(3 Hours) **[Total Marks: 80]**

N.B. 1) Question No. 1 is **compulsory**

2) Answer any **Three** questions from remaining **Five**

3) Assume suitable data wherever required, justify the same

4) Answer to questions showed be grouped and written together.

1 Solve **any Four** 20

a What is the function of a vibration isolator? Also write a note on commercial isolator material.

b A spring mass system has natural frequency of 12 Hz. When the spring constant is reduced by 800 N/m, the frequency is changed by 50%. Determine the mass and spring constant of original system.

c A 500 kg vehicle is mounted on springs such that its static deflection is 1.5 mm. what is the damping coefficient of a viscous damper to be added to the system in parallel with the springs, such that the system is critically damped?

d A 5 kg mass attached to the lower end of a spring, whose upper end is fixed, vibrates with a natural period of 0.45 sec. determine the natural period when a 2.5 kg mass is attached to the mid-point of the same spring with the upper and lower end fixed.

e Explain with neat sketch, the principal vibration measuring instruments.

2 a For what value of c is the damping ratio of the system of fig. 1 equal to 1.25? 12

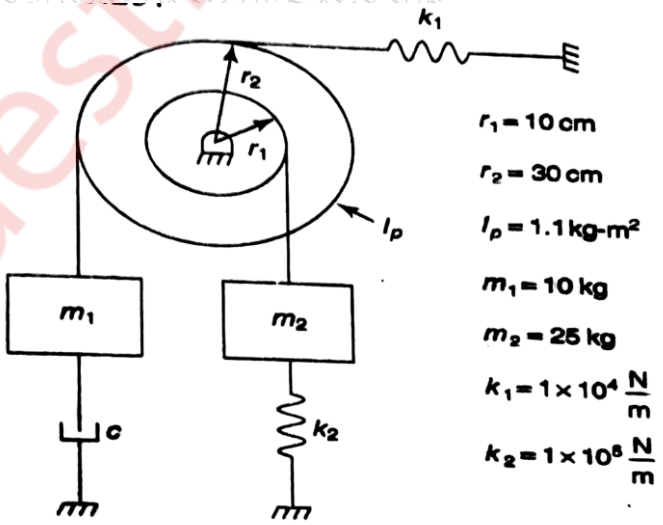

Fig. 1

b A string under tension T, which can be assumed to remain constant for small displacement. For small oscillation find the natural frequency of vertical vibrations of the string shown in fig. 2. 08

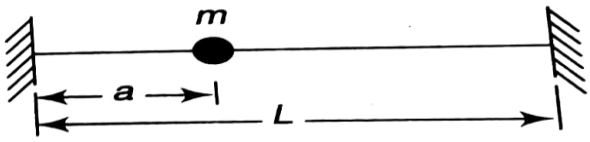

Fig. 2

3 a A 45 kg machine is placed at the end of a 1.6 m cantilever beam of elastic modulus of 200 x 10^9 N/ m^2 and cross – sectional moment of inertia 1.6 x 10^{-5} m^4. As it operates, the machine produces a harmonic force of magnitude 125 N. at what operating speeds will the machine's steady-state amplitude be less than 0.2 mm? 10

b A torsional pendulum has a natural frequency of 200 cycles/minute when vibrating in vacuum. The mass moment of inertia of disk is 0.2 kg-m^2. It is then immersed in oil and its natural frequency is found to be 180 cycles/minute. Determine the damping constant. If the disk, when placed in oil, is given an initial displacement of 2^0, find the displacement at the end of first cycle. 10

4 a Determine the maximum percent error of a vibrometer in the frequency ratio range $4< r < \infty$ with damping ratio of 0.63. 08

b A steel shaft of diameter 10 cm is carrying three masses 2.5 kg, 3.75 kg and 7 kg respectively as shown in fig. 3. The distance between the rotors are 0.7 m. determine the natural frequencies of torsional vibrations? The radii of gyration of three rotors are 0.20, 0.30 and 0.40m respectively. Take G = 9 x 10^8 N/m^2. 12

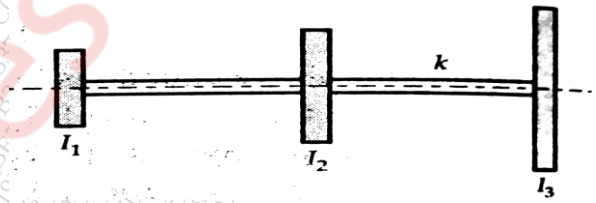

Fig. 3

5 a A single DOF system consists of a mass of 20 kg and a spring stiffness 4000 N/m. the amplitude of successive cycles are found to be 50, 45, 40, 35 ……mm. determine the nature and magnitude of the damping force and frequency of damped vibrations. 06

b A four cylinder engine has cranks arranged symmetrically along the shaft as shown in Fig. 4, the distance between the outer cranks A and D is 5.4 meters and that 14

between the inner cranks B and C is 2.4 meters. The mass of the reciprocating parts belonging to each of the outer cylinders is 1.5 tonnes, and that belonging to each of the inner cylinders is m tonnes.
If the primary and secondary forces are to be balanced and also the primary couples, determine the crank angle positions and the mass of the reciprocating parts (m) corresponding to the inner cylinders.
Find also the maximum value of the unbalanced secondary couple, if the stroke is 1 meter, the connecting rod length 2 meters, and the speed of the engine is 110 rpm.

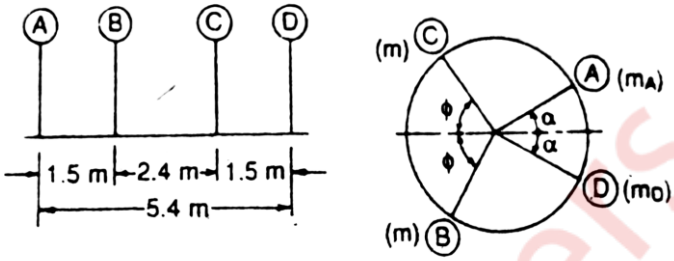

Fig. 4

6 a The natural frequency of transverse vibration of a beam in fig.5 is 20 rad/sec. find the natural frequency of vibration if another load 30 N is added at 0.40 m from the left support. 14

$$u_{ij} = \frac{s_i z_j\left(l^2 - s_i^2 - z_j^2\right)}{constant} = u_{ji} \text{ for } s_i \text{ not greater than } z_j$$

where u_{ij} is the deflection of section I due to unit load at section j and s_i is the distance of section I from left support and z_j is the distance of section j from right support.

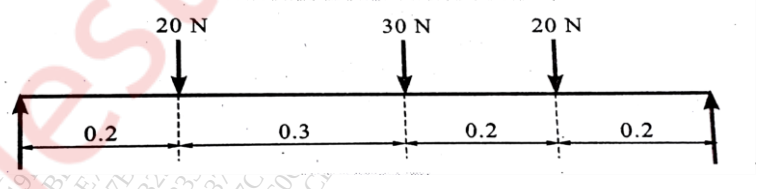

Fig. 5

b Discuss how a single revolving mass is balanced by two masses revolving in different planes 06

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