

Roll No.
Total No. of Questions: 09

Total No. of Pages: 02

B. Tech. (ME)
MECHANICAL VIBRATIONS
SUBJECT CODE: ME-408 MAY 2014
Paper ID: [A0841]

Time: 03 Hours


Maximum 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.
4. Use of non-programmable scientific calculators is permitted.

Section – A

Q. 1

- (a) If the motion of a particle is represented by $x = A \sin(\omega t)$: determine its velocity at time, $t = 1$ s, given $A = 7.5$ mm and $\omega = 3$ rad/s.
- (b) Find the beat frequency, along with minimum / maximum amplitudes of the resultant of $x_1 = 8 \sin 8.7t$ and $x_2 = 10 \sin 9.0t$
- (c) Represent vector, $V = 4e^{j2}$ in rectangular form.
 $V = 4[\cos 2 + j \sin 2] = -1.66 + j3.64$
- (d) Determine the magnitude and direction with respect to x_1 for $x_R = x_1 + x_2$, where:
 $x_1 = 2 \sin \omega t$
 $x_2 = 5 \sin (\omega t + 0.5)$
- (e) For a vehicle of mass 1000 kg, determine the critical damping coefficient, c_c , of the suspension system, if it undergoes static deflection of 98 mm under its dead weight.
- (f) Determine the damped natural frequency (ω_d) of a system having undamped natural frequency (ω_n) of 10 Hz and damping ratio, $\zeta = 0.2$.
- (g) Determine the critical speed of a vertical shaft of stiffness $k = 72000$ N/m, if it is carrying a disc of mass $m = 5$ kg.
- (h) Determine the actual displacement amplitude of a machine running at 120 rpm and producing SHM vibrations, if a vibration measuring device having natural frequency of 5 Hz indicates the displacement amplitude of 0.04 mm. Assume damping to be zero.
- (i) Neglecting friction and inertia forces, determine the (flexibility) influence coefficients for the system shown in figure.

- (j) Determine the lowest natural frequency of a system by Dunkerley's method, if its component frequencies are 100, 70 and 150 Hz.

Section – B

- Q. 2 A string of length L under tension T is carrying a mass m at a distance a from one end. The mass is pulled by x displacement. Assuming tension to remain unchanged for small values of x , determine the natural frequency of vibration of mass m from the principle of conservation of total mechanical energy ($=KE+PE$) of the system.
- Q. 3 In a hanging spring-dashpot arrangement involving stiffness, $k = 50\text{KN/m}$, damping factor, $\zeta = 0.2$ and mass, $m = 500\text{kg}$. find the time in which the weight would settle to one-hundredth of initial deflection once it is deflected and released.
- Q. 4 A delicate piece of electronic instrument weighing 2kg is mounted in a cockpit, whose surface is vibrating at 7000Hz with an amplitude of 0.5mm . Determine the stiffness required for the suspension spring, so that the amplitude of vibrations undergone by the instrument gets reduced to $5\mu\text{m}$.
- Q. 5 A lightweight cantilever steel spindle of diameter 1 cm carries two discs of mass $m_1=3\text{ kg}$ and $m_2=2\text{ kg}$, mounted at a distance of 18cm and 30cm respectively from the fixed end. Estimate the first natural frequency of the system by Dunkerley's lower-bound method. Take $E=1.96\times 10^{11}\text{ N/m}^2$.
- Q. 6 Determine the critical speed for a vertical lightweight steel shaft of 1cm diameter and 50cm length, carrying a disc of mass, $m = 2\text{kg}$ midway along its length. Also determine the dynamic load on bearings at an operating speed of $\omega = 68\text{rad/s}$. if eccentricity of disc, $e = 0.03\text{mm}$. Take $E = 1.96\times 10^{11}\text{N/m}^2$

Section – C

- Q. 7 Obtain the Fourier Series for the square-wave function given below:
 $f(t) = -1/2$ for $-\pi < t < 0$
 $f(t) = 1/2$ for $0 < t < \pi$
- Q. 8 A gun barrel with mass 600kg has a recoil spring of 350 kN/m . If the barrel recoils one meter on firing, find: (a) The initial recoil velocity of the gun. (b) The critical damping coefficient of a dashpot which is engaged at the end of the recoil stroke and (c) The time required for the barrel to return to a position 5cm from its initial position.
- Q. 9 A machine having total mass of 2500kg is mounted on suspension having stiffness, $K = 245\text{ kN/m}$ and damping factor, $\zeta = 0.2$. A vertically mounted piston of mass 15kg in the machine undergoes SHM with a stroke of 0.4m . Find the steady state amplitude, X of the oscillations undergone by machine at a piston speed of 600 cpm . Also determine the force transmitted to the ground through the suspension.