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

*(An Autonomous Institution affiliated to VTU, Belagavi)*

**Sixth Semester, B.E. - Automobile Engineering**

**Semester End Examination; May/June - 2018**

**Mechanical Vibrations**

*Time: 3 hrs* *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

## UNIT - I

1 a. Explain briefly the following terms :

(i) Free vibration (ii) Forced vibration

(iii) Amplitude (iv) Degrees of freedom — 6

b. Determine the natural frequency of a simple pendulum by neglecting the mass of the rod. — 6

c. A mass '*m*' hangs from a chord attached to a circular homogeneous disc of mass '*M*' and radius '*R*' as shown in Fig.1 Q. No. 1(c). The disc is restrained from rotation by a spring attached at a radius '*r*' from the centre. Determine the natural frequency of the system for vertical oscillations of mass '*m*'. — 8

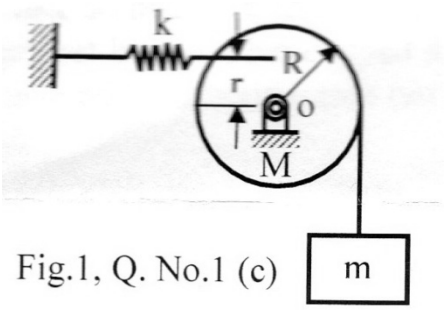


Fig.1, Q. No.1 (c)

2 a. What is logarithmic decrement? Show that logarithmic decrement δ for a single degree of freedom spring mass dashpot system is given by the equation;

$\delta = \frac{1}{n}\log_e\left(\frac{x_o}{x_n}\right)$, where $x_o$ = initial amplitude, $x_n$ = amplitude of vibration after *n* cycles. — 10

b. A body weighing 100 N is suspended by a helical spring having stiffness of 2 kN/m. A dashpot having a resistance of 0.6 N at a velocity of 3 m/min is connected between the weight and the fixed end of the spring. Determine the ratio of successive amplitudes and the amplitude of the body 9 cycles after which it was released with an initial amplitude of 12 mm. — 10

## UNIT - II

3 a. What is magnification factor? Derive an expression for magnification factor. — 8

b. A weight of 100 N is suspended by a spring of stiffness $1.2 \times 10^3$ N/m is forced to vibrate by a harmonic force of 10 N. Assuming viscous damping of 86 Ns/m, find the resonant frequency, the amplitude at resonance, the phase angle at resonance, the frequency corresponding to the peak amplitude, the peak amplitude. — 12

Contd…2

4 a. Explain the terms vibration isolation and transmissibility. What are the materials used for vibration isolation? Explain briefly 8

b. The springs of an automobile trailer are compressed 100 mm under its own weight. Find the critical speed when the trailer is travelling over a road with a profile approximated by a sine wave of amplitude 75 mm and wave length 15 meters. What will be the amplitude of vibration at 64 km/hour? 12

**UNIT - III**

5 a. What are seismic instruments? Explain briefly the principle of Vibrometer and Accelerometer. 8

b. A Vibrometer has a period of free vibration of 2 s. It is attached to a machine with a vertical harmonic frequency of 1 Hz. If the Vibrometer mass has an amplitude of 2.5 mm relative to the Vibrometer frame, what is the amplitude of vibration of the machine? 5

c. A commercial type vibration pick up has a natural frequency of 6 cycles/s and a damping factor $\xi = 0.6$. What is the lowest frequency that can be measured with 2 % error? 7

6 a. Define critical speed of a rotating shaft. What are the assumptions used to derive the expression for maximum deflection of the shaft? 6

b. A single rotor weighing 100 N is mounted midway between the bearings on a steel shaft of 10 mm diameter. The bearing span is 400 mm. It is known that the centre of the rotor is 0.025 mm from its geometric centre. If the system rotates at 1000 rpm and the damping ratio is estimated to be 0.06, find out the amplitude of vibration, the dynamic load transmitted to the bearings, and the maximum stress induced in the shaft, when the shaft is supported horizontally. Neglect the weight of the shaft. Assuming the shaft to be simply supported and take $E = 2 \times 10^5$ N/mm$^2$. 14

**UNIT - IV**

7 a. Explain briefly the following:

(i) Normal modes (ii) Principal coordinates

(iii) Dynamic vibration absorber (iv) Semi definite system 8

b. Determine the natural frequencies and the corresponding mode shapes of the double pendulum shown in Fig. 2. Q. No. 7(b). 12

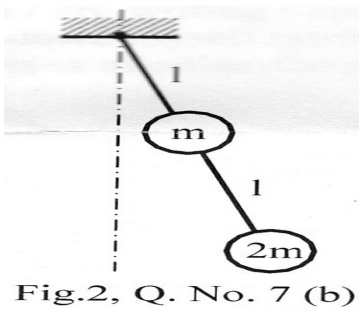


Fig.2, Q. No. 7 (b)

Contd…3

8 a. Explain the principle of dynamic vibration absorber. 6

b. What are influence coefficients? Discuss Maxwell's reciprocal theorem. 4

c. Determine the influence coefficients of the system shown in Fig. 3 Q. No. 8(c). 10

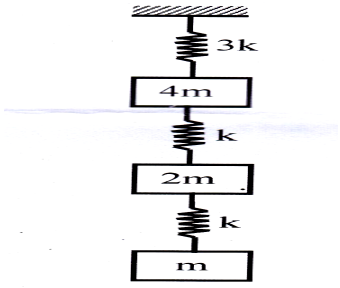


Fig.3, Q. No.8 (c)

**UNIT - V**

9. Determine the fundamental natural frequency of the system shown in Fig. 4, Q. No. 9 by using (i) Stodola method (ii) Matrix iteration method 20

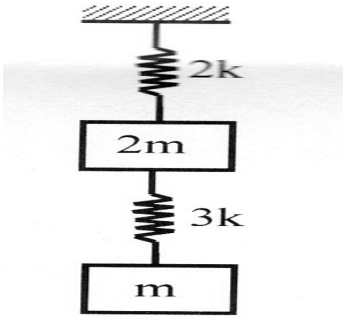


Fig.4, Q. No.9

10. Determine the natural frequencies of the system shown in Fig.5, Q. No. 10 by using Holzer's method. 20

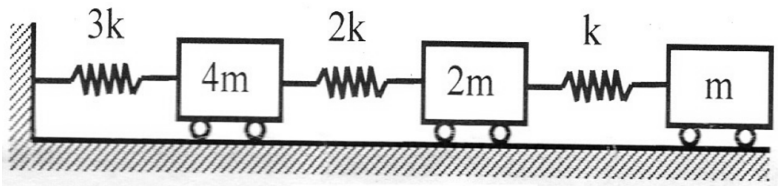


Fig.5, Q. No.10

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