10AU73

Seventh Semester B.E. Degree Examination, Aug./Sept. 2020
Mechanical Vibrations and Vehicle Dynamics

Time: 3 hrs. Max. Marks:100

Note: *Answer any FIVE full questions, selecting at least TWO questions from each part.*

PART – A

1 a. A body is subjected to two harmonic motions $x_1 = 15 \sin(wt + \frac{\pi}{6})$; $x_2 = 8 \cos(wt + \frac{\pi}{6})$.

   b. What harmonic is to be given to the body to bring it to equilibrium? **(08 Marks)**
      Explain the rectangular wave shown in fig. Q1(b) in Fourier series.
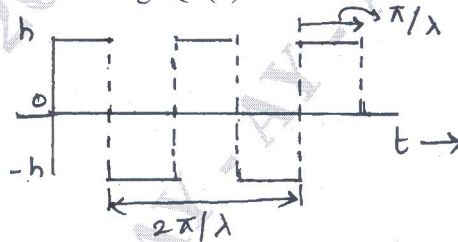

Fig. Q1(b) **(06 Marks)**

   c. Classify the vibration for following examples
      (i)   Vibration of cantilever beam
      (ii) Up and down motion of spring mass system
      (iii) Twisting of disc on the shaft. **(03 Marks)**

   d. Define the following:
      (i)   Degrees of freedom
      (ii) Resonance
      (iii) Non – linear vibrations. **(03 Marks)**

2 a. A solid wooden cylinder of diameter D and heigh H floats partially immersed in water. Find the natural frequency of free vertical oscillations of the cylinder. **(05 Marks)**

   b. A circular cylinder of radius R and mass M is held by spring as shown in fig. 2(b). if the body rolls on horizontal surface, write the equation of motion using Energy method.
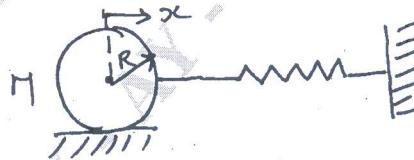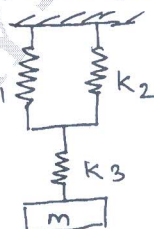

Fig.Q2(b)

   Also find out the equivalent mass of system. **(06 Marks)**

   c. Obtain the natural frequency of the system as shown in fig. 2(c).

m = 109N
k_1 = 10 N/mm
k_2 = 10 N/mm
k_3 = 5 N/mm

Fig.Q2(c) **(09 Marks)**

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3 a. An under damped shock absorber is to be designed for a motor cycle of mass 200kg. When a shock absorber is subjected to an initial velocity (vertical) due to road bump, the resulting displacement – time curve is as shown fig, Q3(a). Find the necessary stiffness and damping constants of the shock absorber if the damped period of vibration is to be 2s and the amplitude x_1 is to be reduced to one – fourth in one half cycle (i.e $x_{1.5} = x_1/4$). **(10 Marks)**
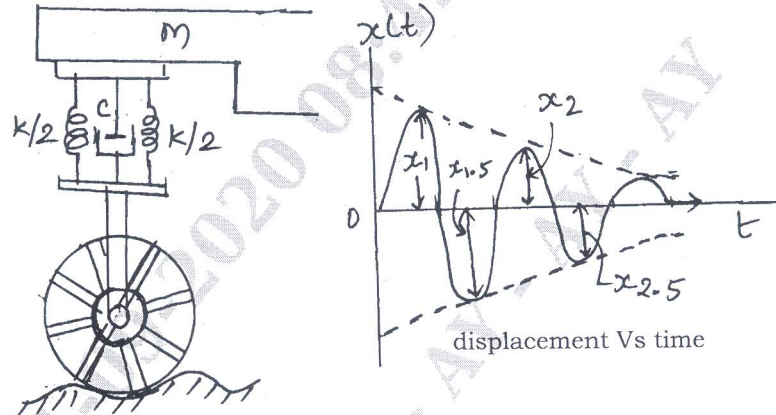
Fig, Q3(a)

