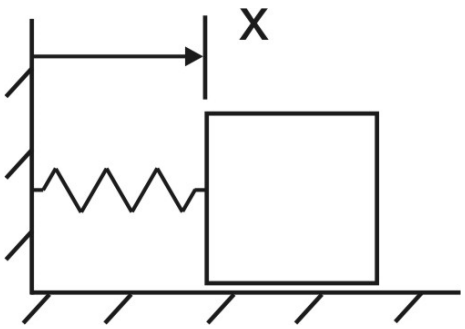
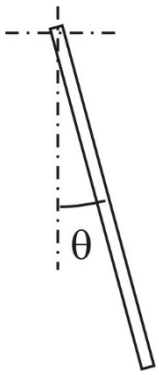
# Dynamics 2 – Tutorial 9

Free Oscillations

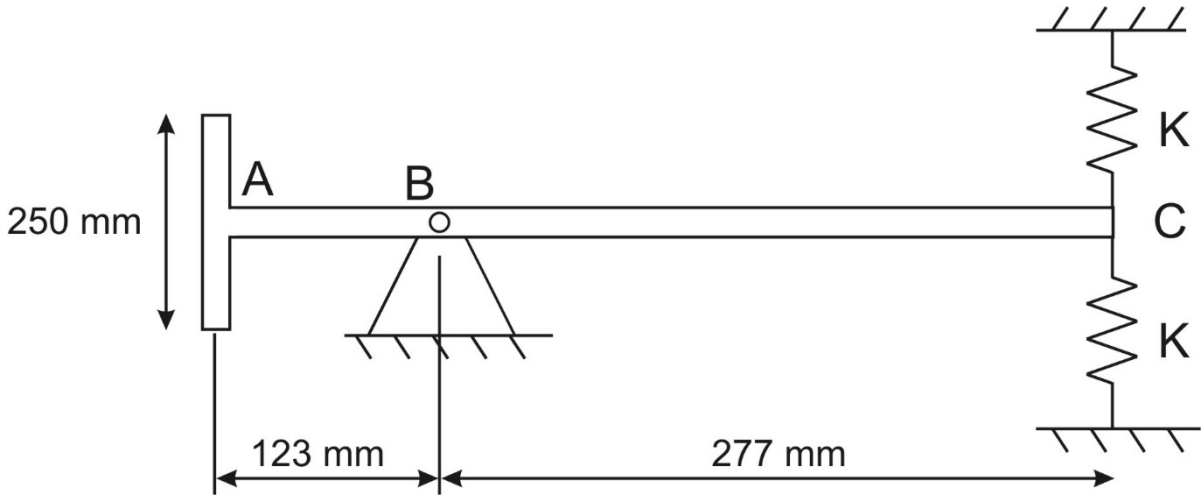
1. In the figure a mass of 45 kg is attached to a spring of stiffness 28.425 kN/m.
   (a) If the mass is disturbed, at what frequency in Hz would it oscillate? Write down an expression for the general solution of the free vibration of the mass. [4Hz]
   (b) If the mass is given an initial velocity of 1.5 m/s to the right, how long would it take to reach the position of greatest spring extension, and what would be the maximum spring force on the wall? [62.5 ms, 1697 N]




2. A uniform steel bar of mass 18 kg and length 0.65 m is suspended from a nail at its top. What would be the frequency of small angular oscillations if disturbed? [0.76 Hz]



3. Two lengths of steel are welded together to form the T-shaped bar as shown. The total mass is 4.5 kg. The bar is supported by a frictionless pivot at its centre of gravity (point B) and has two springs of stiffness K attached at the end.
   (a) What is the moment of inertia about B? [0.0885 $kgm^2$]
   (b) If the bar oscillates with a frequency of 6.2 Hz when given a small angular disturbance, what is the value of K? [875.2 N/m]
   (c) The frequency of oscillations can be lowered to 6 Hz by welding a small mass m to the bar at point C. Calculate m [0.078 kg]




4. A horizontal rigid steel platform has a mass of 240 kg. It is supported on four vertical coil springs, one at each corner, each of stiffness 1000 N/m.
   (a) If the platform is disturbed vertically, what would be the period of oscillation? [1.54s]
   (b) if a 70 kg bag of sand is dropped from a height of 1.5 m on to the middle of the platform. Determine the amplitude of the consequent free vibration oscillations of the platform, assuming that the bag does not bounce off. [0.341 m] Hint: use conservation of momentum for the colliding masses to get the initial downward velocity immediately after the impact. The springs can be ignored at this stage. Use the initial velocity in the boundary conditions of the differential equation to get the specific solution.