1) A solid cylinder with center G and radius a rolling on the rough inside surface of fixed cylinder with center O and radius b , $(b>a)$. Find the Lagrange's equation of motion and deduce the period of the small oscillations.
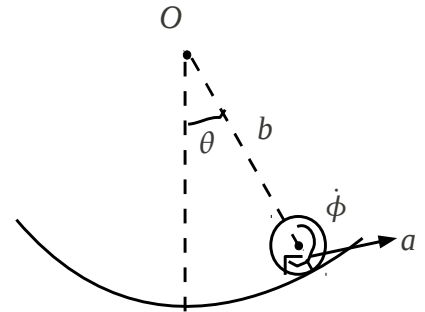
2) A surface of revolution has two parallel rings as its boundary. What should be the shape of the surface be so that it has the minimum possible area. Let the rotation take place around x axis and the curve that connects the rings be represented by $y=y(x)$. Let the boundary conditions be $c_1=y(a_1)$, $c_2=y(a_2)$ (Hint: Minimize area using Euler's equation,
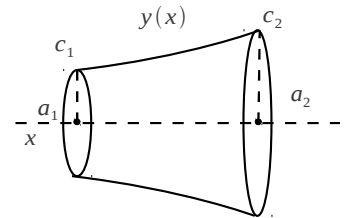
$$A=\int_{a_1}^{a_2} 2\pi y \sqrt{1+y'^2} dx \text{)}$$

3) Two masses each having mass m are connected by a spring to each other and by springs to fixed position spring 1, 2, and 3 have spring constants k, k_{12}, and k respectively. Find the eigenfrequencies of the system using the Lagrangian method of small oscillations.
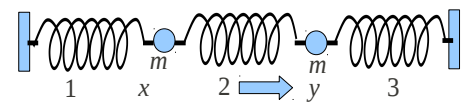
4) Determine the eigenfrequencies and describe the normal mode motion for two pendula of equal length b and equal masses m connected by a spring of force constant k . Choose the generalized coordinates and solve using Lagrangian method for small oscillations.
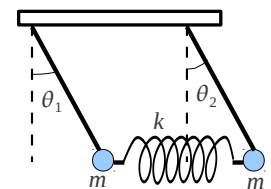
5) Determine the eigen-frequencies and describe the normal mode motions of a symmetrical linear triatomic molecule similar to CO_2 . The central atom has mass M and the symmetrical atoms have masses m . Both longitudinal and transverse vibrations are possible.
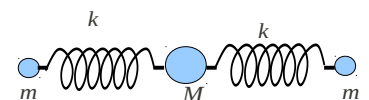
6) Find the Hamilton's equation of motion for a an LC circuit that have no resistance contained in it. Initially the capacitor is change to a charge of q . What is the generalized momentum of the system?

7) Use Hamilton's equation of motion for a spherical pendulum of mass m and length b. (Hint: Write down the Lagrangian for system that have two degrees of freedom, then formulate Hamiltonian of the system.)