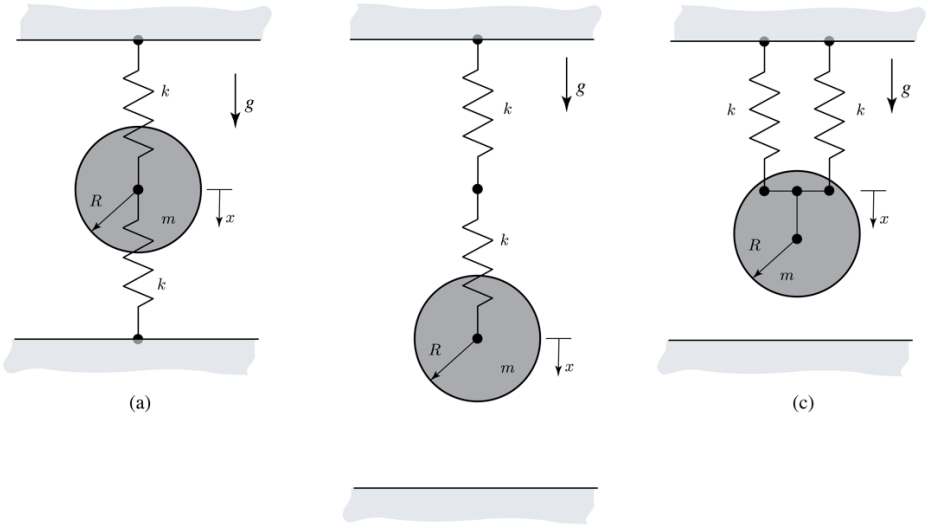
ME 563-Fall 2025

Homework No. 1

Due: September 10, 2025 11:59 pm on Gradescope

ME 563 -Fall 2025
Homework Problem 1.1

Consider each one-degree-of-freedom system shown below consisting of springs of stiffnesses k, and cylinders of masss m.

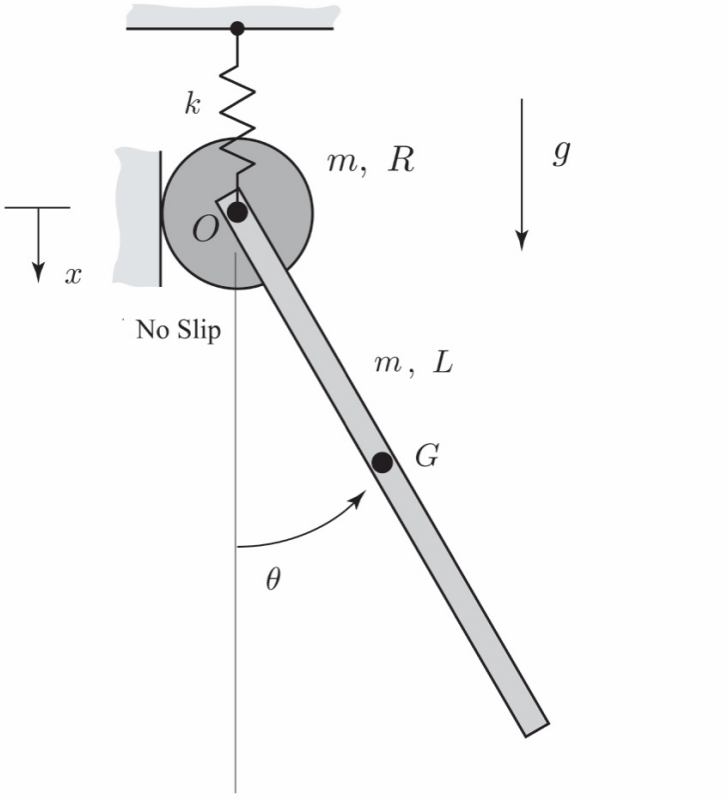


a) Determine the equivalent spring stiffness for each system. Do this by drawing a FBD of each mass and spring as needed.

b) Determine the equilibrium position of the system, x_{st}, for each system. Which system deflects the most due to gravity?

