CBCS SCHEME

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18CAE/MDE12

First Semester M.Tech. Degree Examination, June/July 2019
Advanced Theory of Vibrations

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. What is the effect of mass of a spring on its natural frequency? Derive. **(10 Marks)**

b. A vibratory body of mass 150 kg supported on springs of total stiffness 1050 kN/m has a rotating unbalance force of 525 N at a speed of 6000 rpm. If damping factor = 0.3. Determine: (i) Amplitude of vibration and phase angle (ii) Transmissibility ratio (iii) Force transmitted to foundation. **(10 Marks)**

OR

2 a. A gun barrel having mass 560 kg is designed with the following data. Initial recoil velocity 36 m/sec, recoil distance on firing 1.5 m. calculate: (i) Spring constant (ii) damping coefficient (iii) time required for the barrel to return to a position of 0.12 m from its initial position. **(10 Marks)**

b. The seat of helicopter, with the pilot, weighs 1000 N and is found to have a static deflection of 10 mm under self-weight. The vibration of the rotor is transmitted to the base of the seat as harmonic motion with frequency 4 Hz and amplitude 0.2 mm.

i) What is the level of vibration felt by the pilot?

ii) How can the seat be redesigned to reduce the effect of vibration? **(10 Marks)**

Module-2

3 a. Explain the various equipments needed for experimental modal analysis with sketch. **(10 Marks)**

b. A vibration measuring instrument is used with a machine running at 120 rpm. The natural frequency of instrument is 5 Hz and it records a relative amplitude of 0.004 cm. Calculate the displacement, velocity of acceleration of the machine (neglect damping). **(10 Marks)**

OR

4 a. Explain briefly machine condition monitoring techniques. **(10 Marks)**

b. A vibrometer indicate 2% error in measurement and its natural frequency is 5 Hz. If the lowest frequency that can be measured is 40 Hz, find the value of damping factor 'ξ'. **(10 Marks)**

Module-3

5 a. Determine the response of a single DOF system to the step excitation as shown in Fig.Q5(a).

Fig.Q5(a) **(10 Marks)**

b. A single DOF system with natural frequency $\omega_n = \sqrt{\frac{k}{m}}$ and damping $\xi = 0.2$ is excited by the force

$$F(t) = F\cos\frac{1}{2}\omega_n t + F\cos\omega_n t + F\cos\frac{3}{2}\omega_n t$$
$$= \sum_{m=\frac{1}{2},1,\frac{3}{2}} F\cos m\omega_n t$$

Determine the mean square response and compare the output spectrum with that of the input. **(10 Marks)**

OR

6 a. Write a note on shock isolation. **(08 Marks)**

b. A random single has a spectral density that is a constant S(f) = 0.004 cm^2/cps between 20 and 1200 cps and that is zero outside this frequency range. Its mean value is 2.0 cm. Determine its rms value and its standard deviation. **(12 Marks)**

Module-4

7 a. Determine the phase plane of a single DOF oscillator $\ddot{x} + \omega^2 x = 0$. **(10 Marks)**

b. Explain briefly the sources of non-linearity. **(10 Marks)**

OR

8 a. Determine the nature and stability of the equilibrium positions of the system of Fig.Q8(a).

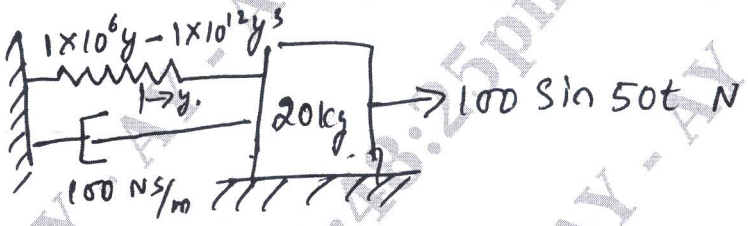


Fig.Q8(a) **(10 Marks)**

b. Explain briefly self-excited vibration. **(10 Marks)**

Module-5

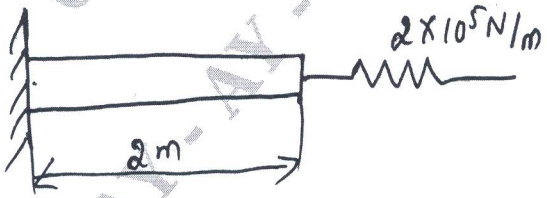
9 a. Determine the natural frequencies and mode shapes of a free-free rod (a rod with both ends free). **(10 Marks)**

b. Derive the general solution for the torsional vibration of a circular shaft. **(10 Marks)**

OR

10 a. Determine the natural frequencies of vibration of a uniform beam clamped at one end and free at the other. **(10 Marks)**

b. Determine the lowest natural frequency of longitudinal motion for the system of Fig.Q10(b).



$A = 3 \times 10^{-6}\ m^2$
$E = 200 \times 10^9\ N/m^2$
$\rho = 7800\ kg/m^3$

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

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