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10ME72

Seventh Semester B.E. Degree Examination, July/August 2021

Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

Note: Answer any FIVE full questions.

1 a. Add the following motions analytically $x_1 = 4\cos(\omega t + 10^\circ)$, $x_2 = 6\sin(\omega t + 60^\circ)$ **(06 Marks)**

b. A harmonic motion has amplitude of 0.05 m and a frequency of 10 Hz. Find its period, maximum velocity and maximum acceleration. **(04 Marks)**

c. Represent the periodic motion given in Fig.Q1(c) by harmonic series.

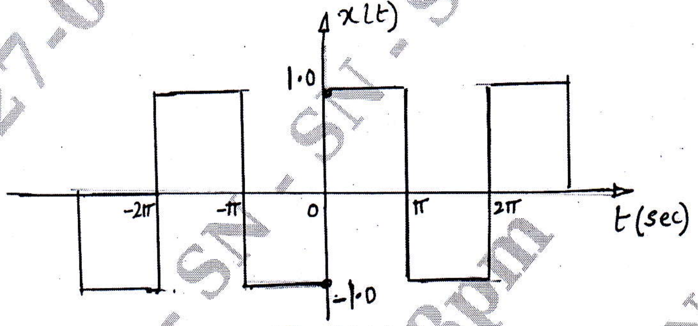

Fig.Q1(c) **(10 Marks)**

2 a. Determine the natural frequency of a simple spring mass system by:
(i) Newton's method (ii) Energy method (iii) Rayleigh's method **(10 Marks)**

b. Determine the natural frequency of the simple pendulum:
(i) If the mass of the rod is negligible
(ii) If the mass of the rod is considered **(10 Marks)**

3 a. The mass of a spring-mass-dashpot is given an initial velocity (from the equilibrium position) of AW_n where W_n is the undamped natural frequency of the system. Find the equation of motion for the system when (i) $\xi = 1.0$ (ii) $\xi = 0.3$. **(10 Marks)**

b. Determine:
(i) Critical damping coefficient (ii) Damping factor
(iii) Natural frequency of the damped vibration (iv) Logarithmic decrement
(v) Ratio of two consecutive amplitudes of a vibrating system which consists of a mass of 25 kg, a spring of stiffness 15 kN/m and a damper. The damping provided is only 15% of the critical value. **(10 Marks)**

4 a. Define transmissibility. Derive the expression for force transmissibility, with the characteristic plots of T.R. versus frequency ratio for different damping factor. **(10 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 a disturbing force of 800 N at a speed of 3000 rpm. Assuming $\xi = 0.2$. Determine:
(i) Amplitude of motion due to unbalance
(ii) Transmissibility
(iii) Transmitted force **(10 Marks)**

5 a. Explain the principles of vibration measuring instrument and indicate the conditions for using it as a vibrometer and as an accelerometer. **(08 Marks)**

b. A vertical shaft 1.5 cm diameter and 100 cm long is held in long bearings. The weight of the disc at the centre of the shaft is 16 kg. The eccentricity of the centre of gravity of the disc from the centre of the rotor is 0.05 cm. Neglecting the mass of the shaft, find:

(i) Critical speed of the shaft

(ii) Range of speed over which it is unsafe to run the shaft. Take permissible stress in the shaft material as 70 MN/m^2, E = 200 GPa. **(12 Marks)**

6 a. A reciprocating machine of mass M runs at a constant speed of N rpm. After it was installed, it was found that the forcing frequency is too close to natural frequency of the system. What dynamic vibration absorber should be added, if the nearest natural frequency of the system be at least 25% from the impressed frequency? **(08 Marks)**

b. For the system shown in Fig.Q6(b), determine:
(i) Equation of motion (ii) Natural frequencies (iii) Norma modes of system

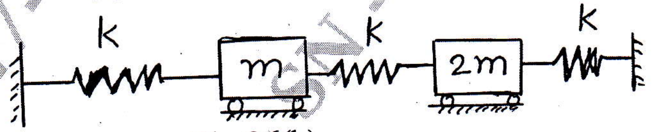

Fig.Q6(b) **(12 Marks)**

7 a. Find the influence coefficients of the system shown in Fig.Q7(a).

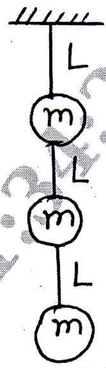

Fig.Q7(a) **(08 Marks)**

b. Using Stodala method find the first natural frequency and mode shape of the shaft with three rotors as shown in Fig.Q7(b).

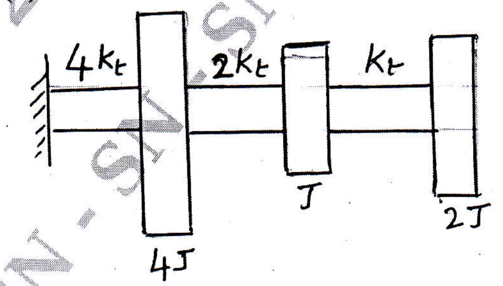

Fig.Q7(b) **(12 Marks)**

8 a. What is machine condition monitoring? Explain machine condition monitoring techniques. **(10 Marks)**

b. Explain in detail experimental modal analysis. **(10 Marks)**

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