Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(CE)/SEM-8/CE-802/5/2012

2012

STRUCTURAL DYNAMICS & 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 Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) The maximum displacement of a linear elastic system for a constant force applied suddenly is

   a) $2\ y_{st}$ b) y_{st}

   c) $3\ y_{st}$ d) $0{\cdot}5\ y_{st}$.

   ii) Consider a beam has two lumped mass and the corresponding mass points translate in vertical direction and rotational displacement. The number of Dynamic Degrees of Freedom (DOF) is

   a) 2 b) 12

   c) 4 d) 8.

iii) A mass 2 kg is attached to the end of a spring with stiffness 0·8 kN/mm. The critical damping constant is

a) 74·92 Ns/m b) 80 Ns/m

c) 40·7 Ns/m d) 70 Ns/m.

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

a) $\delta = \log\left(\frac{Y_1}{Y_2}\right)$ in free vibration

b) $\delta = ln\left(\frac{Y_2}{Y_1}\right)$ in forced vibration

c) $\delta = ln\left(\frac{Y_1}{Y_2}\right)$ in free vibration

d) $\delta = ln\left(\frac{Y_2}{Y_1}\right)$ in free vibration.

v) The dynamic magnification factor is defined as the

a) $\frac{Y_{st}}{Y}$ b) $Y \times Y_{st}$

c) $\frac{Y}{Y_{st}}$ d) $\sqrt{\frac{Y}{Y_{st}}}$

where, Y_{st} and Y are the static deflection and steady state amplitude.

vi) 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.

vii) Seismic waves can be classified as

a) only body wave

b) Rayleigh light waves & surface waves

c) only surface wave

d) surface wave & body wave.

viii) During any fault it is associated with

a) gaining of strain energy

b) release of strain energy

c) gaining and release of strain energy

d) none of these.

ix) A mass on a structure deforms in three dimensional space. Then the D.O.F. will be

a) 1 b) 3

c) 6 d) 9.

x) A damping force is chosen as

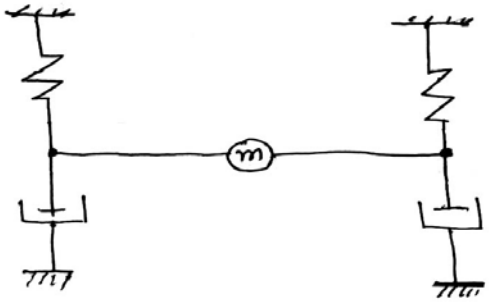
a) opposite to the direction of velocity of motion

b) opposite to the direction of frictional force

c) both (a) and (b)

d) none of these.

xi) The following system is associated with



a) vertical excitation b) torsional excitation

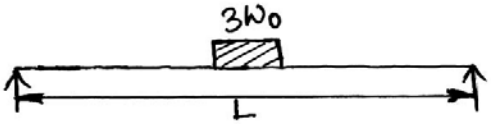
c) horizontal excitation d) none of these.

GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

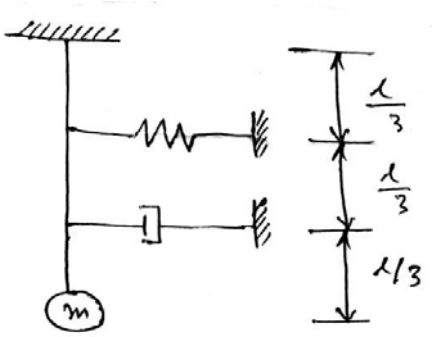
2. State d'Alembert's principle. Explain the fundamental differences between static and dynamic problems.

3. At t = 0 one-third of the weight is suddenly removed. What will be the equation of deflection of curve at any instant ? The figure is shown below :



4. Derive equation of motion for an undamped harmonic excitation.

5. A mass is attached to a rigid mass-less bar of length l. A spring of stiffness, k and a damping coefficient, c is attached to the bar as shown in figure below. Derive the equation of motion of the system.

