U.S.N

P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Sixth Semester, B.E. - Mechanical Engineering

Semester End Examination; May/June - 2019

Mechanical Vibrations

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Missing data, if any, may be suitably assumed.

UNIT - I

1 a. Discuss the energy method used to obtain governing differential equation of an undamped free vibratory system of single degree freedom. 6

b. Obtain the natural frequency of vibration of the spring-mass-pulley system shown in Fig. Q1(b), using energy method . 8

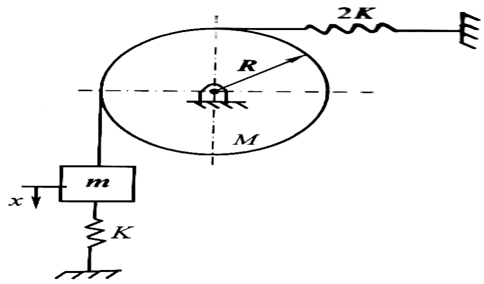

Fig. Q1(b)

c. Determine the natural frequency of a compound pendulum. 6

2 a. A 25 kg mass is resting on a spring of 4900 N/m and dash pot of 147 N-s/m in parallel. If a velocity of 0.1 m/s is applied to the mass at rest position, estimate its displacement at the end of the first second. 10

b. A vibrating system is defined by the following parameters :
M = 3 kg, k = 100 N/m, C = 3 N-s/m. Determine; 10
i) The damping factor
ii) The natural frequency of damped vibration
iii) Logarithmic decrement
iv) The ratio of two consecutive amplitudes
v) The number of cycles after which the original amplitude is reduced to 20 percent

UNIT - II

3 a. The mass M of a machine is mounted on an elastic foundation modeled as a spring of stiffness k in parallel with a various damper of damping coefficient C. The machine is subjected to a harmonic excitation of $F_o \sin\omega t$. Derive an expression for its steady-state amplitude. 12

b. A 75 kg machine is mounted on springs of stiffness 11.76×10^5 N/m with an assumed damping factor of 0.2. A 2 kg piston within the machine has a reciprocating motion with a stroke of 0.08 m and a speed of 3000 c.p.m. Assuming the motion of piston to be harmonic, determine the amplitude of vibration of the machine and vibratory force transmitted to the foundation. 8

4 a. What is vibration isolation? Briefly explain force isolation and motion isolation. 6

b. Define motion transmissibility and write the expression for the same. 4

c. A vehicle has a mass of 490 kg and total spring constant of its suspension system is 58800 N/m and the damping factor is 0.5. The profile of the road may be approximated to a sine wave of amplitude 40 mm and wave length 4 m. Determine; 10
i) Critical speed of the vehicle
ii) The amplitude of steady-state motion of the mass when the vehicle is driven at critical speed
iii) The amplitude of steady-state motion of the mass when the vehicle is driven at 57 km/hr.

UNIT - III

5 a. With neat diagram, write a note on vibration measuring instrument. 4

b. A seismic instrument with natural frequency of 6 Hz is used to measure the vibration of a machine running at 120 rpm. The instrument gives the reading for the relative displacement of the seismic mass as 0.5 mm. Determine the amplitude of displacement, velocity and acceleration of the machine. Neglect damping. 8

c. Add the following motions analytically : 8

$x_1 = 2\cos(\omega t + 0.5)$ $x_2 = 5\sin(\omega t + 1.0)$

6 a. Derive an expression for deflection of shaft rotating at critical speed by considering damping. 8

b. The rotor of a turbine weight 14 kg is supported at the mid span of shaft with bearings 0.4 m apart. The end condition of bearings is assumed to be simply support. The rotor has an unbalance of 25×10^{-4} kg-m. Determine the force exerted on bearing at a speed of 6000 rpm, if dia of shaft is 25 mm. Take, E = 210 GPa and density of shaft material $\rho = 8000$ kg/m^3. 12

UNIT - IV

7. Two simple pendulums are connected by a spring as shown in Fig. Q7. Determine the natural frequencies and corresponding mode shapes. 20

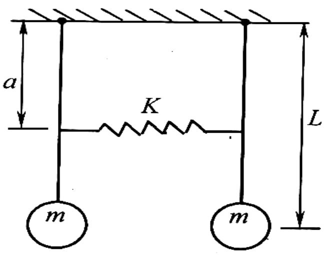

Fig. Q7

8 a. What is meant by principle mode of vibration and normal mode of vibration? 4

b. Discuss on undamped dynamic vibration absorber. 6

c. Three equal masses are attached to the string as shown in Fig.Q8(c), obtain the influence coefficients of the system. 10

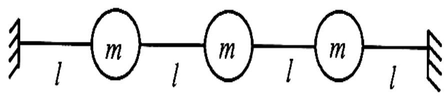

Fig. Q8(c)

UNIT - V

9. Obtain the fundamental natural frequency and mode of vibration for the system shown in Fig. Q9 using Stodola method and compare that frequency by Dunkerley's method. 20

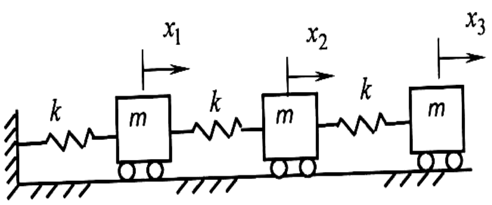

Fig. Q9

10. Determine the natural frequencies of the system shown in Fig. Q10 by using Holzer's method. Take $m_1 = 2$ kg, $m_2 = 4$ kg, $m_3 = 2$ kg, $k_1 = 5$ N/m and $k_2 = 10$ N/m. 20

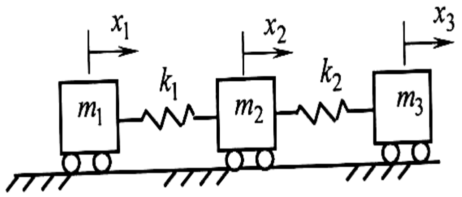

Fig. Q10

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