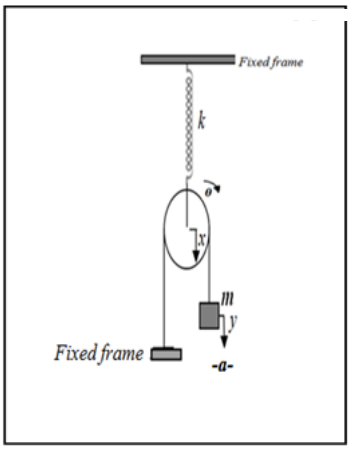
National Higher School of Autonomous Systems Technology
Academic year : 2024/2025

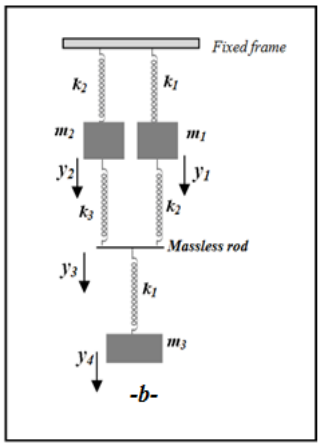
Module : Physics 3
2nd year 2024/2025

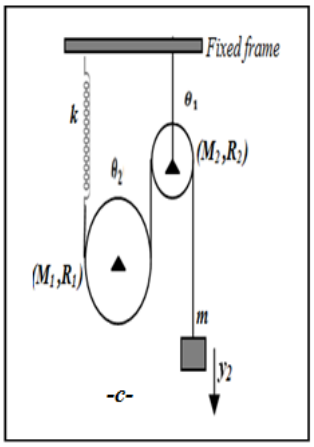
Set N⁰ 1
Degrees of freedom- kinetic & potential energy

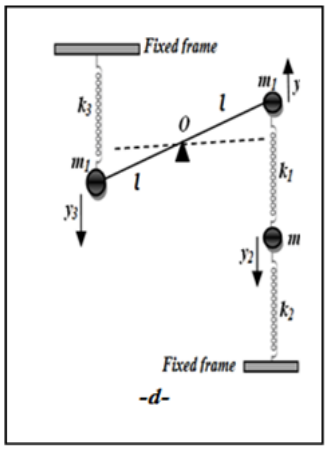
Exercise 1:

1. Find the mathematical expressions of the constraints, if they exist, for the following mechanical systems.
2. Deduce the number of degrees of freedom and identify the most suitable generalized coordinates to describe each system.





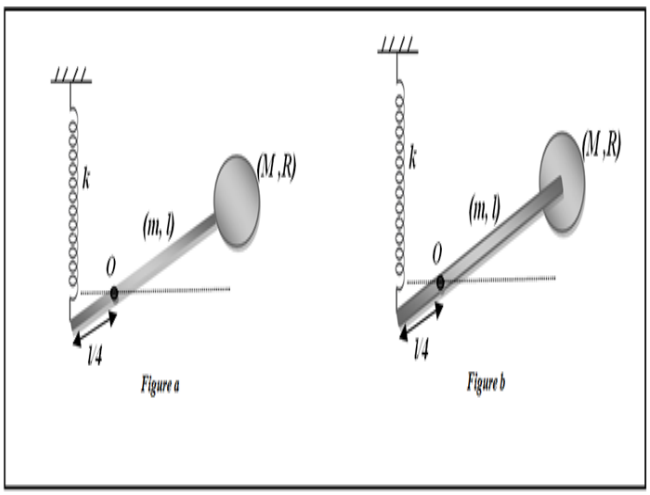




Exercise 2:

In the two systems shown in the figure, the bar of mass mmm and length lll is pinned to the ground at point O and supported by a spring with stiffness k. The other end of the bar is connected to a disk of mass M and radius R. In Figure (a), the disk is rigidly connected to the bar, while in Figure (b), the connection is pinned, allowing the disk to rotate freely. Assume that in both cases, the system is in static equilibrium when the bar is horizontal.

1. Find the number of degrees of freedom in both cases.
2. Calculate the kinetic and potential energy for each system.



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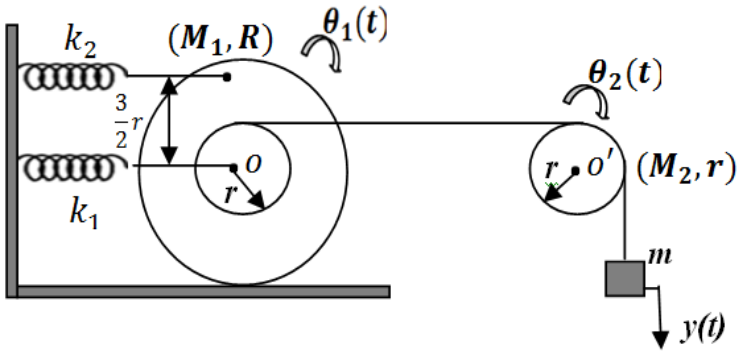
Exercise 3:

Consider a mechanical system composed of a pulley (M_1, R) that rolls without slipping on the ground, while the pulley (M_2, r) can freely pivot around its fixed center at O′. All other data for the exercise are provided in the figure of the system.

1. Determine the degrees of freedom of the system, specifying any mathematical constraints if they exist.
2. Calculate the kinetic and potential energy of the system.



Exercise 4:

Consider a mechanical system composed of a homogeneous disk (M, R), which can rotate without slipping on a horizontal plane, a rod (m, l) that can oscillate around a fixed axis at O, perpendicular to the plane of motion, and a spring with a stiffness constant *k*. The horizontal bar CA has negligible mass. The system undergoes small amplitude oscillations.

1-What is the degree of freedom of this system?

2-Calculate the potential and kinetic energy of the system.