ME 563 -Fall 2025
Homework Problem 1.2

Consider the two-degree-of-freedom system shown below made up of a rod *G* and a cyilnder *O* each of mass m, each of mass m. The rotation of the rod is denoted by θ. The spring is unstretched when $x=\theta=0$. The cylinder rolls without slip.



a) Draw individual free body diagrams of each body.

b) Use the Newton- Euler formulation to derive two differential equations of motion for the system. Your final equations should not include any forces of reaction

c) Determine the x and θ at equilibrium.

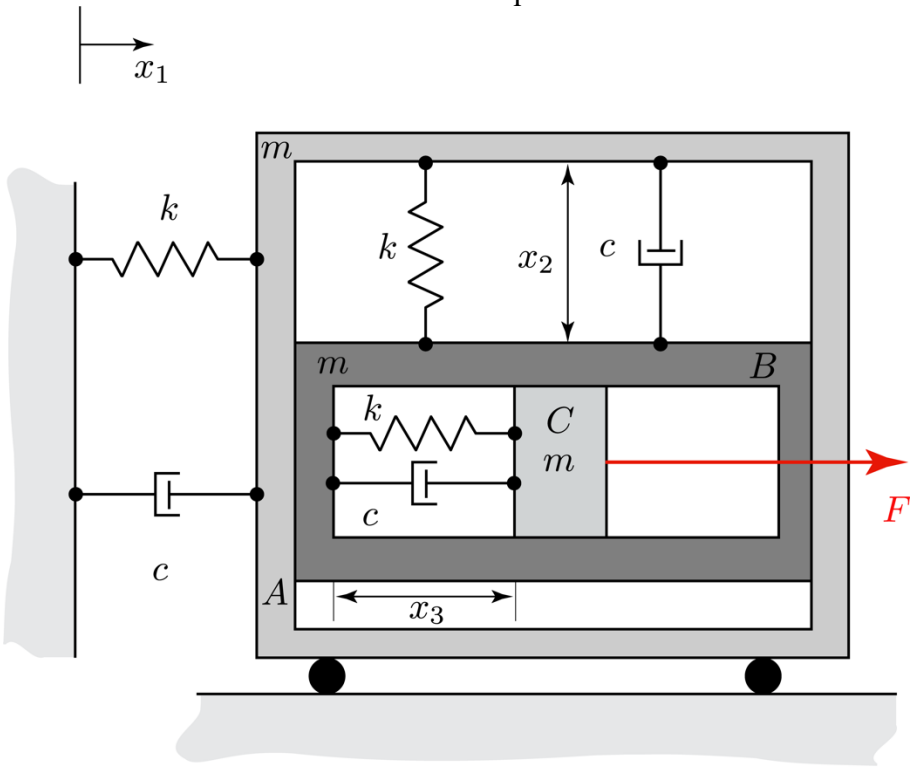
ME 563 -Fall 2025
Homework Problem 1.3

Consider the three-degree-of-freedom system shown below made up of three particles *A*, *B*, and *C*, each of mass m, with system moving within a horizontal plane. Let x_1, describe the absolute motion of particle *A*, x_2 describe the motion of paticle *B* relative to *A* and x_3 describe the motion of particle *C* relative to *B*. All the springs are unstretched when $x_1=x_2=x_3=0$. Assume all surfaces to be smooth.

a) Draw individual free body diagrams of each particle.

b) Use the Newton- Euler formulation to derive three differential equations of motion for the system. Your final equations should not include any forces of reaction.

c) Write the equations of motion derived in b) in matrix form. Identify the mass, damping, and stiffness matrices in these equations.



ME 563 -Fall 2025
Homework Problem 1.4

Consider the system below: it consists of a drum of mass of m, and inner radius R, an outer radius $2R$ and a centroidal of inertia I_O. A spring of stiffness k connects the center of the drum O to a fixed wall. Block A has a mass of m. The inner surface of the disk rolls without slipping on the ground at point C. The cable does not slip on the outer radius of the drum. A force F acts to the right at the center of the drum O. Let ϕ be the rotation angle for the drum. The spring is unstretched when ϕ=0.

a) Using the Newton-Euler formulation, determine the equations of motion for the system using the coordinate ϕ. Draw the free body diagrams of the drum and block individually before writing down the Newton-Euler equations.

b) Using the power equation formulation, determin the equations of motion for the system using the coordinate ϕ. Draw a free body diagram of the entire system before writing down the power equation.