Total No. of printed pages = 4

ME 181701

29/12/22

Roll No. of candidate | | | | | | | | | | |

2022

B.Tech. 7th Semester End-Term Examination

ME

VIBRATION OF MECHANICAL SYSTEM

New Regulation (w.e.f. 2017-18) &

New Syllabus (w.e.f. 2018-19)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer question No. 1 and any *three* from the rest.

1. Answer the following questions : (10 × 1 = 10)

(i) For steady-state forced vibrations, the phase lag at resonance is

(a) 0° (b) 45°

(c) 90° (d) 180°

(ii) Which of the following is correct for a body in simple harmonic motion?

(a) Acceleration is proportional to displacement from mean position

(b) Velocity is minimum at the mean position

(c) Acceleration is maximum at the mean position

(d) None of the above

(iii) The damping force is constant in magnitude but opposite in direction to that of motion of vibrating bodies in case of

(a) Viscous damping (b) Columb damping

(c) Slip damping (d) Structural damping

[Turn over

(iv) Which of the following parameters has higher value during whirling of a shaft?

(a) Speed (b) Acceleration

(c) Frequency (d) Amplitude

(v) In vibration isolation if ω/ω_n is less than $\sqrt{2}$ then transmissibility will be

(a) Less than one (b) Equal to one

(c) Greater than one (d) Zero

(vi) When there is a reduction in the amplitude for every cycle of vibration then the body is said to be in

(a) Forced vibration (b) Un-damped vibration

(c) Free vibration (d) Damped vibration

(vii) Critical damping is the

(a) Largest amount of damping for which no oscillation occurs in free vibration

(b) Smallest amount of damping for which no oscillation occurs in free vibration

(c) Largest amount of damping for which the motion is simple harmonic in free vibration

(d) Smallest amount of damping for which the motion is simple harmonic in free vibration

(viii) The ratio of the amplitude of the steady-state response of forced vibrations to the static deflection under the action of a static force is known as

(a) Damping ratio (b) Damping factor

(c) Transmissibility (d) Magnification factor

(ix) The static deflection of the shaft under the flywheel is 25 mm. Assuming g = 10 m/sec^2, the critical speed in rad/sec will be

(a) 30 (b) 10

(c) 40 (d) 20

(x) In the spring-mass system, if the mass of the system is double with spring stiffness halved, the natural frequency of vibration is

(a) Remains unchanged (b) Doubled

(c) Halved (d) Quadrupled

2. (a) A harmonic motion is given by $x(t)=10\sin\left(30t-\frac{\pi}{3}\right)mm$, where t is in seconds and phase angle in radians. Find

(i) Frequency and the period of motion

(ii) The maximum displacement, velocity and acceleration. (5)

(b) A body describes simultaneously two motions, $x_1=3\sin 40t$, $x_2=4\sin 41t$. What is the maximum and minimum amplitude of combined motion and what is the beat frequency? (5)

(c) An unknown mass m is attached to one end of a spring of stiffness k having natural frequency of 6 Hz. When 1 kg mass is attached with m the natural frequency of the system is lowered by 20%. Determine the value of unknown mass m and stiffness k. (10)

3. (a) A gun barrel having mass 560 kg is designed with the following data: Initial recoil velocity 36 m/sec; Recoil distance on firing 1.5 m. Calculate :

(i) spring constant,

(ii) damping coefficient and

(iii) time required for the barrel to return to a position 0.12 m from its initial position. (3+3+4=10)

(b) A vibrating system is defined by the following parameters :

m = 3 kg, k = 100 N/m, C = 3 N-sec/m

Determine (i) the damping factor, (ii) the natural frequency of damped vibration, (iii) logarithmic decrement, (iv) the ratio of two consecutive amplitudes and (v) the number of cycles after which the original amplitude is reduced to 20 percent. (5 × 2 = 10)

4. (a) What is transmissibility? Derive the mathematical formula for the transmissibility. What is the difference between a vibration absorber and a vibration isolator? (2+4+4=10)

(b) A vibratory body of mass 150 kg supported on springs of total stiffness 1050 kN/m has a rotating unbalance force of 525 N at a speed of 6000 rpm. If the damping factor is 0.3, determine (i) the amplitude caused by the unbalance and its phase angle, (ii) the transmissibility and (iii) the actual force transmitted. (5+3+2=10)

5. (a) A vehicle of mass 490 kg and total spring constant of its suspension spring is 60×10^3 N/m. The profile of the road may be approximated to a line curve of amplitude 4.0 cm and wavelength of 4.0 meters. Determine

(i) The critical speed of the vehicle,

(ii) The amplitude of the steady state motion of the mass when the vehicle is driven at critical speed and the damping factor is 0,5; and

(iii) The amplitude of the steady state motion of the mass when the vehicle is driven at 57 km/hr and the damping factor same as in (ii).

(3+3+4 = 10)

(b) Find the natural frequency of the system as shown in figure 1. (10)

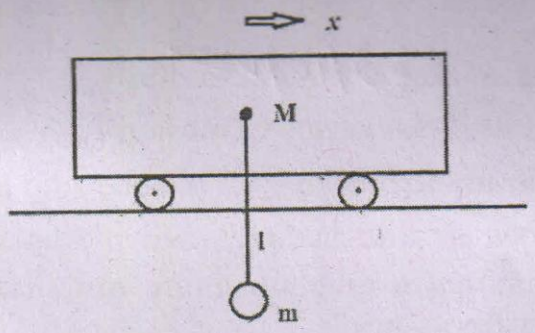

Figure – 1

6. Write short notes on the following : (any *four)* (4 × 5 = 20)

(a) Semi-definite system

(b) Seismic instruments

(c) Rayleigh method

(d) Logarithmic decrement

(e) Critical damping

(f) The compound pendulum

(g) Co-ordinate coupling

(h) Critical speed.

7. Determine the natural frequencies and mode shapes of the mechanical system as shown in figure 2. (20)

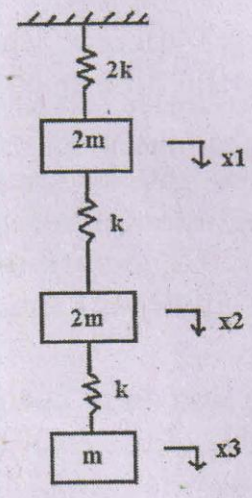

Figure – 2