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BIMEE-008

B.Tech. MECHANICAL ENGINEERING (BTMEVI)

Term-End Examination

June, 2013 00497

BIMEE-008 : MECHANICAL VIBRATION

Time : 3 hours *Maximum Marks : 70*

Note : *Answer **any seven** questions. All questions carry **equal** marks. Use of scientific calculator is **permitted**.*

1. A mass 'm' of 400 gm shown in figure 1 is connected to a light spring whose force constant is 5 N/m. It is free to oscillate on a horizontal frictional track. If the mass is displaced 10 cm from equilibrium and released from rest, find : **10**

(a) period of motion,

(b) maximum speed of the mass,

(c) maximum acceleration of the mass,

(d) equations for displacement, speed, and acceleration as function of time.

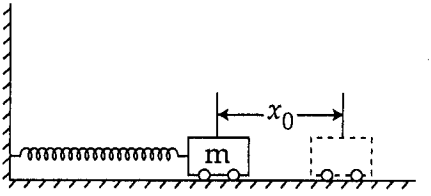

Figure - 1 : A mass spring system

2. A 1500 kg truck cab is assumed to be supported by four springs each with stiffness 120 kN/m. Determine the resonant frequency of the cab in unit of Hz and the amplitude of vibration if the displacement input of each accelator is $d = 0.05 \sin 6t$. **10**

3. A vibrating system consists of weight $W = 9.81$ kN, a spring stiffness 20 kN/cm and a dash pot with coefficient 0.071 kN/cm/sec, as shown in figure 2. Find : **10**

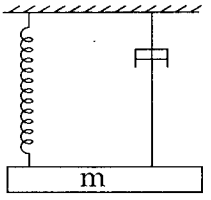

Figure - 2

(a) damping factor

(b) logarithmic decrement

(c) ratio of any two consecutive amplitudes

4. An automobile tested in a laboratory as shown in figure 3 is modelled as 3000 kg mass on a spring stiffness $K = 400$ kN/m. The system has a damping factor of $C/Cc = 0.4$. Assume that the spring and dash pot are attached to the base whose vertical displacement are defined by $d = 0.04 \sin 6t$. Write the equation of motion of m for steady state vibration. Determine the **10**

magnification factor of the amplitude of vibration, the amplitude A and phase angle ψ.

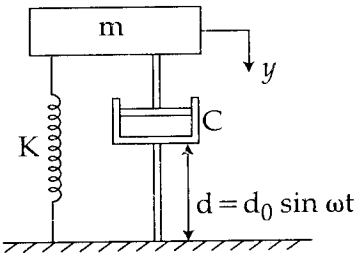

Figure - 3

5. A body having a mass of 15 kg is suspended from a spring which deflects 12 mm under weight of the mass. Determine the frequency of free vibration and also the viscous damping force needed to make the motion periodic or a speed of 1 mm/s. When dampened to this extent, a disturbing force having a maximum value of 100 N and vibrating at 6 Hz is made to act on the body. Determine the amplitude of ultimate motion. **10**

6. Find the stiffness of each spring when a refrigerator unit having a mass of 30 kg is to be supported on three springs. The force transmitted to the supporting structure is only 10% of the impressed force. The refrigerator unit operates at 420 rpm. **10**

7. A vertical shaft is held in long bearings and a disc is attached to the shaft at its mid-point. The centre of gravity of the disc does not coincide with the axis of the shaft. **10**

Determine :

(a) The critical speed of the shaft, and

(b) The range of the speed over which it is unsafe to 'run the shaft'.

The diameter of the shaft is 15 mm and the span of the shaft between the bearing is 1 metre. The mass of the disc is 20 kg and the C.G of disc from the axis of shaft is 0.30 mm. Take $E = 200\ GN/m^2$ and permissible stress in the shaft material is $70\ MN/m^2$.

8. Determine the frequency of the free vibration, when a body of mass 20 kg is suspended from a spring which deflects 15 mm under the weight of the body. Also find the viscous damping force required to make the motion a periodic at a speed of 1 m/s. **10**

If when damped to this extent, a distinguish force having a maximum value of 187.5 N and vibrating at 8 Hz is made to act on the body, find the amplitude of the ultimate motion.

9. A harmonic exciting force of 25 N is acting on a machine part, which is having a mass of 2 kg and is vibrating in a viscous medium. This exciting force causes a resonant amplitude of 12.5 mm with a period of 0.20 seconds. Determine the damping co-efficient. 10

If the system is excited by a harmonic force of frequency 4 Hz, find the increase in amplitude of forced vibration when damper is removed.

10. A shaft of length 985 mm is 100 mm in diameter for the first 300 mm of its length, 150 mm in diameter for the next 160 mm of the length, 120 mm in diameter for the next 125 mm of the length and 90 mm in diameter for the remaining 400 mm of its length. The shaft carries two rotors at two ends. The mass moment of inertia of the first rotor is 168.75 kgm^2 whereas of the second rotor is 405 kgm^2. Determine the frequency of the torsional vibrations. It is desired to have the node at the mid-section of the shaft of 120 mm diameter by changing the diameter of the section having a 90 mm diameter. 10

What will be the new diameter ?