Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.TECH/CE/SEM-8/CE-802/5/2013

2013

STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING

Time Allotted : 3 Hours *Full Marks :* 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Questions)

1. Choose the correct alternatives for any *ten* of the following :

10 × 1 = 10

i) In a single degree freedom damped forced vibration, magnification factor μ is given by (if r = frequency ratio and ε = damping ratio)

a) $\dfrac{1}{\sqrt{(1-r^2)^2+4\varepsilon^2 r^2}}$ b) $\dfrac{1}{\sqrt{(1-r)^2+4\varepsilon r}}$

c) $\dfrac{1}{\sqrt{(1-r^2)^2+4\varepsilon r}}$ d) none of these.

ii) The equivalent stiffness of a system comprising of two linear springs (constants k_1 and k_2) connected in series is

a) $k_1 + k_2$

b) $\frac{k_1 k_2}{k_1 + k_2}$

c) $\frac{1}{k_1} + \frac{1}{k_2}$

d) none of these.

iii) A system is said to have overdamped condition when

a) $c > c_{cr}$

b) $c = c_{cr}$

c) $c < c_{cr}$

d) All of these.

iv) For underdamped free vibration, logarithmic decrement is given by

a) $\frac{2\pi D}{\sqrt{1 - D^2}}$

b) $\frac{2\pi\sqrt{1 - D^2}}{D}$

c) $\frac{2\sqrt{1 - D^2}}{\pi D}$

d) $\frac{2\pi}{D\sqrt{1 - D^2}}$.

v) The equation of motion for undamped free vibration is

a) $m\ddot{u} + ku = 0$

b) $m\ddot{u} + c\dot{u} + ku = f(t)$

c) none of (a) and (b)

d) both of (a) and (b).

vi) A dynamic periodic load is that which

a) varies in magnitude with time and repeats itself at regular intervals

b) varies in magnitude with time and does not repeat itself at regular intervals

c) does not vary in magnitude with time and repeats itself at regular intervals

d) none of these.

vii) Earthquake resistant design and construction of buildings is guided by

a) IS 1893	b) IS 4326
c) IS 13827	d) none of these.

viii) Logarithmic decrement (δ) is defined as (where Y_1 and Y_2 are the two consecutive peaks)

a) $\delta = \log (Y_1 / Y_2)$ in free vibration

b) $\delta = ln (Y_2 / Y_1)$ in forced vibration

c) $\delta = ln (Y_1 / Y_2)$ in free vibration

d) $\delta = ln (Y_2 / Y_1)$ in free vibration.

ix) The degree of relative isolation is

a) Transmissibility b) Resonance

c) Damping d) Vibration.

x) The ratio of Importance factor (I) and Response reduction factor (R) shall not be

a) Less than unity b) Equal to unity

c) Greater than unity d) None of these.

xi) A vibrating system consisting of a weight of W = 15 N and a spring with stiffness k = 2 N/m. The angular natural frequency of the system is

a) 4·4 b) 5·7

c) 3·5 d) 5·0.

xii) A vibrating system consists of a mass of 5 kg, a spring stiffness of 5 N/mm and a dashpot with a damping coefficient of 0·1 N-s/m. The damping ratio is

a) 0·413 b) 0·313

c) 0·922 d) 0·612.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Write short notes on the following : 3 + 2

   a) Elastic rebound theory

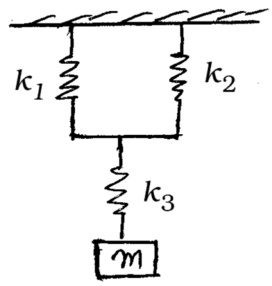
   b) Natural frequency.

3. Determine the magnification factor of forced vibration produced by an oscillator fixed at the middle of a beam at a speed of 600 rpm. The weight concentrated at the middle of the beam is 5000 N and produces a statical deflection of the beam equal to 0·025 cm. Neglect the weight of the beam and assume that the damping is equivalent to a force acting at the middle of the beam proportional to the velocity and equal to 500 N at a velocity of 2·5 cm/sec.

4. What is Duharmels integral ? Discuss its application in solving structural dynamics problems.

5. Discuss the underdamped and overdamped systems with relevant graphs and expressions.

6. A system as shown in figure below, having $k_1 = k_2 = 6 \times 10^4$ N/m and $k_3 = 2 \cdot 5 \times 10^4$ N/m, m = Mass = 200 kg. Determine the equivalent stiffness and natural frequency of the system.

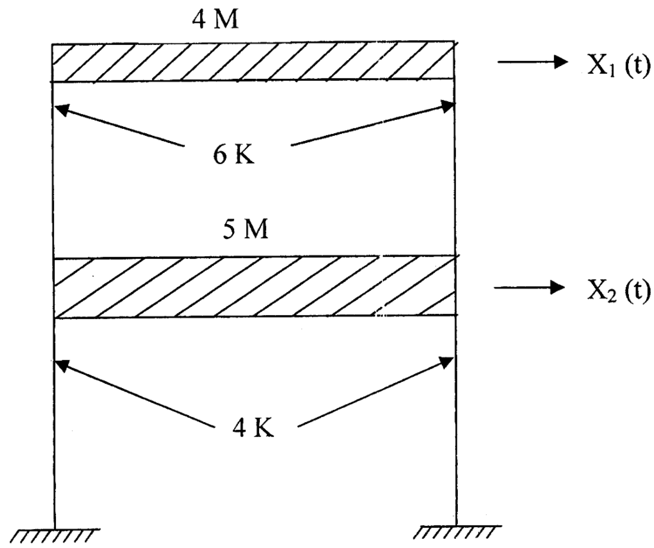


GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. Consider the two-storied building as shown below :



a) Derive the mass and stiffness matrices.

b) Calculate the natural periods and draw mode shapes.

7 + 8

8. a) Discuss the graphs for magnification factor versus frequency ratio.

   b) For a block foundation whose weight is 2500 kg is resting on soil spring of stiffness k = 200000 N/m.

      (i) Determine natural frequency.

      (ii) If the foundation is subjected to a harmonic force 100 sin $2t$, evaluate the dynamic magnification factor considering damping is zero.

      (iii) If the foundation is having damping coefficient 5 %, evaluate its magnitude of damping.

   c) What is vibration isolators and why is it required ?

5 + 7 + 3

9. Write short notes on the following : 3 × 5

   a) Transmissibility ratio

   b) Resonance

   c) Seismograph.

10. a) What is logarithmic decrement ? Derive its expression.

    b) A rotor of mass 2kg was running at a constant speed of 30 cycles/sec with an eccentricity of 160 mm. The motor was mounted on an isolator with damping factor of 0·25. Determine the stiffness of the isolator spring such that 15% of the unbalanced force is transmitted to the foundation. Also determine the magnitude of the transmitted forces. 7 + 8

11. A five-storied RCC framed building will be constructed in Delhi in medium soil. Floor to floor weight = 3·2 m. It is a square building of plan size 12 m × 12 m. Columns are spaced 4 m c/c in both the direction. Live load on floor = 4 kN/m^2 and no live to be considered on roof. Thickness of floor and roof = 130 mm. The size of beam may be considered 250 mm × 450 mm and columns may be considered 400 mm × 400 mm. Determine the base shear and its distribution along the height as per IS 1893 – 2002.