University of Badji Mokhtar-Annaba **2025-2026**
Faculty of Engineering Sciences
Department of Science and Technology,
2nd Year
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Module: Physics 3

<u>Exercise 1:</u>

A mass m=0.453kg attached to a spring stretches it by 7.787 mm at rest. Determine the angular frequency of the mass-spring system.

<u>Exercise 2:</u>

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

<u>Exercise 3:</u>

A solid of mass m that can slide without friction on a horizontal support is fixed to a spring with stiffness $k = 48\,\mathrm{N/m}$. Its elongation x measured from its equilibrium position is given by $x = x_m \sin(8t - \pi)$ To make the mass m oscillate, it is given an energy of 0.24 J.
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 the velocity and acceleration at this point.

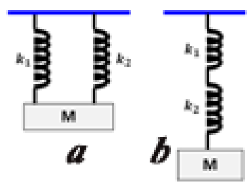
<u>Exercise 4:</u>

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

<u>Exercise 5:</u>

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

(a) Ressorts in parallel



(b) Ressorts in series

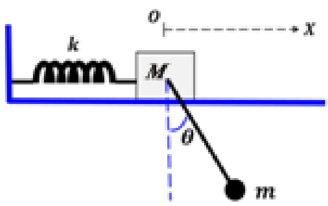
(Fig.1)

<u>Exercise 6:</u>

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

<u>Exercise 7:</u>

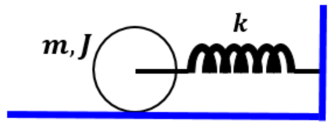
A simple pendulum of length l and mass m, attached to a mass M that can slide without friction on a horizontal plane as shown in figure 2, oscillates in the vertical plane. Let x be the displacement of M and θ be the angle of rotation of the pendulum. Write the Lagrangian of the system.



(Fig.2)

Exercise 8:

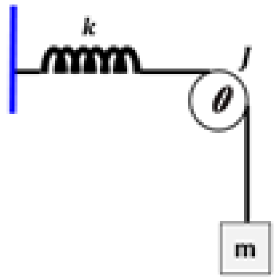
Consider the mechanical system shown in figure 3 below. The cylinder of radius R, mass m, and moment of inertia j can roll without slipping on the horizontal plane. Determine the frequency of the oscillatory motion of the cylinder.



(Fig.3)

Exercise 9:

Consider the mechanical system shown in figure 4. The disk of moment of inertia J, radius R, and mass M can rotate freely around the horizontal axis passing through O. The rope supporting the mass m is inextensible and does not slip on the disk. Determine the equation of motion of m knowing that at the initial time the mass m is pulled down 4 cm from its equilibrium position and released without velocity. Calculate the angular frequency of the oscillations.



(Fig.4)

Exercise 10:

In the following figure (figure 5), a spring with coefficient k from one side attached to a disc at distance a from 0 and from other side is attached to the wall. This disc can rotate around point 0. A mass with a non-deformable cable is connected to this disc. Find the equivalent stiffness and natural frequency for this structure. Choose the angular displacement θ of the disc as the generalized coordinate.

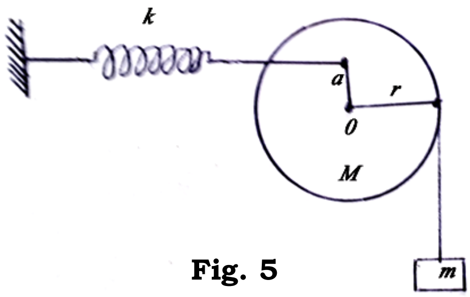
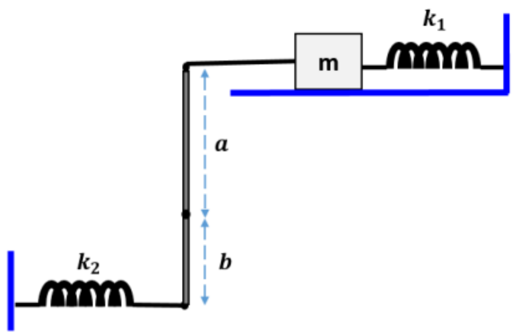


Fig. 5

Exercise 11:

Determine the angular frequency of oscillations of the system shown in figure 6 in the case of small movements.



(Fig.6)