upright. The moment of inertia of the rotating parts of the engine is 0.18 kg-m$^2$. The engine rotates 4.5 times the speed of the road wheel in the same sense. Find the angle of heel necessary when the motor cycle is taking a turn of 40 m radius at a speed of 70kmph

## PART C

***Answer any four full questions, each carries 10 marks.***

9 a) By neglecting the mass of the slender uniform rod is shown in Fig. 4(a), determine the natural frequency of free vibration of the mass for small oscillations (5 )

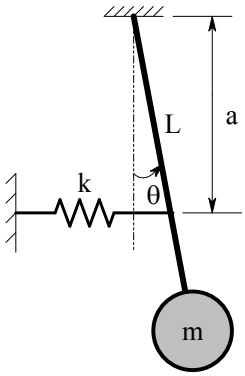


Fig. 4 (a) An oscillating pendulum

b) Find the frequency of the oscillations of the system shown in Fig. 4(b). The roller rolls on the surface without slipping. ( 5 )

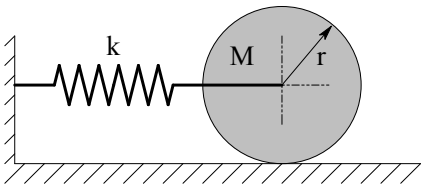


Fig. 4(b) A Cylinder rolling on a floor

10 A mass of 4.5 kg, hangs from a spring and makes damped vibration. The time of 50 complete oscillations is found to be 18 seconds and the ratio of first down ward displacement to the sixth is found to be 2.5. (10)

Find (i) the natural frequency of the system,
(ii) the stiffness of the spring in KN/m,
(iii) the damping coefficient in N-s/m,
(iv) the critical damping coefficient.

11 An electric motor weighing 100 kg is supported on isolators having a damping factor of 0.2. It runs at a speed of 1500 rpm and has a rotating unbalance of 10 kg-cm. What should be the stiffness of the isolators if the forces transmitted to the foundation is to be less than 10 % of the unbalanced force (10)

12 A rotor has a mass of 12 kg and mounted midway on a 24 mm diameter horizontal shaft supported at ends by bearings. The bearings are 1 m apart. The shaft rotates at (10)

2400 rpm. If the centre of mass of the rotor is 0.11 mm away from the geometric centre of the rotor due to certain manufacturing defects. Find the amplitude of steady state vibration. Take E = 200GPa

13 A centrifugal pump rotating at 400 rpm is driven by an electric motor at 1200 rpm through a single stage reduction gearing. The moment of inertia of the pump impeller and the motor are 150 kg-$m^2$ and 450 kg-$m^2$ respectively. The lengths of the pump shaft and the motor shaft are 500 mm and 200 mm and their diameters are 100 mm and 50 mm respectively. Neglecting the inertia of the gears, find the frequency of torsional oscillations of the system, and draw the mode shape. Take $G = 82\,GPa$ (10)

14 What do you understand by vibration pickups? With neat diagram explain the working of a seismometer. (10)

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