CBCS SCHEME

USN | | | | | | | | | | 18AE56

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022
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. Add the following harmonics analytically and check the solution graphically:
$x_1 = 3\sin(wt + 30°)$
$x_2 = 4\cos(wt + 10°)$ **(10 Marks)**

b. Explain the phenomenon of the beats. **(10 Marks)**

OR

2 a. Represent the periodic motion given in Fig.Q.2(a) by Harmonic series. **(12 Marks)**

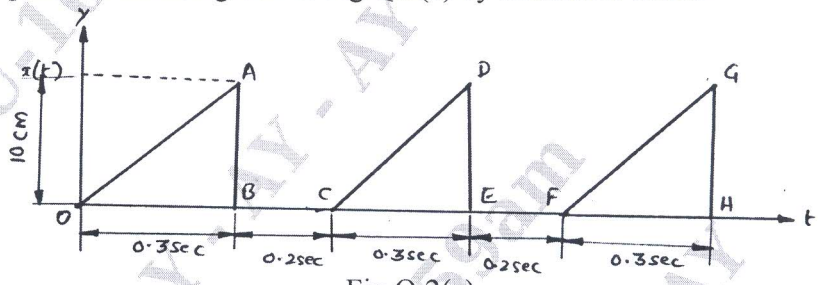

Fig.Q.2(a)

b. Explain the types of vibration. **(08 Marks)**

Module-2

3 a. Determine the natural frequency of a spring mass system where the mass of the spring is also to be taken into account. **(10 Marks)**

b. The solution to the differential equation for single degree freedom motion is given by $x = X\cos(100t + \phi)$ with initial condition $\dot{x}_{(0)} = 1250\text{mm/sec}$ and $x_{(0)} = 0.25\text{mm}$. Find the values of X and ϕ and express the given equation in the form $x = A\sin w_n t + B\cos w_n t$. **(10 Marks)**

OR

4 a. Define logarithm decrement and prove that the logarithmic decrement $\delta = \frac{1}{n} \ell n \frac{x_0}{x_n}$, where x_0 is the initial and x_n is the amplitude after 'n' cycles. **(10 Marks)**

b. A mass of 7.5kg hangs from a spring and makes damped oscillations. The time for 60 oscillations is 35secs and the ratio of first to seventh displacement is 2.5. Find the following:
i) Stiffness of spring
ii) Damping resistance
iii) Critical damping resistance
iv) Damping factor. **(10 Marks)**

Module-3

5 a. What is magnification factor? Derive an expression for the same and discuss its variation with frequency ratio. **(10 Marks)**

b. A machine of total mass 68kg mounted on springs of stiffness 11,000 N/cm. With an assumed damping factor of 0.2. A piston within the machine has a mass of 2kg has a reciprocating motion with stroke 7.5cm and a speed of 3000rpm. Assuming the motion of piston to be S.H.M. Determine:

i) Amplitude of motion.
ii) Phase angle with respect to exciting force.
iii) Transmissibility and force transmitted to ground.
iv) Phase angle of transmitted force with respect to exciting force. **(10 Marks)**

OR

6 a. Derive an expression for critical speed of whirling of shafts without air damping. **(10 Marks)**

b. 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 i) 1% error ii) 2% error. **(10 Marks)**

Module-4

7 a. Fig.Q.7(a) shows a system subjected to vibration. Find an expression for the natural frequency. Locate the mode and draw mode shapes. **(12 Marks)**

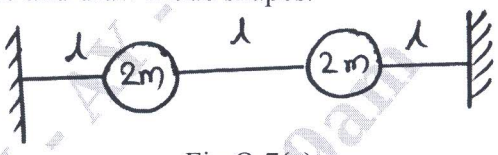

Fig.Q.7(a)

b. Explain the following:

i) Principal modes and normal modes of vibration
ii) Coordinate coupling. **(08 Marks)**

OR

8 a. For the rotor system shown in Fig.Q.8(a), find the natural frequencies and mode shapes. **(10 Marks)**

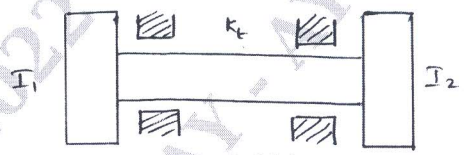

Fig.Q.8(a)

b. For the system shown in Fig.Q.8(b), obtain the equations of motion. Also obtain the condition for system not to have elastic coupling. **(10 Marks)**

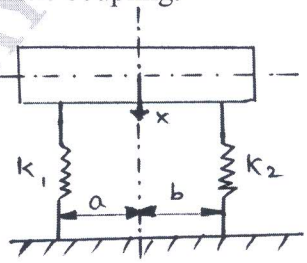

Fig.Q.8(b)

Module-5

9 a. State and prove Maxwell's reciprocal theorem. **(08 Marks)**

b. For the system shown in Fig.Q.9(b), find the lowest natural frequency by Stodola's method.

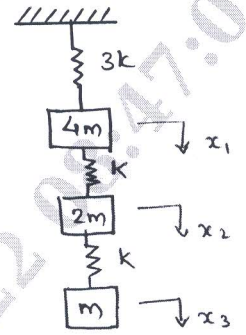

Fig.Q.9(b)

(12 Marks)

OR

10 Find all the natural frequencies of the four degree of freedom system shown in Fig.Q.10 by using Holzer's method.

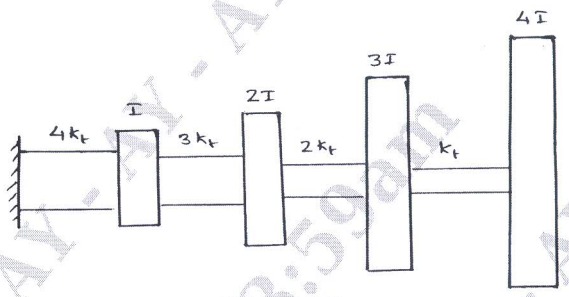

Fig.Q.10

(20 Marks)

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