Université Badji Mokhtar-Annaba **2024-2025**
Faculté des Sciences de l'Ingéniorat
Département de Tronc Commun ST 2ème Année
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Module : Physique 3

Exercise 1: A mass $m = 0{,}453 kg$ attached to a spring elongates it by 7.787 mm at rest. Determine the vibration frequency of the mass-spring system

Exercise 2: A harmonic oscillator consisting of a mass $m = 2\,kg$ and a spring with a stiffness constant k has an angular vibration frequency $\omega_0 = 10\,rads/s$ and a mechanical energy $E_m = 5\,Joules$. Calculate the amplitude of the system's vibrations.

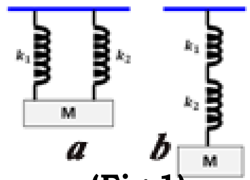
Exercise 3: A solid mass m, able to slide without friction on a horizontal support, is attached to a spring with a stiffness constant $k = 48$ N/m. Its elongation x, measured from its equilibrium position, is given by $x = x_m \sin(8t - \pi)$. To make the mass m oscillate, 0.24 J of energy is supplied. Determine:

a) The mass m of the solid.
b) The amplitude of the motion.
c) The maximum velocity of the oscillator.
d) The elongation of the oscillator for which the potential energy is equal to half of the kinetic energy.
e) The components of velocity and acceleration at this point.

Exercise 4: The ratio k/m of a vertical mass-spring system is equal to 4. If at $t = 0$ the mass is pulled from 2 cm below its equilibrium position and released with a velocity of $8\,cm/s$, determine the resulting motion and maximum acceleration.

Exercise 5:
Determine the equivalent stiffness constants, k_{eq}, for the following systems (Fig.1):
Compare k_{eq} with the equivalent capacitances, C_{eq}, of two capacitors in series and parallel

(a) Springs in parallel



(b) Springs in series

(Fig.1)

Exercise 6:
A mass-spring system m_1, k_1, has a natural frequency ω_1. If a second spring with stiffness k_2 is added in series with the first spring, the natural frequency of the system becomes $\frac{1}{2}\omega_1$. Determine k_2 in terms of k_1.

Exercise 7:
A simple pendulum of length l and mass m, attached to a mass M that can slide without friction on a horizontal plane as shown in Figure 2, oscillates in the vertical plane. Let x be the displacement of M and θ the angle of rotation of the pendulum. Write the Lagrangian of the system

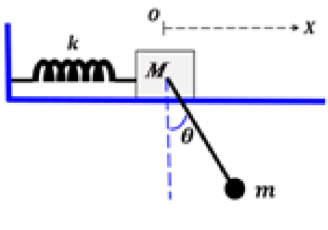
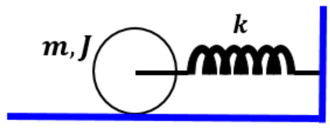


Fig.2)

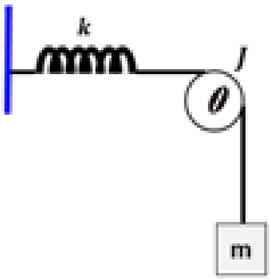
Exercise 8:
Consider the mechanical system shown in the following Figure 3. The cylinder with radius R, mass m, and moment of inertia J can roll without slipping on the horizontal plane. Determine the frequency of the oscillatory motion of the cylinder.



(Fig.3)

Exercise 9:

Consider the mechanical system shown in Figure 4. The disk with moment of inertia J, radius R, and mass M can freely rotate around the horizontal axis passing through 0. The cord supporting the mass m is inextensible and does not slide on the disk. Determine the equation of motion for m, knowing that at the initial instant, the mass m is pulled downward by $4cm$ from its equilibrium position and released without velocity. Calculate the frequency of the oscillations.



(Fig.4)

Exercise 10:

Determine the frequency of the oscillations of the system shown in Figure 5 in the case of small movements.

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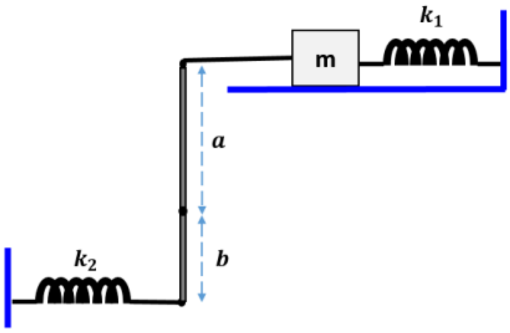

(Fig.5)