CBCS SCHEME

USN | | | | | | | | | | 15AU82

Eighth Semester B.E. Degree Examination, Feb./Mar. 2022
Mechanical Vibrations

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Explain the following: (i) Control of vibration (ii) Types of vibration **(08 Marks)**

b. Superimpose the harmonic motions analytically: $x_1 = 2\cos(w_n t + 0.5)$, $x_2 = 5\sin(w_n t + 1.0)$. **(08 Marks)**

OR

2 a. Explain equivalent stiffness of spring combination:
(i) Spring in series (ii) Spring in parallel **(06 Marks)**

b. Determine 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)**

Module-2

3 a. Define logarithmic decrement and derive an expression for logarithmic decrement. **(08 Marks)**

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

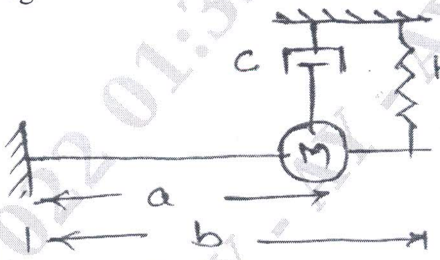

Fig.Q3(b) **(08 Marks)**

OR

4 a. Obtain an expression for whirling of shaft with air damping. **(08 Marks)**

b. A steel shaft of diameter 2.5 cm and length 1m 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. **(08 Marks)**

Module-3

5 a. Define the following terms:
(i) Vibration isolation
(ii) Magnification factor
(iii) Transmissibility **(06 Marks)**

b. A machine of total mass 200 kg is supported on springs of total stiffness 16000 N/cm has an unbalanced rotating element which results in disturbing force 800 N at a speed of 300 rpm. Assuming $\xi = 0.3$. Determine:
   (i) Amplitude of motion due to unbalance
   (ii) Transmissibility
   (iii) Transmitted force **(10 Marks)**

OR

6 a. Show that providing damping in vibration isolation is not useful when the frequency ratio is more than 1.414 or $\sqrt{2}$. **(06 Marks)**

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

Module-4

7 a. Obtain the natural frequencies of the double pendulum as shown in Fig.Q7(a). Assume $\ell_1 = \ell$ and $\ell_2 = 2\ell$, $m_1 = m_2 = m$.

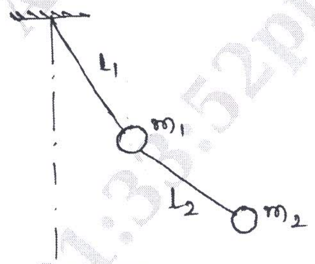

Fig.Q7(a) **(08 Marks)**

b. What is dynamic absorber? Show that when excitation frequency is equal to the natural frequency of absorber system, the amplitude of main system is zero. **(08 Marks)**

OR

8 a. Discuss the principle of operation of seismic instrument with a neat sketch. **(08 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 recorded in the instrument is 9.75 m/sec^2. Determine the damping constant and the spring stiffness of the accelerometer. **(08 Marks)**

Module-5

9 a. Determine the influence coefficients of the triple pendulum shown in Fig.Q9(a).

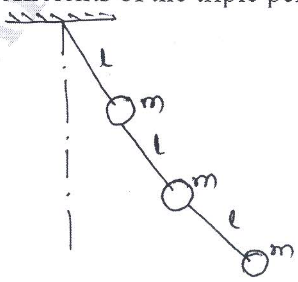

Fig.Q9(a) **(08 Marks)**

b. Determine the natural frequencies of spring mass system in Fig.Q9(b) by Dunkerley's method.

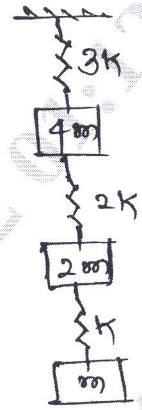

Fig.Q9(b) **(08 Marks)**

OR

10 Using Holzer method, find the natural frequencies of the system as shown in Fig.Q10. Assume $m_1 = m_2 = m_3 = 1$ kg and $k_1 = k_2 = k_3 = 1$ N/m.

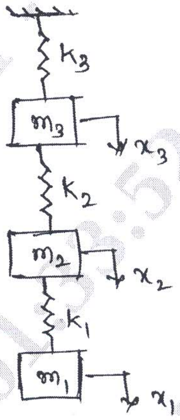

Fig.Q10 **(16 Marks)**

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