CBCS SCHEME

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15AU82

Eighth Semester B.E. Degree Examination, November 2020
Mechanical Vibrations

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions irrespective of modules.

Module-1

1 a. Define the following :
   i) Natural frequency
   ii) Resonance
   iii) Degrees of freedom
   iv) Longitudinal vibration
   v) Transient vibration. **(05 Marks)**

b. Define simple Harmonic motion and obtain velocity and displacement equation. **(03 Marks)**

c. Add the following harmonic motions analytically and check the solution graphically. $x_1 = 4\cos(wt + 10^\circ)$ and $x_2 = 6\sin(wt + 60^\circ)$. **(08 Marks)**

2 a. Determine the natural frequency of a spring mass system. Where the mass of the spring is also to be taken into account. **(09 Marks)**

b. Determine the natural frequency of the system shown in Fig Q2(b). Using Energy Method.

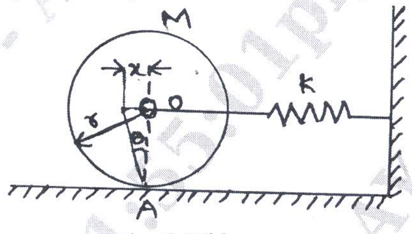


Fig Q2(b) **(07 Marks)**

Module-2

3 a. What is the need of Damping? Name different types of damping. **(02 Marks)**

b. Set up the differential equation for a spring mass damper system and obtain complete solution for over damped system. **(10 Marks)**

c. Vibrating system consisting of a mass of 50kg, a spring of stiffness 30kN/m and a damper. Damping is 20% of the critical value. Determine :
   i) Damping factor
   ii) Critical Damping coefficient
   iii) Logarithmic decrement
   iv) Ratio of two consecutive amplitudes. **(04 Marks)**

4 a. Define whirling speed and obtain an Expression for whirling speed of shaft without air damping. **(08 Marks)**

b. Explain the following with suitable equations
   i) Damping Ratio ii) Logarithmic decrement. **(03 Marks)**

c. A steel shaft simply supported in bearings 50mm diameter and 1.5m long, carries a solid rotor of weight 1600N at its centre. Find its critical speed in rpm if $E = 200\ GN/m^2$. **(05 Marks)**

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-3

5 a. Define forced vibration and explain the term Magnification Factor (MF) with suitable notations. **(04 Marks)**

b. Obtain the solution for spring, mass, damper system, excited by a rotating unbalance of a machine. **(08 Marks)**

c. Explain the term vibration Isolation. **(04 Marks)**

6 a. Derive the expression for absolute motion of a system excited by base or support. **(08 Marks)**

b. A machine of total mass 17kg is mounted on springs having stiffness k = 11,000 N/cm. A piston within the machine has a mass of 2kg has a reciprocating motion with stroke 7.5cm and speed 6000 rpm. Assuming the motion to be SHM. Determine :

i) Amplitude of machine
ii) Transmissibility
iii) Force transmitted to the ground.

Take $\xi = 0.2$ **(08 Marks)**

Module-4

7 a. For the system shown in Fig Q7(a).

i) Derive the equation of motion
ii) Set up frequency equation and obtain natural frequencies of the system.

Neglect the inertia of wheels and friction between wheel and surface.

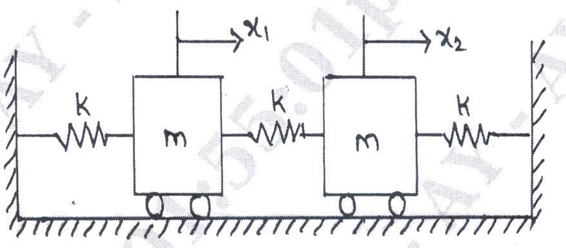


Fig Q7(a) **(08 Marks)**

b. A machine part vibrates with large amplitudes when the compressor speed is 250rpm. To study the vibration, a spring, mass system is suspended from the machine part to act as an absorber. A 2kg absorber mass tuned to 250cpm resulted in two resonant frequencies of 200 and 300cpm. Determine the equivalent spring and mass constants for machine part. **(08 Marks)**

8 a. With a neat sketch explain the concept of Fullarton Tachometer. **(06 Marks)**

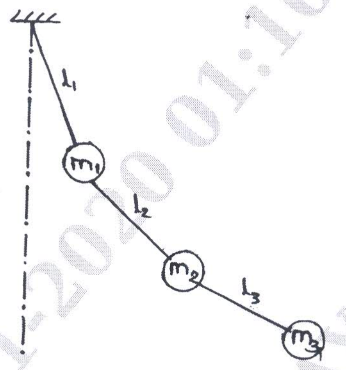
b. A vibrometer having a natural frequency of 5 rad/sec and $\xi = 0.25$ is attached to a structure that performs an harmonic motion. If the difference between the maximum and minimum recorded values is 10 mm. Find the amplitude of motion of the vibrating structure when its frequency is 50 rad/sec. **(04 Marks)**

c. A vibration pickup has a natural frequency of 7.5Hz and a damping factor of 0.5. Determine the Lowest frequency beyond which the amplitude can be measured within 1% error. **(06 Marks)**

Module-5

9 a. State and prove Maxwell's reciprocal theorem. **(06 Marks)**

b. Determine the influence coefficients for the system shown in Fig Q9(b)



$m_1 = m$
$m_2 = 2m$
$m_3 = 3m$
$\ell_1 = \ell_2 = \ell_3 = \ell$

Fig Q9(b) **(10 Marks)**

10 a. Using Stodola's method find the fundamental mode of vibration and its natural frequency of the spring mass system shown in Fig Q10(a). For $k_1 = k_2 = k_3 = 1N/m$ and $m_1 = m_2 = m_3 = 1kg$.

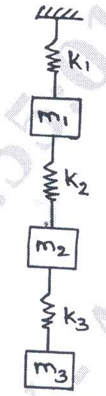


Fig Q10 (a)

(10 Marks)

b. A shaft carries 3 discs of mass 15kg, 25kg and 35kg. The deflection of shaft under each disc. When all the 3 discs are in position is 1.75×10^{-5}m. The fundamental natural frequency of transverse vibration. (Rayleigh's Method). **(06 Marks)**

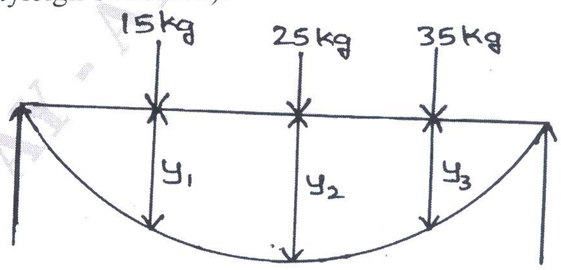


Fig Q10 (b)

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