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Total No. of Pages : 03

Total No. of Questions : 09

B.Tech.(ME) (2011 Onwards) (Sem.-7,8)

MECHANICAL VIBRATIONS

Subject Code : BTME-803

Paper ID : [A3064]

Time : 3 Hrs.

Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

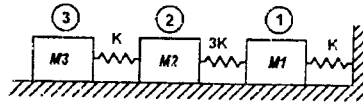
1. SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.
2. SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.
3. SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.

SECTION-A

Q1 Write briefly :

- a) If the motion of a particle is represented by $x = A \sin(\omega t) + B \sin(2\omega t)$; determine its velocity at time, $t = 2s$, given: $A = 4mm$, $B = 2mm$ and $\omega = 5 \text{ rad/s}$.
- b) Calculate the number of samples ($2k$) that will be recorded per cycle of the fifth harmonic of a 1 kHz periodic signal by a 1 MHz data recorder.
- c) Given $V_1 = 4e^{j0}$ and $V_2 = 2e^{j\frac{3\pi}{2}}$; determine analytically the phase-angle β of the resultant, V_R with the first vector V_1
- d) Determine damped natural frequency, ω_d for a system having mass, $m = 1000kg$, static deflection, $\Delta = 98mm$ and damping coefficient, $c = 10^4 \text{ N/m/s}$. Take $g = 9.8 \text{ m/s}^2$
- e) Determine the minimum and maximum values for periodic function $f(t) = e^{\sin(\omega t)}$ and without solving, comment whether the constant term a_0 in Fourier analysis of this function would be a negative, zero or positive quantity.
- f) The damped natural frequency (ω_d) of a system is 86.6Hz, while the maximum amplitude occurs at an exciting frequency (ω_p) of 70.7 Hz. Find the damping factor (ζ) and the undamped natural frequency (ω_n).
- g) State the design criteria for acceleration measuring instruments.

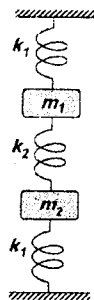
- h) Applying Euler's theorem to the complex representation of vector $V = 1e^{j\frac{\pi}{2}}$ where $j = \sqrt{-1}$, show that j^j is real.
- i) Neglecting friction and inertia forces, determine all nine (flexibility) influence coefficients for the system shown in figure.



- j) Determine the estimate for lowest natural frequency of a 3 DoF system by Dunkerley's method, if its component frequencies are 10, 14 and 20 Hz.

SECTION-B

- Q2 If two harmonic motions x_1 and x_2 of equal amplitude X and frequencies ω_1 and ω_2 respectively are added, show that their resultant displacement x is in the form of product of a higher and a lower frequency motion.
- Q3 Determine the mass M to be placed at the end of the reeds of a Frahm's tachometer so as to get a frequency of 50 rad/s; Given : Length of reed, $L = 50\text{mm}$; width, $w = 6\text{mm}$; thickness, $t = 0.5\text{mm}$; and $E = 19.6 \times 10^{10} \text{N/m}^2$.
- Q4 For the 2DoF spring-mass system shown in figure is constrained at both ends. The two springs on sides are identical with a stiffness of $k_1 = 2000 \text{ N/m}$, while the middle spring has a stiffness of $k_2 = 3000 \text{ N/m}$, $m_1 = m_2 = 20\text{kg}$. Determine the two natural frequencies of the system.



- Q5 A shaft AE of 50mm diameter and length, $L = 6\text{m}$ carries three discs at locations B , C and D of 1kg each, mounted at a distance of $L_i = 2, 3$ and 4 m from the left end. Find the lowest frequency of vibration by Dunkerley's method. Given, $E = 1.96 \times 10^{11} \text{ N/m}^2$, deflection, $y_i = \frac{(m_i g) L_i^2 (L - L_i)^2}{3EIL}$ for simply supported shaft.
- Q6 Starting with the expression for strain energy u during free longitudinal vibrations of a bar of length L and uniform cross-section, determine the normal functions for the boundary conditions as one end fixed and the other end free.

SECTION-C

- Q7 Using analytical method, determine the harmonics of the saw-tooth wave function given by $f(t) = 3t$ for $0 < t < 2$
- Q8 A beam having $L = 0.42\text{m}$, $I = 1 \times 10^{-6} \text{ m}^4$ and $E = 1.96 \times 10^{11} \text{ N/m}^2$ is supporting two masses, $m_1 = 40\text{kg}$ and $m_2 = 20\text{kg}$ at distances of 0.16 and 0.24m from left end.
- Determine the lowest natural frequency of the system by Rayleigh's method.
- Q9 A torque T_0 applied at the midpoint of a uniform circular shaft of length L twists it by an angle θ_0 radians. Solve for the resulting motion of the shaft if this torque is released suddenly.