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Sixth Semester B.E. Degree Examination, June / July 2014

Theory of Vibrations

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define the following terms:
i) Natural frequency ii) Degree of freedom iii) SHM **(03 Marks)**

b. Add the following harmonic motions analytically,

$x_1 = 4\cos(\omega t + 20^\circ)$

$x_2 = 7\sin(\omega t + 45^\circ)$ **(07 Marks)**

c. A periodic motion observed on an oscilloscope is shown in Fig. Q1 (c). Represent this motion by a harmonic series. **(10 Marks)**

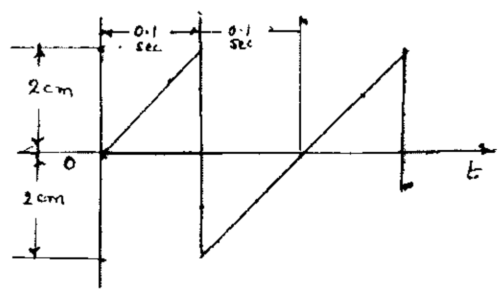

Fig. Q1 (c)

2 a. Obtain an expresion for the natural frequency of a compound pendulum subjected to small oscillation with usual notations. **(06 Marks)**

b. Determine the natural frequency of the system shown in Fig. Q2 (b) assuming the bar to be weightless and rigid. **(07 Marks)**

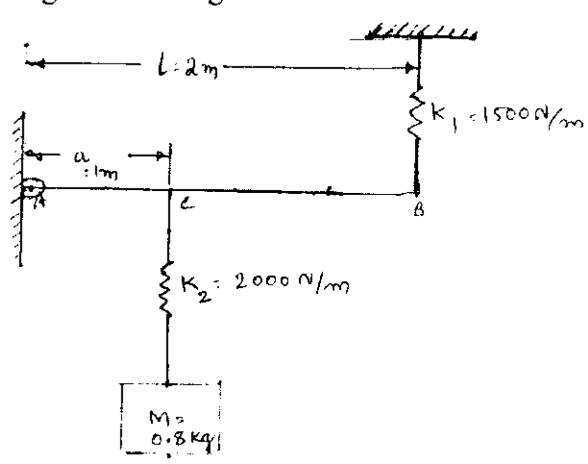

Fig. Q2 (b)

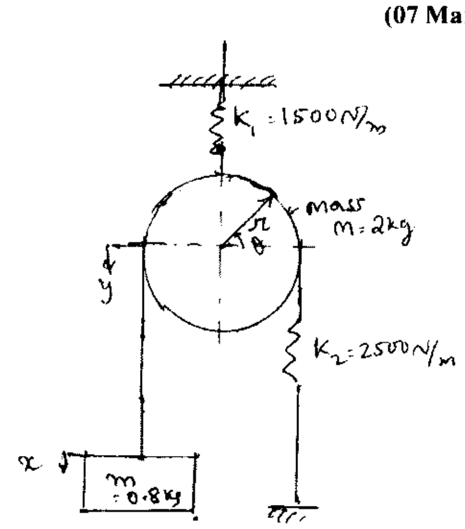

Fig. Q2 (c)

c. Using energy method, determine the natural frequency of the system shown in Fig. Q2 (c). Assume the cord to be unextensible and there is no slip. **(07 Marks)**

3 a. Derive an expression for the displacement x(t) of a mass-spring-dashpot system having a characteristic equation $m\ddot{x}+c\dot{x}+kx=0$ for underdamped case in terms of x_0, ω_n, α **(12 Marks)**

b. The measurement on a mechanical vibrating system having a mass of 8 kg shows that the equivalent spring stiffness is 6200 N/m. It also has a dashpot attached to it which exerts a force of 50 N when the mass has a velocity of 0.6 m/sec. Determine i) Critical damping coefficient (C_C) ii) Damping ratio (α) iii) Logarithmic decrement (δ) iv) Ratio of consecutive amplitudes v) Ratio of amplitudes after 4 cycles. **(08 Marks)**

4 a. Obtain the complete response equation for the motion of a spring-mass-dashpot system subjected to a harmonic force $F_0 \sin\omega t$ starting from differential equation of motion. **(10 Marks)**

b. A TV set of 30 kg mass must be isolated from a machine vibrating with an amplitude of 0.001 m at 1500 rpm. The set is mounted on 5 isolators (mounted in parallel) each having certain stiffness and damping constant values. If the amplitude of vibration of the TV set is measured as 0.0004 m, determine the damping constant values and the stiffness of each isolator assuming that they are connected in parallel and the damping ratio of the system is 0.048. Also determine the dynamic load on each isolator. **(10 Marks)**

