

**Seventh Semester B.E. Degree Examination, Dec.2023/Jan.2024**  
**Mechanical Vibrations**

Time: 3 hrs.

Max. Marks:100

**Note: Answer any FIVE full questions, selecting at least TWO questions from each part.**

**PART – A**

- 1 a. Derive an expression for work done by a harmonic force and comment on, the magnitude of work done when phase angle is  $0^\circ$  and  $90^\circ$  respectively. (10 Marks)  
 b. A particle is subjected to two harmonic motions as given below. Add them analytically and check graphically.

$$x_1 = 15 \sin(\omega t + 30^\circ)$$

$$x_2 = 8 \cos(\omega t + 60^\circ)$$

(10 Marks)

- 2 a. Find an expression for the natural frequency of a spring mass system considering mass of spring also. (10 Marks)  
 b. For the system shown in Fig.Q.2(b), AB is massless rigid bar and 'm' is point mass attached at 'O'. Find the natural frequency by finding equivalent spring stiffness. (10 Marks)

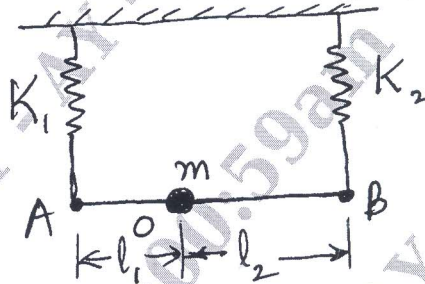


Fig.Q.2(b)

- 3 a. Derive an equation for logarithmic decrement for an underdamped system. (10 Marks)  
 b. In a damped free vibration system following data are noted:

$$K = 15000 \text{ N/m}, \quad C = 120 \text{ NS/m}, \quad M = 5 \text{ kg}$$

Determine:

- i) Undamped natural frequency  
 ii) Damped natural frequency  
 iii) Critical damping coefficient  
 iv) Logarithmic decrement  
 v) Ratio of amplitudes of two successive waves (10 Marks)
- 4 a. The springs of an automobile trailer are compressed 0.1m under its own weight. Find the critical speed in kmph of the automobile when it is travelling over a road with a profile approximated by a sine wave of amplitude 0.08m and wavelength of 14m. Also find the amplitude of vibration at 60 kmph. (10 Marks)  
 b. Define 'Transmissibility'. State the expression for the same. How do you achieve effective transmissibility when  $w \gg w_n$ ? Explain in brief with the help of transmissibility versus  $\frac{w}{w_n}$  curves. (10 Marks)

## PART - B

- 5 a. Explain the working principle of vibrometer and velocity pick-up. (06 Marks)  
 b. With the help of neat diagram explain the functioning of Frahm's reed tachometer. (06 Marks)  
 c. A rotor having a mass of 10 kg is mounted at the midspan of 80 cm long horizontal shaft. The shaft diameter is 2 cm. CG of the rotor is 0.1 mm away from geometric center. If the shaft rotates at 3000 rpm, find amplitude of steady state vibration.  $E = 200$  GPa. (08 Marks)
- 6 a. Find the natural frequencies of the following system and draw the mode shapes of vibration.

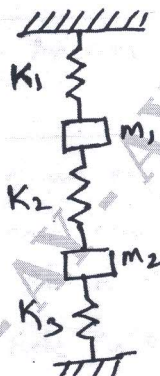


Fig.Q6(a)

- b. Explain the working principle of dynamic vibration absorber. (14 Marks)  
 (06 Marks)
- 7 Write short notes on:  
 i) Maxwell's reciprocal theorem.  
 ii) Influence coefficients.  
 iii) Dunkerly's method.  
 iv) Orthogonality of principal modes. (20 Marks)
- 8 a. Draw a neat diagram experimental modal analysis setup and explain the different components of the same. (10 Marks)  
 b. Explain the different machine condition monitoring techniques. (10 Marks)

\* \* \* \* \*