USN

06ME62

Sixth Semester B.E. Degree Examination, June 2012

Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

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

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.

PART – A

1 a. Define the following terms:
i) Resonance
ii) Simple harmonic motion.
iii) Time period. **(06 Marks)**

b. Add the following motions analytically:
$X_1 = 2\cos(wt + 0.5)$; $x_2 = 5\sin(wt + 1.0)$. **(04 Marks)**

c. Periodic motion in time domain is given by $x(t) = -20t + 2$ for $0 \le t \le 2$.
Obtain Fourier's series equation in frequency domain. **(10 Marks)**

2 a. A spring mass system has a stiffness of k N/m and a mass of M kg. It has natural frequency of vibration of 12 cps. An extra 2 kg mass is coupled to M and its net frequency becomes 10 cps. Find k and M. **(10 Marks)**

b. Determine the natural frequency of the system shown in Fig.Q2(b). The pulleys are mass-less and there is no slippage between pulley and rope.

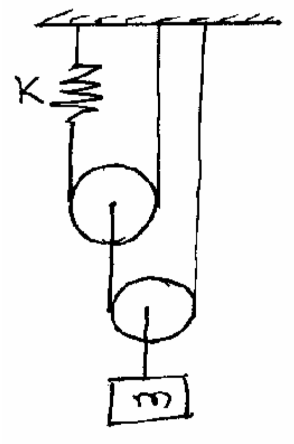


Fig.Q2(b) **(10 Marks)**

3 a. Define logarithmic decrement. Show that logarithmic decreement can be expressed as $\delta = \frac{1}{n}\log_e \frac{x_o}{x_n}$ (Derive the expression), where, x_o is amplitude at particular maximum and x_n is amplitude after 'n' cycles. **(10 Marks)**

b. A torsional pendulum has a natural frequency of 200 cpm when vibrating in vaccum (no damping). The mass moment of inertia of the disc is 2.5 kg cm^2. It is then immersed in oil and is observed that its damped natural frequency is 180 cpm. Determine the damping torque per radian per second. If the disc is displaced 3° when in oil, find its displacement at the end of first complete cycle. **(10 Marks)**

4 a. A mass of 100 kg is suspended on a spring having a stiffness of 19600 N/m and is acted upon by a harmonic force of 39.2 N at the undamped natural frequency. The damping coefficient is 98 N-s/m.
Determine:
i) Undamped natural frequency
ii) Amplitude of vibration of mass.
iii) Phase difference between force and displacement. **(10 Marks)**

b. The springs of an automobile trailer are compressed 0.1 under its own weight. Find the critical speed when the automobile is traveling over a road with a profile approximated by a sine wave of amplitude 0.08 m and a wavelength of 14 m. What will be the amplitude of vibration at 60 Km/hr. **(10 Marks)**

PART – B

5 a. A commercial vibration pick-up has a natural frequency of 5.75 cps and a damping factor of 0.65. What is the lowest frequency beyond which the amplitude can be measured within ± 1% error? **(10 Marks)**

b. A rotor having a mass of 5 kg is mounted midway on a 1 cm diameter shaft supported at ends by bearings. Bearings span is 40 cm. Eccentricity is 0.02 mm. If the system rotates at 3000 rpm find the amplitude of steady state vibrations and dynamic force transmitted to bearings. $E = 1.96 \times 10^{11}$ N/m^2. Neglect damping. **(10 Marks)**

6 a. Determine the natural frequencies and mode shapes for a system shown in Fig.Q6(a).
J_1 and J_2 are mass moment inertias of the discs. K_t is torsional stiffness of shaft. **(10 Marks)**

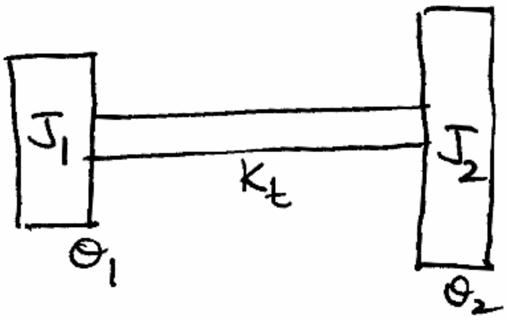


Fig.Q6(a)

b. A string is tightly stretched between two supports as shown in Fig.Q6(b). The tension T in the string may be assumed to be constant for small displacement. Obtain the two natural frequencies for the system.

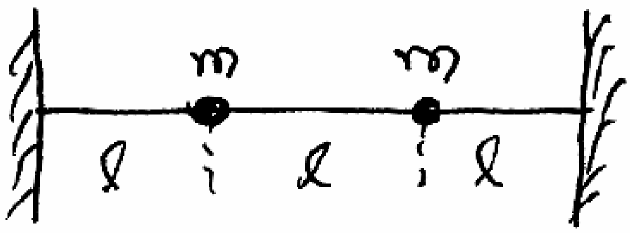


Fig.Q6(b) **(10 Marks)**

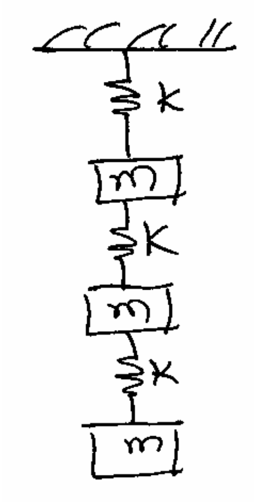
7 From the first principles show that the general solution for torsional vibration of circular shaft can be obtained as:

$$\theta = \sum_{i=1,2,3}^{\infty} \left(A_i \sin \frac{W_i\, x}{c} + B_i \cos \frac{W_i\, x}{c} \right) \left(C_i \sin W_i\, t + D_i \cos W_i\, t \right).$$

where, $C = \sqrt{\frac{G}{\rho}}$ = velocity of wave propagation G is modulus of rigidity and ρ is density.

(20 Marks)

8 a. Using stodola method find the fundamental natural frequency and mode shape of the system shown in Fig.Q8(a).



Assume k = 1 N/m
And m = 1kg.

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

b. Obtain influence coefficients for the system shown in Fig.Q8(b).

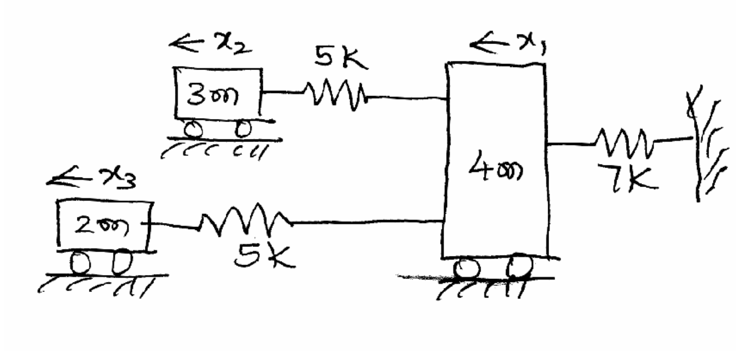


Fig.Q8(b) **(10 Marks)**

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