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10AE65

Sixth Semester B.E. Degree Examination, June/July 2019
Theory of Vibrations

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Name and explain the causes of vibrations. **(04 Marks)**

b. Add the following harmonic motions analytically and check the solution graphically $x_1 = 3\sin(\omega t + 60)$, $x_2 = 4\cos(\omega t + 10)$. **(06 Marks)**

c. Explain the phenomenon of Beats with suitable sketches. **(04 Marks)**

d. Develop the Fourier series for the curve show in Fig.Q1(d).

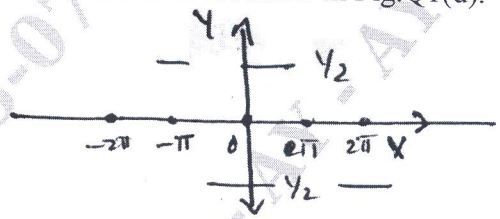

Fig.Q1(d) **(06 Marks)**

2 a. Define the terms:
i) Degree of freedom ii) Resonance
iii) Damping iv) Free and forced vibrations **(04 Marks)**

b. Determine the natural frequency of spring mass system taking the mass of the spring into account. **(06 Marks)**

c. A 'U' tube as shown in Fig.Q2(c) contains liquid of density 'ρ'. Determine the equation of motion.

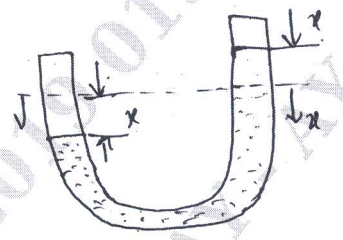

Fig.Q2(c) **(04 Marks)**

d. Using energy method, determine the natural frequency of the system shown in Fig.Q2(d).

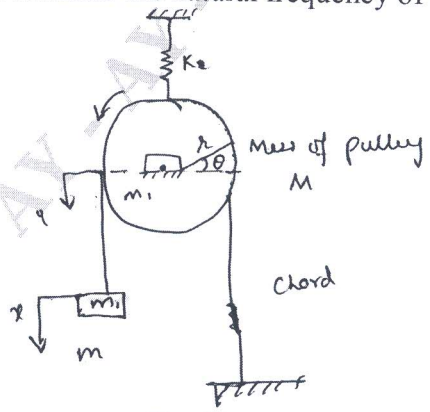

Fig.Q2(d) **(06 Marks)**

3 a. Explain viscous, coulomb, structural and interfacial damping. **(04 Marks)**

b. 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 0.12 m from its initial position. **(10 Marks)**

c. Derive the equation for damped free vibration and solve for critical damping system. **(06 Marks)**

4 a. Define the transmissibility ratio and show that transmissibility ratio

$$\in = \sqrt{\frac{1+(2\xi W/Wn)^2}{1-(W/Wn^2)^2+(2\xi W/Wn)^2}}$$ **(08 Marks)**

b. The vibrations of the platform of railway station are periodic at the frequency range of 12-50 Hz. A vibration measuring instrument is to be installed on some foundation independent of the platform. The small foundation is supported by four identical springs resting on the platform. The total mass of the instrument and foundation is 50 kg. What is the maximum value of spring stiffness, if the amplitude of transmitted vibration is to be less than 10% of the platform vibration over the given frequency range. Take $\varepsilon = 0.20$. System is treated as single degree of freedom. **(08 Marks)**

c. Prove that an undamped measuring instrument will show a true response for frequency ratio $(\omega/\omega_n) = \frac{1}{\sqrt{2}}$. **(04 Marks)**

PART – B

5 a. Explain the working of a seismic instrument with a neat sketch. State the condition for which the instrument functions as (i) vibrometer (ii) Accelerometer. **(10 Marks)**

b. Obtain an expression for the critical speed of shaft with damping. **(10 Marks)**

6 a. Derive and explain the principal mode and normal mode vibration of an undamped two degree of freedom systems. **(14 Marks)**

b. A torsional gear system is shown in Fig.Q6(b). Determine stiffness of equivalent shaft and torsional frequency.

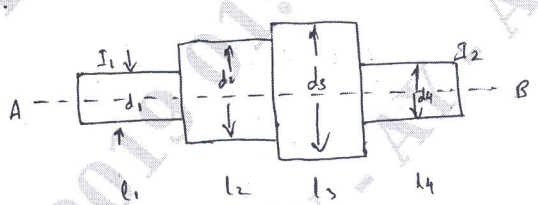

Fig.Q6(b) **(06 Marks)**

7 a. Derive the Euler's equation for beams and solve. **(10 Marks)**

b. Derive the vibration equation for string and solve. **(10 Marks)**

8 a. State and prove Maxwell's reciprocal theorem. **(05 Marks)**

b. Use Stodola's method to find the natural frequency of the system shown in Fig.Q8(b).

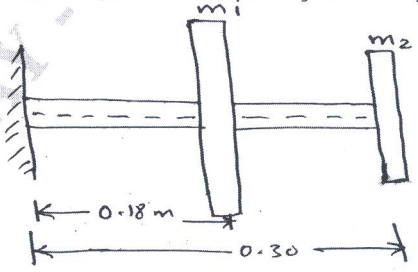

Fig.Q8(b) **(15 Marks)**

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