1. A system is shown rotating freely with an angular speed \( \omega \) of 2 rad/sec. A mass \( A \) of 1.5 kg is held against a spring such that the spring is compressed 100 mm. If the device \( a \) holding the mass in position is suddenly removed, determine how far toward the vertical axis of the system the mass will move. The spring constant \( K \) is 531 N/mm. Neglect all friction and inertia of the bar. The spring is not connected to the mass.

![Diagram 1](image)

2. A single cam \( A \) is mounted on a shaft as shown. The cam has a mass of 10 kg and has a center of mass 300 mm from the centerline of the shaft. Also, the cam has a radius of gyration of 180 mm about an axis through the center of mass. The shaft has a mass per unit length of 10 kg/m and has a diameter of 30 mm. A torque \( T \) given as

\[
T = 0.001t^2 + 10 \text{ N-m}
\]

is applied at coupling \( D \) (\( t \) is in seconds). What are the force components in the bearings after 25 sec if the cam has the position shown in the diagram at this instant?

![Diagram 2](image)
3. A box of mass \( m \) is placed on a cart as shown. Assuming that the cart is accelerated in the \( x \) direction, find the condition for the box to slide and the condition for the box to fall down. Also assume that \( \mu_s \), the coefficient of maximum static friction between the box and the floor of the cart, is 0.3. If the acceleration of the cart is increased from zero to 0.4g, where g is the gravitational acceleration constant, will the box fall down to the floor? (20%) 

![Figure 3. Box placed on a cart.](image)

4. A box of mass \( m \) is placed on an inclined plane with the angle of inclination equal to 30°. Find the work done when the box is moved upward at a constant speed along the inclined plane for a distance of 5 m. Assume that mass \( m \) is 10 kg and that the coefficient of sliding friction \( \mu_k \) is 0.3. (15%) 

![Figure 4. Box placed on an inclined plane.](image)

5. Derive the equation of motion for the pendulum system (with a point mass \( m \)). Assume that when the pendulum is vertical there is no spring force. (15%) 

![Figure 5. Pendulum system](image)