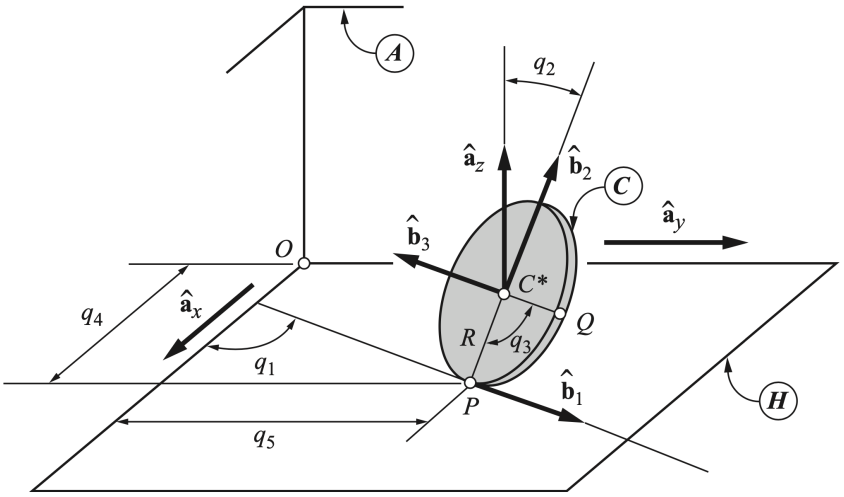
AE 6210: Advanced Dynamics
Final Project

Consider Problem 2.7 from the book (and figure below) describing a circular disk in contact with a horizontal plane.



Phase 1: Assume that the disk and plane have a frictionless interface. The disk has 6 configuration variables, 1 holonomic constraint, 5 generalized coordinates, 0 non-holonomic constraints, and 5 generalized velocities. Derive the equations of motion using:

1) Kane's equations
2) Lagrange's equations
3) Newton-Euler equations

As you derive the equations you will have to:

a) choose your generalized coordinates (you can choose the generalized coordinates that the book uses if you prefer or use any others)
b) choose your motion variables/generalized velocities for Kane's approach (and if you wish for the Newton-Euler approach)

Show that all three approaches give equivalent equations of motion. You can do this either (i) analytically (by deriving one set of equations from another), or (ii) semi-analytically (by numerically calculating the accelerations using the different sets of equations for the same assumed state, i.e., assumed values for generalized coordinates and generalized velocities), or (iii) computationally (by simulating the system using the different sets of equations for the same assumed initial condition).

Phase 2: Re-solve the problem assuming that the friction between the disk and plane is sufficient so that the disk rolls (without slipping). The disk has 6 configuration variables, 1 holonomic constraint, 5 generalized coordinates, 2 non-holonomic constraints, and 3 generalized velocities.

Phase 3: Re-solve the problem for a non-zero coefficient of friction assuming that the disk is slipping. The disk has 6 configuration variables, 1 holonomic constraint, 5 generalized coordinates, 0 non-holonomic constraints, and 5 generalized velocities. Simulate and visualize the three cases studied.