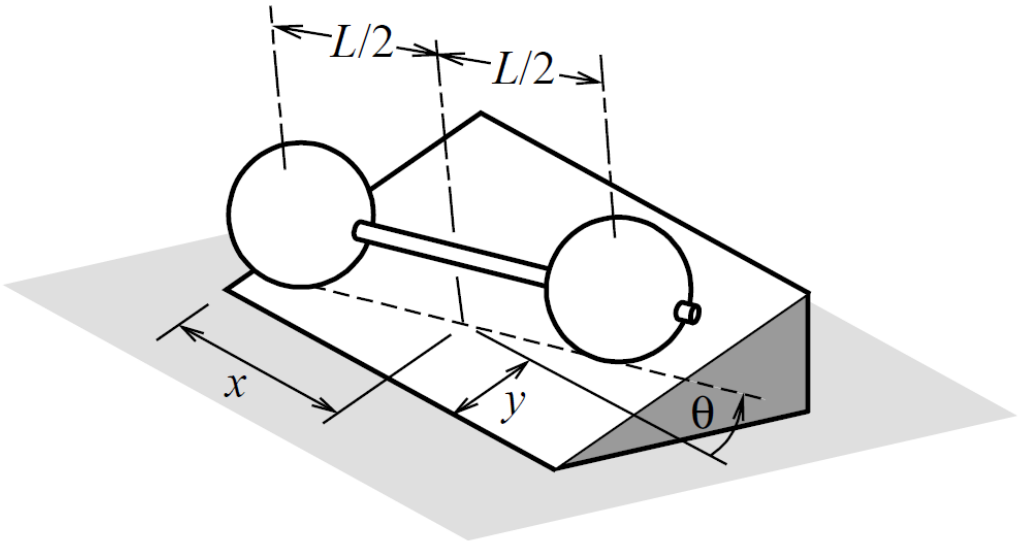
Analytical Dynamics Midterm Exam **Time: 120 min**

Student Name:

1. The distance L between the spheres remains constant as the spheres spin freely about the connecting shaft. The spheres are identical, with mass m and radius R, and the mass of the shaft also is m. The spheres roll without slippage over the inclined surface.

a) Define generalized coordinates for this problem.
b) Derive expressions for the system constraints. What is DOF?
c) Calculate the kinetic and potential energies, and derive the Lagrange equations of motion.
d) Define suitable quasi-velocities for this problem and obtain differential equations of motion using ML method.



2. Two rods, each of mass m and length l are connected by a joint at B and move in a horizontal plane. A knife-edge constraint requires that any motion at A be perpendicular to the rod. Choose $(x, y, \theta_1, \theta_2)$ as generalized coordinate.

a) Obtain differential equations of motion using Elimination method.
b) Derive a general relation for modified Lagrange's method for impulse problems including constraints.
c) Using results of part b, solve for quasi-velocities, if the system is initially at rest, and then a transverse horizontal impulse $\hat{F}$ is applied to C, perpendicular to rod BC.