Roll No. ..... Total No. of Pages : 5

BT6/M11 **8647**

Mechanical Vibrations

Paper : ME-306-E

Time : Three Hours] [Maximum Marks : 100

Note :— Attempt any FIVE questions, at least ONE from each unit. Unless stated otherwise, the Symbols have their usual meanings in context with the Subject. Assume suitably and state, additional data required, if any.

UNIT—I

1. (a) A harmonic motion has amplitude of 0·05 m and a frequency of 25 Hz. Find the time period and the maximum acceleration. 2

(b) Represent the following in exponential form :

(i) $3 + j\,4$

(ii) $-3 + j4$. 4

(c) Represent the following in rectangular form :

(i) $9\,e^{j\pi}$

(ii) $14\,e^{-j\pi/2}$. 4

(d) Represent the periodic motion given in the Fig. 1 by harmonic series. 10

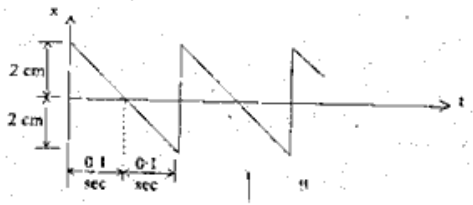

Fig. 1

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2. (a) A mass of 10 kg when suspended from spring causes a static deflection of 1 cm. Find the natural frequency of the system. 2

(b) Find the natural frequency of oscillation for the system shown in Fig. 2 assuming the bell crank lever to be light and stiff and the mass 'm' to be concentrated. 4

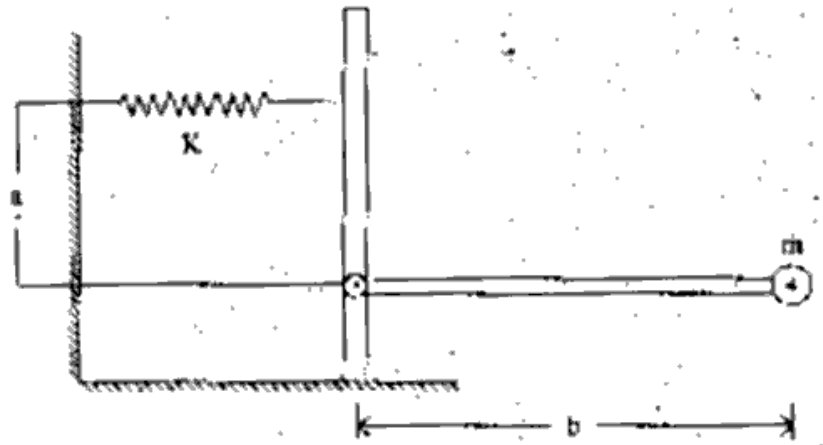

Fig. 2

(c) A torsion pendulum has to have a natural frequency of 5 Hz. What length of steel wire of diameter 2 mm should be used for this pendulum ? The inertia of the mass fixed at the free end is 0·0098 kg-m². Take $G = 0.83 \times 10^{11}$ N/m². 4

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(d) Determine the natural frequency of the spring-mass-pulley system shown in Fig. 3 10

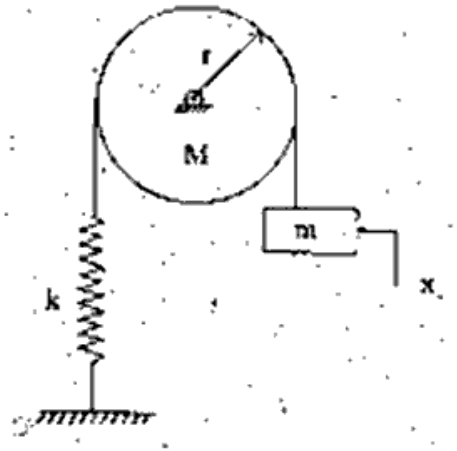

Fig. 3

UNIT—II

3. (a) A mass of 1 kg is attached to a spring having a stiffness of 3920 N/m. The mass slides on a horizontal surface, the coefficient of friction between the mass and the surface being 0·1. Determine the frequency of vibrations of the system and the amplitude after one cycle if the initial amplitude is 0·25 cm. 10

(b) A centrifugal compressor of mass 100 kg is supported on isolators having a damping factor of 0·2. It runs at a constant speed of 1500 rpm and has a rotating unbalance of 0·1 kg-m. What should be the stiffness of the isolators if the force transmitted to the foundation is to be less than 10% of the unbalanced force ? 10

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4. Derive an expression for the natural frequency of the torsional system shown in Fig. 4 and draw the normal mode curve. Show that the nodal distance from J_2 is $L_2(1 + k_1/k_2)/(1 + J_2/J_1)$. 20

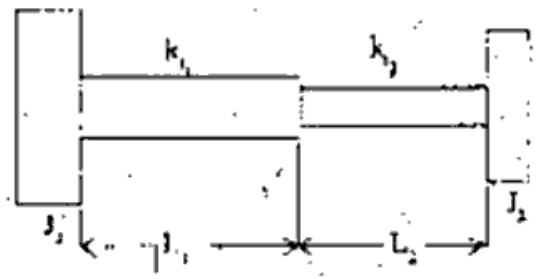

Fig. 4

UNIT—III

5. Find by Holzer's method the natural frequency of the torsional system shown in Fig. 5 when the right end is fixed. 20

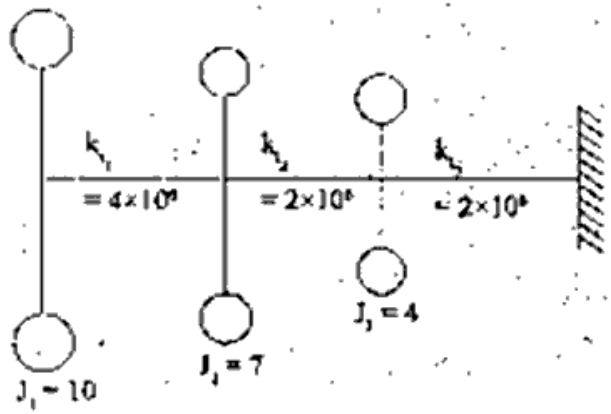

Fig. 5

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6. Find the first natural frequency of the triple pendulum shown in Fig. 6 by the method of matrix iteration using influence coefficients. Do at least four iterations. 20

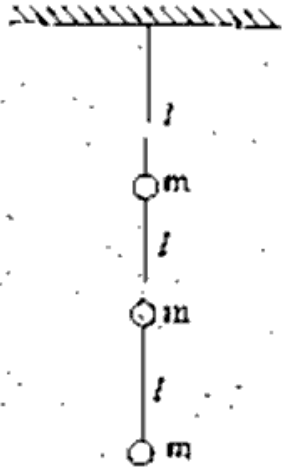

Fig. 6

UNIT—IV

7. A cantilever consists of uniform bar of length L. At mid point along the length a force P which acts away from the fixed end is applied and released at time t = 0, suddenly. Find the ensuing motion. 20

8. Write short notes on followings :—

(i) Whirling of shafts.

(ii) Phase plane method. 10, 10