Also find the minimum initial velocity that leads to a maximum displacement of 250mm.

b. With suitable graph, explain the different types of stability of the system. **(05 Marks)**

c. Show that the logarithmic decrement can be depressed as $\delta = \dfrac{1}{n}\left(\log_e \dfrac{x_0}{x_n}\right)$. Also show that, if the number of cycles needed for the amplitude to diminish by half is n, then n = 0.1103/n. **(05 Marks)**

4 a. What do you mean by forced vibration and explain term magnification factor (MF) with usual mathematical notation. **(04 Marks)**

b. A 5kg mass is placed at the end of a 300mm long steel beam as shown in Fig Q4(b). the Young's modulus of elasticity of steel is 200GPa and the moment of inertia of beam $10^{-8}m^4$. When the system is excited by a harmonic excited force of 150N, an amplitude of 0.5mm is observed. Find the frequency of excitation.
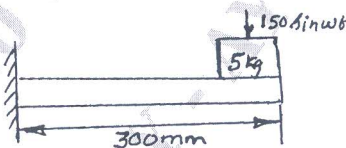

Fig Q4(b) **(06 Marks)**

c. A machine of total mass 68kg mounted on springs of stiffness K = 11,000N/cm. with an assumed damping factor $\xi = 0.2$. A piston within the machine has a mass of 2 kg has a reciprocating motion with stroke 7.5cm and a speed of 3000rpm. Assuming the motion of piston to be SHM. determine :
   i) Amplitude of machine
   ii) Phase angle with respect to exciting force
   iii) Transmissibility and force transmitted to foundation
   iv) Phase angle of transmitted force with respect to exciting force. **(10 Marks)**

PART – B

5 a. Why we need to measure vibration? And explain measurement scheme? **(05 Marks)**
   b. Explain Frahm tachometer with a neat diagram. **(05 Marks)**
   c. Obtain an expression for whirling of shaft with air damping. **(10 Marks)**

6 a. Explain system with 2 degrees of freedom, neat diagram for different examples? (Any two).
(05 Marks)

b. For the system shown in Fig Q 6(b)
   i) Derive the equation of motion.
   ii) Set up frequency equation and obtain natural frequency of the system
   iii) Obtain modal vectors
   iv) Draw mode shapes
   Neglect the inertia of wheels and friction between wheel and surface.
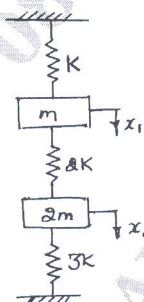
FigQ6(b) (15 Marks)

7 Determine the normal modes of vibration if the automobile is simulated by the simplified two degree of freedom system as shown in Fig.Q7 with the following numerical values:
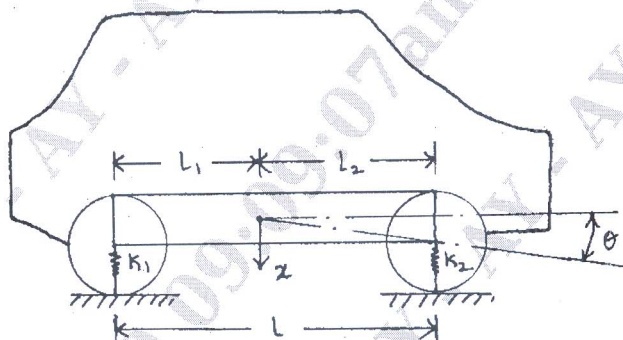m = 1500 kg, l_1 = 1.35 m, l_2 = 1.65 m, l = 3m, k = 1.2 m, k_1 = 35 × 10³ N/m and k_2 = 40 × 10³ N/m.

Fig.Q7 (20 Marks)

8 What is Stodola's method? Explain their steps and also find the fundamental mode of vibration and its natural frequency of the spring mass system as shown in Fig.Q8 with $k_1 = k_2 = k_3 = 1$ N/m and $m_1 = m_2 = m_3 = 1$ kg.

Fig.Q8 (20 Marks)

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