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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 = 1s, given A = 7.5mm and ω = 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:

$x_1 = 2 \sin \omega t$

$x_2 = 5 \sin (\omega t + 0.5)$

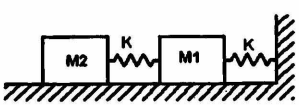
(e) For a vehicle of mass 1000kg. determine the critical damping coefficient. c_c of the suspension system, if it undergoes static deflection of 98mm under its dead weight.

(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 = 72000N/m, if it is carrying a disc of mass m = 5kg.

(h) Determine the actual displacement amplitude of a machine running at 120rpm and producing SHM vibrations, if a vibration measuring device having natural frequency of 5Hz is indicates the displacement amplitude of 0.04mm. 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 = 50KN/m, damping factor, $\zeta = 0.2$ and mass, m = 500kg. 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 5μm.

Q. 5 A lightweight cantilever steel spindle of diameter 1 cm carries two discs of mass m_1=3 kg and m_2=2 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=1.96X10^{11} 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 = 2kg midway along its length. Also determine the dynamic load on bearings at an operating speed of ω = 68rad/s. if eccentricity of disc, e = 0.03mm. Take E = 1.96x10^{11}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 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.

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