Roll No. .... Total Pages : 5

BT-6/M-20 **36042**

MECHANICAL VIBRATIONS

Paper–ME-306E

Time : Three Hours] [Maximum Marks : 100

Note : There are *eight* questions in total. Attempt any *five* questions.

1. (a) Determine the torsional spring constant of the steel propeller shaft shown in figure 1. 5

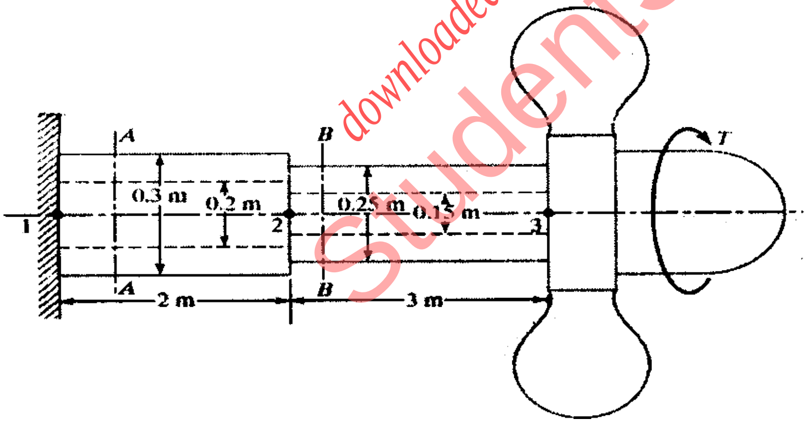

Figure 1.

(b) Find the sum of the two harmonic motions $x_1(t) = 10 \cos \omega t$ and $x_2(t) = 15 \cos(\omega t + 2)$. 5

(c) A vibrating system of single degree of freedom is defined by the following : Mass (m): 3 kg, stiffness k = 100 N/m, Damping Coefficient c = 3 N-S/m. Determine the following :

(i) Damping Factor

(ii) Damped natural factor

(iii) Logarithmic Decrement

(iv) Number of cycles after which the amplitude is reduced to 20 percent. 5

(d) Differentiate between free vibrations and forced vibrations giving suitable examples. 5

2. (a) Derive an expression for vibration response of a single degree of freedom system if the damping provided is over damped system. 10

(b) Find the normal modes of the system shown in Figure 2. Assume $k_1 = k_2 = k$ and $m_1 = m_2 = m$. 10

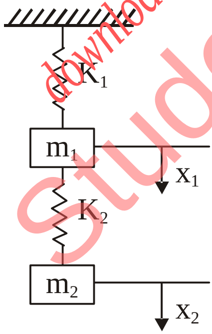

Figure 2.

3. (a) A vibrating body having mass 2 kg is suspended by a spring of stiffness 2000 N/m and it is put to harmonic excitation of 20 N. Assuming viscous damping, determine : 5

(i) the resonance frequency

(ii) phase angle at resonance

(iii) amplitude at resonance

(iv) the frequency corresponding to the peak amplitude

(v) damped frequency.

Assume viscol+s damping coefficient = 40 N-sec/m.

(b) Determine centrifugal pendulum vibration absorber.5

(c) Determine: 10

(i) Critical damping coefficient.

(ii) Damping factor.

(iii) Natural frequency of damped vibrations.

(iv) Logarithmic decrement.

(v) Ratio of Consecutive amplitudes of vibrating system.

Which consist of mass of 100 kg of a spring of stiffness 30 kN/m and a damper. The damping provided is only 25% of the critical value.

4. (a) Explain the working principle of dynamic absorber. 10

(b) Define transmissibility and derive an expression for the transmissibility ratio. 10

5. (a) Explain Dunkerley's method to evaluate the natural frequency of structures. 10

(b) Determine the natural frequencies and mode shapes of the system shown in the Figure 3. Assume $m_1 = m_2 = m_3 = m$ and $k_1 = k_2 = k_3 = k$. 10

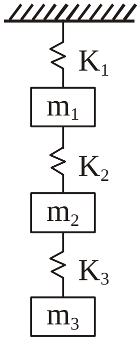

Figure 3.

6. (a) Explain in detail Rayleigh-Ritz method. 10

(b) Determine the natural frequencies of the system shown in Figure 4 by Holzer's method. Given $J_1 = J_2 = J_3 = 1$ kg m ^{2}. $k_{11} = k_{12} = 1$ N-mt/rad. 10

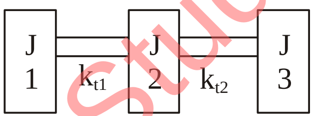

Figure 4.

7. (a) Derive frequency equation for a beam with both ends free and having transverse vibration. 5

(b) A spring mass system has spring constant *k* N/m and mass *m* kg. It has natural frequency of vibration as 12 c.p.s. An extra 2 kg mass is coupled to *m* and nature frequency reduced by 2 c.p.s. Find the values of *k* and *m*. 5

(c) Derive the frequency equation of torsional vibrations for a free-free shaft of length *l*. 10

8. (a) Derive the wave equation of a transverse vibration of a string and obtain its solution. 10

(b) Find the lowest natural frequency of vibration of system shown in Figure 5 by Rayleigh's method. Assume $E = 1.96 \times 10^{11}$ N/m^2, $I = 10^{-6}$ m^4. 10

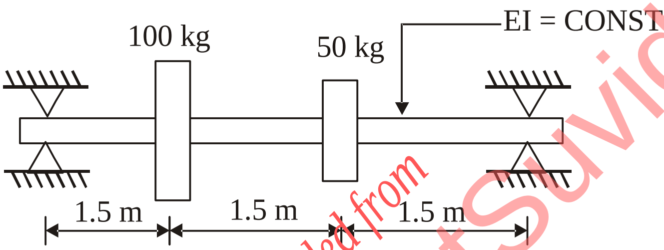

Figure 5.