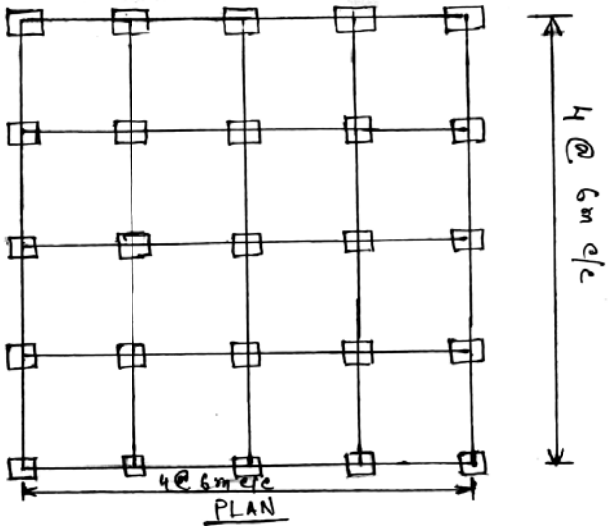


6. Determine the value of horizontal seismic coefficient for a community centre situated in Kolkata. The geotechnical exploration carried out at the site indicated soft clay up to 10 m depth and therefore needing pile foundation for the structure. Take natural time period as 0·4 sec with damping ratio of 5%. Use response spectrum method. (Use IS:1893-2002)

GROUP – C
(Long Answer Type Questions)

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

7. a) A G+4 OMRF building has plan dimension as shown below :



Numerical Data :

Size of column — 300 mm × 450 mm

Size of beam — 250 mm × 300 mm

Depth of slab — 125 mm

Floor height — 3·3 m

Infill wall — 250 mm thick including plaster in exterior and 125 mm in interior

Imposed load — 3 kN/m^2 in floor level and roof level is 1·5 kN/m^2.

The soil below the foundation is medium and the building is located in Kolkata. Determine the seismic forces and shears at different floor levels by using IS 1893 (Part 1):2002.

b) Sketch the reinforcements at the junction of a beam and column as per IS 13920:1993. 10 + 5

8. a) Derive expressions for the response of a single degree of freedom structure to a constant force.

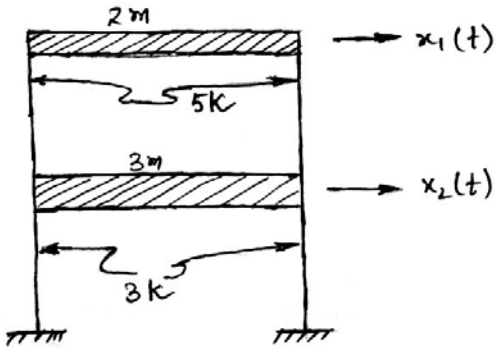
b) A square pulse of time duration T is acting on an undamped system given below :

$$F(t) = F_0 \quad \text{for } 0 \le t \le t_d$$

$$= 0 \quad \text{for } t > t_d$$

Derive an expression for the response of an SDOF structure to this loading, starting from 'at rest' conditions. Determine the maximum amplitude during the impulse and the magnification factor. 5 + 10

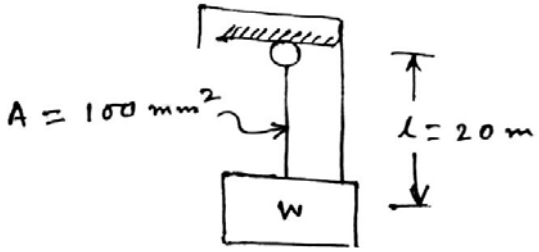
9. Consider the two storey building shown in the figure :



a) Derive the mass and stiffness matrices for the building showing all the considerations in detail, and write down the governing equation for free vibration.

b) Calculate its natural periods and mode shapes. Show a rough plot for each of the mode.

10. An elevator cage of weight, W = 50 kN is supported by a flexible twisted steel cable, the upper end of which in unwinding from a rotating drum as shown below. As the cage is being lowered with uniform velocity of 1 m/sec, the drum suddenly stops when unwounded length of cable is, l = 20 m. Determine amplitude of vibration & maximum tensile stress induced in the cable. Take $E = 2\times10^5$ N/mm^2.



11. Write short notes on the following :

    a) Elastic rebound theory

    b) Plate tectonic theory

    c) *S*-wave and *P*-wave

    d) Resonance

    e) Response Spectrum.

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