SCAN 1st

**Mechanics test 2**

*Friday, 10th April 2020 – Duration: 1h30*

*Formative test*

**Exercise 1:**

The spring of constant $k$ is un-stretched when the slider of mass $m$ passes position B (Figure 1). If the slider is released from rest at point A, determine its speed as it passes points B and C. What is the normal force exerted by the guide on the slider at point C?

*Neglect friction between the slider and the circular guide.* **y** *is the upward vertical axis*

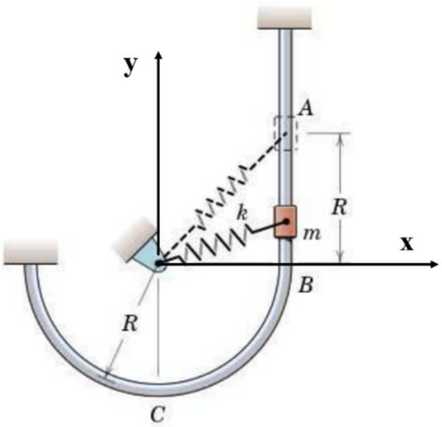


Figure 1.

**Exercise 2:**

The cylinder of mass $m$ is given a vertical displacement $y_0$ from its equilibrium position and released.

1 – Show that the system in Figure 2-a is equivalent to a simple mass-spring system. Determine the stiffness $k_{eq}$ of the equivalent spring. *Hint: use the moment equilibrium about the pulley centre.*

2 – Develop the static equilibrium equation for this system.

3 - Develop the differential equation for the vertical vibration of the cylinder and deduce the natural frequency of the system in Figure 2-a (*Hint: simplify the expressions by using the static equilibrium equation*)

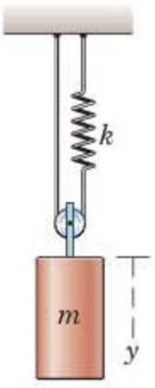


Figure 2-a.

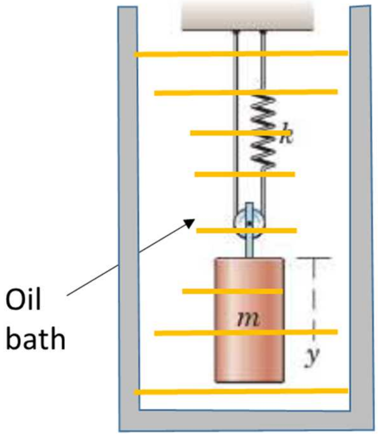


Figure 2-b

4 – The system is now immersed in an oil bath and the same experience is repeated. It is observed that the ratio between two successive positive-displacement amplitudes is 4/1. Determine the viscous damping ratio $\xi$.

**Exercise 3:**

The exercise machine (Figure 3) is made of a lightweight cart mounted on rollers so that friction with the inclined ramp can be neglected. Two cables are attached to the cart (one for each hand) which are supposed to remain parallel in a vertical plane. The mass of the cart is neglected, that of the man is *M*. The angle of the ramp is $\theta$ (direction of the ramp characterised by unit vector $\mathbf{u}$). The angle of the cables with respect to the ramp is $\beta$ (*direction of cables characterised by unit vector* $\boldsymbol{\eta}$ *- Careful* $\beta$ *is not necessarily equal to* $\theta$ *as is represented for the particular position shown in Figure 3*).

1 – Specify what the isolated system is and represent its free-body diagram or give the list of the external forces.

2 - Determine the force $P$, which each hand must exert on its cable in order to maintain an equilibrium position

3 – Determine the reaction force the ramp exerts on the cart.

4 – Numerical application M=80 kg, $\theta = 15°$ and $\beta = 20°$

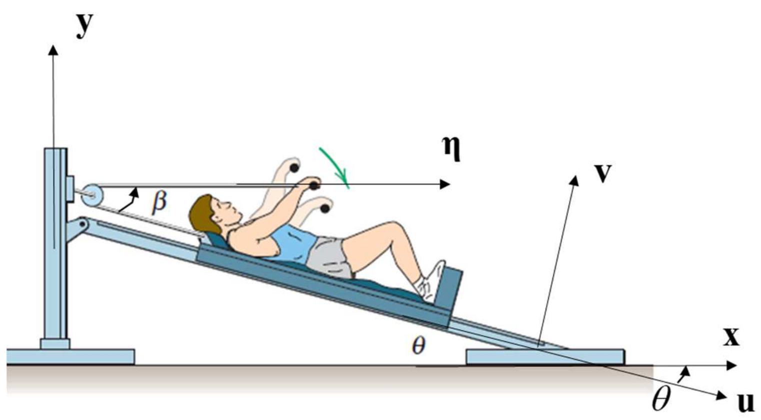


Figure 3.

**Exercise 4:**

The homogeneous 40-kg bar in Figure 4 is held in position by a massless horizontal rope attached to end *C*. *Friction is neglected.*

1 – Find the position of the centre of mass of the bar – Assuming that the bar tip at A is rounded and that the corner at B is also rounded, give the directions of the reaction forces at A and B.

2 – Determine the reaction forces at A and B along with the tension in the rope.

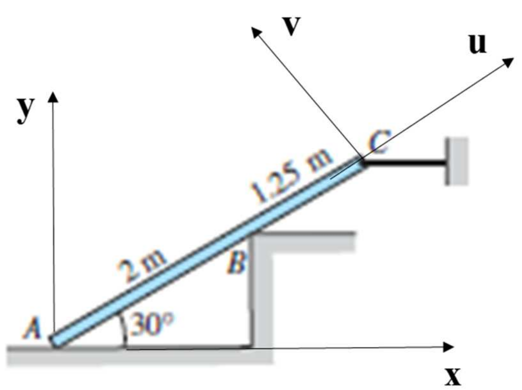


Figure 4