Roll No. | | | | | | | | | | | | | **Total No. of Pages : 03**

Total No. of Questions : 09

B.Tech. (Mechanical Engg.) (Sem.7,8)

MECHANICAL VIBRATIONS

Subject Code : BTME-701-18

M.Code : 90474

Date of Examination : 01-07-22

Time : 3 Hrs. **Max. Marks : 60**

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.**

SECTION-A

1. Write briefly :

a) If the motion of a particle is represented by $x = A \sin(\omega f) + B \sin(2\omega t)$; determine its velocity at time, $t = 0.125$s, given: $A = (\sqrt{2})/\pi$ m, $B = 4/\pi$ m and $\omega = 2\pi$ rad/s.

b) The analog channel of a microcontroller can record data samples at a frequency of 200 kHz. Calculate, the number of samples ($2k$) feat will be recorded per cycle of a 4 kHz periodic signal.

c) Given $x_i = 5\sin(10t)$ and $x_2 = 5\sin(10t + \pi/2)$; determine analytically the phase- angle β of the resultant, XR with the first SHM x_l

d) For a vehicle of mass 1000 kg, determine the critical damping coefficient, cc of the suspension system, if it undergoes static deflection of 98mm under its dead weight.

e) The natural frequency of a IDoF system is 20 rad/s, which drops to 19.6 rad/s upon adding a viscous dashpot. Determine the damping ratio.

f) Determine the damped natural frequency (ω_d) of a system having undamped natural frequency (ω_n) of 10 rad/s and damping ratio, $\zeta = 0.6$.

g) Determine the peak amplitude frequency (ω_p) of a system having undamped natural frequency (ω_n) of 10 rad/s and damping ratio, $\zeta = 0.6$.

h) For a displacement measuring instrument operating above its natural frequency, giving reference to die relationship, state if the indicated relative amplitude would be less than or greater than the absolute amplitude of vibrations.

i) A system comprises of two masses m_1 and m_2. Mass mi is attached to a support towards its left with the help of a string having stiffness K. The mass m_2 is attached to die mass m_1 by means of another spring of stiffness 2K. Determine the four influence coefficients of the system.

j) Determine the critical speed of a vertical shaft of stiffness k = 5000N/m, if it is carrying a disc of mass m = 0.5 kg at its mid-point.

SECTION -B

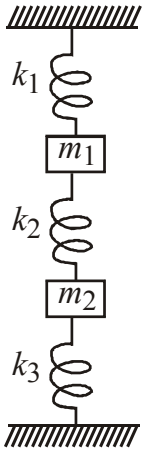
2. Determine the magnitude (X_R) of the resultant of the following two vectors, which represent two harmonic motions:

   $x_l = 3 \sin 20\, t$ and $x_2 = 4 \sin (20\, t + \pi/2)$

3. A mass, m = 10 kg is supported on a suspension of stiffness, k = 1 kN/m and damping coefficient, c = 40 N/m/s. If the mass is given an initial displacement, X_0 = 25mm, determine die residual amplitude (X_2) of free damped oscillations after two complete cycles.

4. Determine actual displacement, Y of a machine operating at 2400 rpm, if a vibrometer having natural frequency, ω_π = 4Hz placed on the machine shows a relative displacement, Z = 0.2mm. Assume damping ratio, ζ = 0 for vibrometer.

5. For the 2DoF spring-mass system shown in figure constrained at both ends, the two springs at the lower and upper ends have a stiffness of k_l = 2000 N/m, while the spring in the middle has a stiffness of k_2 = 5000N/m. If $m_1 = m_2$ = 2kg, determine the natural frequencies of the system. Also draw die corresponding mode-shapes if die masses are farthest apart at time 1 = 0.



6. A cantilever steel shaft having diameter 2cm carries two masses. The first mass weighs 10kg aid is at a distance of 20cm from the support, while the second mass weighs 5kg and is mounted at the free end, which is at a distance of 30cm from the support. Obtain an estimate of first natural frequency of tike system, given E = 200 GPa for steel.

SECTION - C

7. Using analytical method, determine the Fourier harmonics for the periodic function, given by: $f(t) = 20\,t$ for $0 \le t \le 0.1$

8. The barrel of an artillery gun weighs 400kg. When it fires a shell weighing 0.5kg with a velocity of 1000 m/s, the barrel recoils by 20cm against a recoil spring. A viscous dashpot gets engaged at the end of the recoil stroke. Determine the damping coefficient of dashpot, if a damping factor of 1.2 is to be maintained. Neglecting preload of the recoil spring, determine die time taken by die barrel to return back to within 1 cm of the equilibrium position.

9. Derive the general solution for vibration of a stretched string for snail amplitude of oscillation, so that the change in tension scan be neglected Assume a uniform distribution of mass (ρ) per unit length of the string.

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.