Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS / B.TECH (CE-NEW) / SEM-8 / CE-802/5 / 2011

2011

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)   Consider a beam has three lumped mass in 3D-space. The number of dynamic-degree of freedom (DOF) is

         a)   3   b)   9

         c)   12   d)   18.

8133   [Turn over

ii) A mass of 1 kg is attached to the end of a spring with stiffness 0·7 kN/mm. The critical damping constant is

a) 52·92 NS/m

b) 50 NS/m

c) 60·7 NS/m

d) 40 NS/m.

iii) One useful definition of the critically damped condition is that

a) it is a damping for which the responses are delayed exponentially

b) it is the smallest amount of damping for which no oscillation occurs in the free response

c) it is the largest amount of damping for which no oscillation occurs in the free response

d) none of these.

iv) The value of damping coefficient for real structure usually ranges between

a) 2% to 20%

b) 3% to 30%

c) 1% to 10%

d) 5% to 50%.

v) A system is said to have underdamped condition when

a) $C > C_{cr}$
b) $C = C_{cr}$

c) $C < C_{cr}$
d) all of these.

vi) A shaft 10 mm in diameter and 0·2 m long connects a generator to the main engine. If the mass moment of inertia of the generator is 0·55 N-mm-s². The natural frequency in torsion is

[$G = 8 \times 10^6$ N/cm²]

a) 38·73 cycles / sec
b) 42·53 cycles / sec

c) 100 cycles / sec
d) 300 cycles / sec.

vii) 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.

viii) In the limit state design of reinforced concrete structure, DL = 253 kN, LL = 20 kN, EL = 100 kN. The correct answer is

a) 409·5 kN
b) 620·27 kN

c) 447 kN
d) 529·5 kN.

ix) The degree of relative isolation is

a) Transmissibility b) Resonance

c) Damping d) Vibration.

x) The stage when forcing frequency equals natural frequency of the system is known as

a) Resonance b) Steady state

c) Transient response d) none of these.

xi) For designing seismic resistance structure a factor of ductility demand is commonly used as

a) 3 b) 0·02

c) 0·2 d) 2.

GROUP – B

(Short Answer Type Questions)

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

2. Define rectangular impulse.

3. Derive the equation governing the free motion of a simple pendulum as shown in figure below, which consists a point mass, m suspended by a light spring of length 'l'.
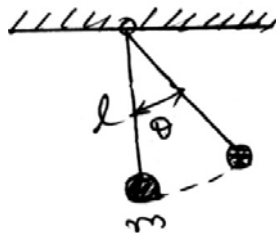
4. Explain in detail what is logarithmic decrement with diagram.

5. Derive an equation for undamped free vibration of MDOF system. Also express the elements of stiffness matrix.

6. Briefly describe the rebound theory of Earthquake.

GROUP – C

(Long Answer Type Questions)

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

7. Describe Plate Tectonic theory and Elastic rebound theory of earthquakes. Describe various waves generated due to earthquakes.   9 + 6

8. Derive an expression for the magnification factor for harmonic loading. Plot curves showing variation of dynamic magnification factor with frequency ratio, *B* for different values of critical damping ratio.   9 + 6
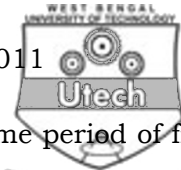
9. a) Determine the natural frequency and time period of free vibration of structure as shown below. The column may be assumed to be mass less and horizontal girder may be assumed to be rigid. 5
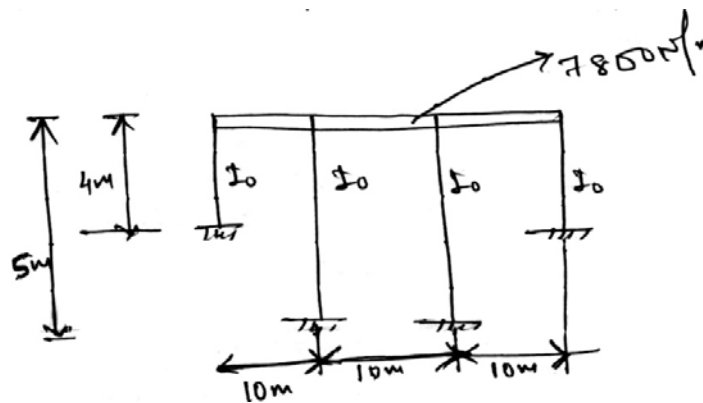

For all dimension $E = 2 \times 10^{11}$ N/m^2, $I_0 = 2 \cdot 7 \times 10^{-5}$ m^4

    b) A body vibrating with viscous damping makes 10 complete oscillations per second. Determine damping coefficient n , if after a lapse of 10 seconds, the amplitude of vibration reduces by 10% with respect to the initial. Determine in what proportion the period of vibration decreases if damping is removed. Calculate logarithmic decrement. 5

c) At $t = 0$, one-fourth of the weight is suddenly removed. What will be the equation of deflection of curve at any instant ? The figure is shown below :
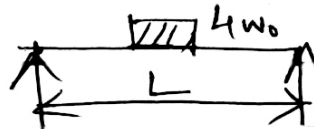
5

10. A two-storey shear frame has the mass and storey stiffness properties as shown in figure below :

Determine the modal expansion of the effective Earthquake force distribution associated with horizontal ground acceleration $ug(t)$.
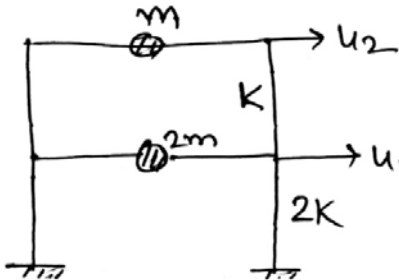
11. Write short notes on the following :

a) Free vibration and forced vibration.

b) Lithosphere and Asthenosphere.

c) Duhamel's Integral.

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