PART – B

5 a. Define "critical speed" of a shaft. Derive an expression for the critical speed of a light shaft having a single disc at the centre considering the damping effect with a neat sketch. State the assumptions you have made. **(10 Marks)**

b. A rotor of mass 5 kg is mounted midway on a 10 mm dia horizontal shaft simply supported over a span of 0.6 m. The C.G. of the rotor is displaced 2.5 mm from the geometric centre. The equivalent viscous damping at the centre of the rotor shaft is 50 N-sec/m. The shaft rotates at 750 rpm calculate the maximum stress in shaft and power required to drive the shaft. Take E = 210 GPa. **(10 Marks)**

6 a. Briefly explain the concepts of first and second principal modes of vibration for a system with two degrees of freedom. **(04 Marks)**

b. A machine runs at 5000 rpm. Its forcing frequency is very near to its natural frequency. If the nearest frequency of the machine is to be at least 20% from the forced freqeuncy design a suitable vibration absorber for the system assuming the mass of the machine to be 30 kg. **(08 Marks)**

c. Two rotors A and B attached to the ends of a 0.5 m long shaft have weights 300 N and 500 N respectively. Their radii of gyrations are 0.3 m and 0.45 m. The diameter of the shaft is 7 cms for first 25 cm, 12 cm for next 10 cms and 10 cms for the remaining length. Take Gas 80 GPa for the shaft material. Determine i) The position of the node ii) Frequency of torsional vibrations. **(08 Marks)**

7 a. Derive frequency equation for a beam with
i) both ends free and having transverse vibrations.
ii) one end free and other end fixed and having transverse vibrations. **(12 Marks)**

b. A bar of uniform cross section having length l is fixed at both ends. The bar is subjected to longitudinal vibrations, having a constant velocity V_0 at all points. Derive mathematical expressions of longitudinal vibrations in bar. **(08 Marks)**

8 a. Determine the natural frequency of the system shown in Fig. Q8 (a) using Stodola method. **(10 Marks)**

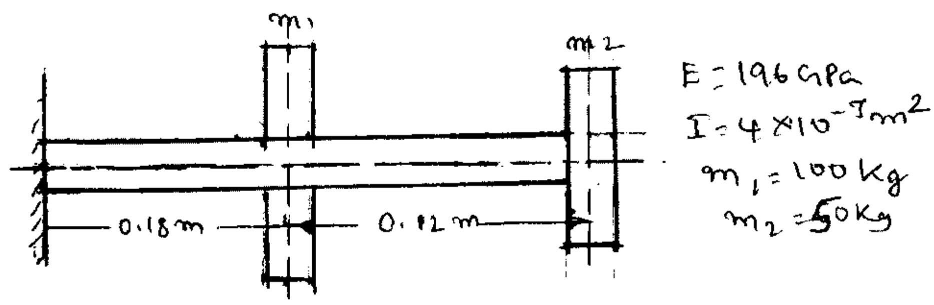

Fig. Q8 (a)

b. A solid steel shaft of uniform diameter which carries discs of weights 600 N and 1000 N is represented by a simply supported beam as shown in Fig. Q8 (b). Determine the fundamental natural frequency of the system assuming E of the material as 196 GPa and mass moment of inertia = 40×10^{-8} m^4. Use Dunkerley's method. **(10 Marks)**

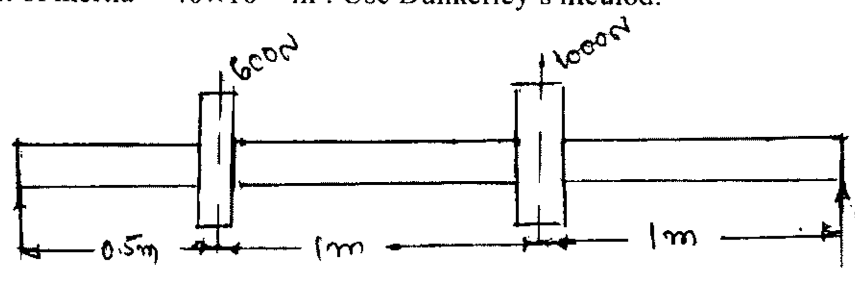

Fig. Q8 (b)

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