CBCS SCHEME

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15AE553

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Theory of Vibrations

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. List the different types of vibrations. Discuss any two types with suitable examples. **(08 Marks)**

b. Represent the periodic motion given in the Fig.Q1(b) by harmonic series. **(08 Marks)**

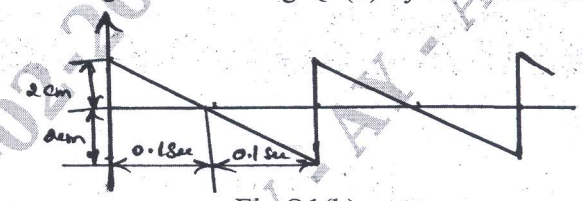

Fig.Q1(b)

OR

2 a. Define vibration. List the root causes of vibrations and different methods of eliminating undesirable vibrations. **(04 Marks)**

b. The motion of a particle is x = 5 sin wt. Show the relative position and magnitudes of the displacements velocity and acceleration vector at time t = 0 when (i) w = 0.5 rad/sec (ii) w = 2 rad/sec. **(06 Marks)**

c. A harmonic motion is given by the equation $x(t) = 5\sin(15t - \pi/4)$ cm where phase angle is in radians and t in seconds. Find
(i) Period of motion (ii) Frequency (iii) Maximum displacement, velocity and acceleration. **(06 Marks)**

Module-2

3 a. Determine the natural frequency of the system shown in Fig.Q3(a) by energy method.

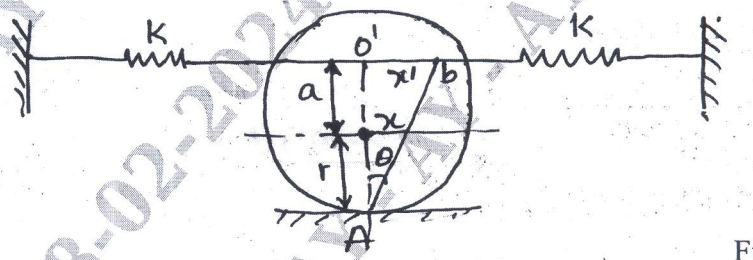

Fig.Q3(a) **(08 Marks)**

b. Determine the natural frequency of spring mass system taking the mass of the spring into account. **(08 Marks)**

OR

4 a. A spring mass-dash-pot system is given an initial velocity of $X\omega_n$ where ω_n is the underdamped natural frequency of the system. Find the equation of motion for the system when (i) $\xi = 2.5$, (ii) $\xi = 1$, (iii) $\xi = 0.5$. **(10 Marks)**

b. Discuss the response of critically damped system using respective response equations. **(06 Marks)**

Module-3

5 a. With sketch explain working of vibrometer, also deduce amplitude ratio with plots. **(08 Marks)**

b. A disc of mass 4kg is mounted midway between bearings which may be assumed simple support. The bearing span is 50cm, shaft diameter 10mm and is horizontal. The CG of disc is displaced by 2mm from GC (Geometric Centre). The equivalent viscous damping of the centre may be assumed as 50M-s/m. If shaft rotates at 250rpm. Determine maximum stresses and power required to drive the shaft at this speed. **(08 Marks)**

OR

6 a. Derive an expression for amplitude ratio and phase angle of an absolute support motion and draw the characteristic curves and explain. **(08 Marks)**

b. A vehicle of mass 490kg and total spring constant of suspension is 60kN/m. The profile of the road may be approximated to a line curve of amplitude 4cm and wavelength 4m. Determine the critical speed of the vehicle, the amplitude of the steady motion when the vehicle is driven at critical speed with $\xi = 0.5$ and also amplitude of the steady motion when the vehicle is driven at 57 km/hr with $\xi = 0.5$. **(08 Marks)**

Module-4

7 a. With help of suitable sketches illustrate the working of the following :
(i) Dynamic Vibration Absorber (ii) Dynamics of reciprocating engines. **(10 Marks)**

b. Describe the principle modes and normal modes of vibration. **(06 Marks)**

OR

8 a. Derive an expression for the free longitudinal vibration of a uniform bar of length L, one end of which is fixed and the other end free. **(08 Marks)**

b. Find the frequency and normal modes of transverse vibration of a simply supported beam of length L. **(08 Marks)**

Module-5

9 Using Stodola method, determine the lowest natural frequency of the four degree of freedom of spring mass system shown in Fig.Q9.

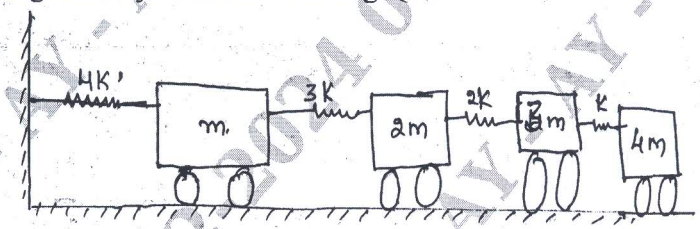

Fig.Q9 **(16 Marks)**

OR

10 a. Explain Dunkerly's method of determining the fundamental natural frequency of a multidegree freedom system. **(08 Marks)**

b. Find the lowest natural frequency of vibration for the system shown in Fig.Q10(b) by Rayleigh's method. $E = 1.96 \times 10^{11}$ N/m^2, $I = 4 \times 10^{-7}$ m^4.

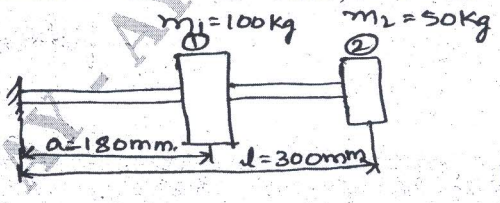

Fig.Q10(b) **(08 Marks)**

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