CBCS SCHEME

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17AU82

Eighth Semester B.E. Degree Examination, Jan./Feb. 2023

Mechanical Vibrations

Time: 3 hrs. Max. Marks: 100

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Explain the following terms:
(i) Causes of vibration (ii) Control of vibration (iii) Beats phenomenon **(06 Marks)**

b. Superimpose the Harmonic motions analytically:
$x_1 = 2\cos(\omega_n t + 0.5)$, $x_2 = 5\sin(\omega_n t + 1.0)$ **(14 Marks)**

OR

2 a. Determine the natural frequency of simple pendulum :
(i) Neglecting the mass of rod by energy method
(ii) Considering the mass of rod by Newton's method **(10 Marks)**

b. A block of mass 0.05 kg of suspended from a spring having a stiffness of 25 N/m. The block is displaced downward from its equilibrium position through a distance of 2 cm and released with an upward velocity of 3 cm/sec. Determine:
(i) Natural frequency (ii) Period of oscillation
(iii) Maximum amplitude of vibration (iv) Maximum velocity
(v) Maximum acceleration (vi) Phase angle **(10 Marks)**

Module-2

3 a. Determine suitable expression for equation of motion of the damped vibrating system as shown in Fig.Q3(a). Find the critical damping coefficients, when a = 0.10 m, b = 0.13 m, K = 4900 N/m and M = 1.5 kg.

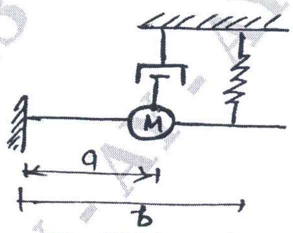

Fig.Q3(a) **(10 Marks)**

b. Derive the expression of logarithmic decrement. Show that $\sigma = \frac{1}{n}\log_e \frac{X_0}{X_n}$, where '$X_0$' is amplitude at particular maximum and X_n is amplitude after 'n' cycles. **(10 Marks)**

OR

4 a. A steel shaft of diameter 2.5 cm and length 1 m is supported at the two ends in bearings. It carries a turbine disc of mass 20 kg and eccentricity 0.005 m, at the middle and operates at 6000 rpm. The damping in the system is equivalent to viscous damping with $\xi = 0.01$. Determine the whirl amplitude of disc at: (i) Operating speed (ii) Critical speed (iii) 1.5 times critical speed. Take E = 207 GPa. **(10 Marks)**

b. Obtain an expression for whirling of shaft with air damping. **(10 Marks)**

Module-3

5 a. A mass of 100 kg been mounted on a spring dashpot system having spring stiffness of 19600 N/m and the damping coefficient of 100 N.sec/m. The mass is acted upon by harmonic force of 39 N at the undamped natural frequency of the system. Determine:
(i) Amplitude of vibration of the mass
(ii) Phase difference between force and displacement
(iii) Force transmissibility ratio **(12 Marks)**

b. Explain the following terms: (i) Vibration isolation (ii) Transmissibility **(08 Marks)**

OR

6 a. A mass of 6 kg suspended by a spring of stiffness 1180 N/m is forced to vibrate by the harmonic force 10 N. Assuming viscous damping coefficients of 85 Nsec/m. Determine:
(i) Resonant frequency
(ii) Amplitude at resonance
(iii) Phase angle at resonance
(iv) Frequency corresponding to the peak amplitude
(v) Peak amplitude and phase angle corresponding to the peak amplitude **(12 Marks)**

b. Show that providing damping in vibration isolation is not useful when the frequency ratio is more than 1.414 or $\sqrt{2}$. **(08 Marks)**

Module-4

7 a. Explain the following terms:
(i) Semi-definite system (ii) Coordinate coupling (iii) Vibration absorber **(12 Marks)**

b. Use Lagrange's equation to find the natural frequency and amplitude ratio of the system shown in Fig.Q7(b).

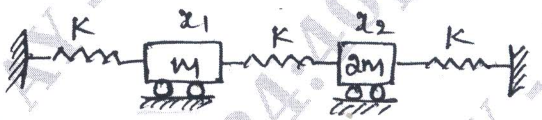

Fig.Q7(b) **(08 Marks)**

OR

8 a. What do you understand by seismic instrument? Explain the theory of seismic instrument giving the conditions under which the instrument can be used as an accelerometer and as vibrometer. **(10 Marks)**

b. An accelerometer with a damped natural frequency of vibration of 160 Hz has a suspended mass of 0.02 kg. When it is mounted on an engine, which is undergoing an acceleration of 10 m/sec^2 at an operating speed of 6500 rpm, the acceleration records in the instrument is 9.75 m/sec^2. Determine damping constant and spring stiffness of the accelerometer. **(10 Marks)**

Module-5

9 Using Holzer method, find the natural frequencies of the system as shown in Fig.Q9. Assume $m_1 = m_2 = m_3 = 1$ kg and $K_1 = K_2 = K_3 = 1$ N/m.

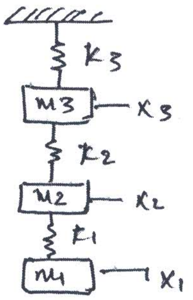

Fig.Q9 **(20 Marks)**

OR

10 a. Determine the natural frequencies of spring mass system in Fig.Q10(a) by Dunkerley's method.

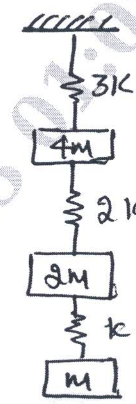

Fig.Q10(a) **(10 Marks)**

b. Determine the influence coefficients of triple pendulum shown in Fig.Q10(b).

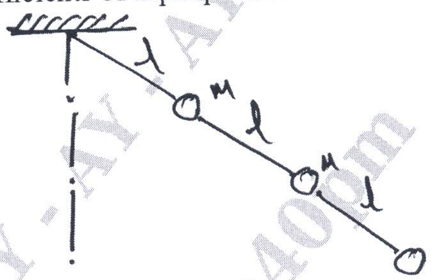

Fig.Q10(b) **(10 Marks)**

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