BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
B.E. 8th SEMESTER (CE) EXAMINATIONS, 2013
Earthquake Engineering (CE –803/2)

Full Marks: 70 **Time: 3 hrs**

Use separate answerscript for each half.
*Answer **SIX** questions, taking **THREE** from each half.*
Two marks are reserved for neatness in each half.
Assume any suitable data, if necessary.
Symbols and abbreviations have their usual meanings.
The use of relevant codes is allowed.

FIRST HALF

1. a) Describe with sketches the different types of inter-plate boundaries and the kind of earthquakes that occur along them.

   b) What are the effects of soil on the intensity of an earthquake at a site? Discuss briefly the case of the 1985 Mexico City earthquake to illustrate your answer.

   c) Name the important scales for the measurement of magnitude and intensity of an earthquake.

   (4+4+3=11)

2. a) Explain how the following features adversely affect the seismic performance of R.C. buildings:

   i) open ground storey for parking, etc.

   ii) short columns due to mezzanines floor, etc.
   iii)floating box construction
   iv) plan asymmetry

   b) Which is to be avoided and why – weak column-strong beam structural system or a strong column-weak beam structural system?

   (8+3=11)

3. A two-storied single bay portal of horizontal span 6m and height 5m for ground floor and 3m for 1st floor, has the following properties:
   I_{xx} for each column = 8604 cm^4; E = 2 x 10^5 N/mm^2; Wt. on each floor = 600 kN (including contribution from columns and walls)
   For seismic analysis in the x-dirn., calculate the natural frequencies and time periods. Also calculate the orthonormal mode shapes.

   (11)

4. a) State the assumptions of a shear building.

   b) Prove the orthogonality property of mode shapes with respect to the mass and stiffness matrices of a MDOF system.

   c) Explain how modal analysis allows the use of the Response Spectrum in the seismic analysis of MDOF systems?

   d) State the limitations of the SRSS modal combination rule.

   (2+4+3+2=11)

5. a) For the system described in Q.3 calculate the modal masses and give your comments on the modal contribution of the various modes.

   b) What is classically damping? Give an example of system each of a classically damped and a non-classically damped.

   c) Differentiate between Design Response Spectrum and the Response Spectrum for a particular earthquake ground motion.

   (5+3+3=11)

SECOND HALF

6. Consider a four-storeyed reinforced concrete office building shown in Fig.Q6. The building is located in seismic zone-IV. The soil conditions are medium stiff and the entire building is supported on a raft foundation. The R.C frames are infilled with brick-masonry. The lump weight due to dead loads is 23 kN/m^2 on floors and 18kN/m^2 on the roof. The floors are to cater for a live load of 4 kN/m^2 on floors and 1.5 kN/m^2 on the roof. The dynamic properties (natural periods and mode shape) for vibration in the X-direction have been obtained by carrying out a free vibration analysis given in Table 1. Calculate the design seismic force in the X-direction by the dynamic analysis method and distribute it with building height as per provisions given in IS: 1893, 2002.

Table 1

Natural Period (Sec)	Mode 1	Mode 2	Mode 3
	0.859	0.266	0.146
	Mode Shape		
Roof	1.000	1.000	1.000
3rd Floor	0.902	0.217	-0.843
2nd Floor	0.716	-0.799	-0.582
1st Floor	0.438	-0.925	1.011

(11)

7. Design the Shear Wall as per IS:13920: 1993 having the following data
   i) Length of the Shear Wall: 4.5m
   ii) Height of the Shear Wall: 5.3m
   iii) Thickness of the Shear Wall: 250mm
   iv) Size of boundary element at both side of the shear wall : 375mm × 750mm
   v) Grade of concrete: M20
   vi) Grade of steel: Fe415

   Give load combination for the shear wall

Loading	Axial Force (Pu)	Moment (Mu)	Shear Force (Vu)
DL+LL	550 kN	375 kN-m	30 kN
Earthquake	215 kN	410 kN-m	115 kN

(11)

8. A R.C.C beam having the following data
   i) Clear span = 5m
   ii) Size of beam = 250mm (Width) × 550mm (Depth)
   iii) Grade of concrete: M25
   iv) Grade of steel: Fe415
   v) Thickness of slab = 125mm

	Area of Reinforcement (mm^2)		
	Left End	Middle	Right End
Top	1825	985	1964
Bottom	950	1025	925

Design and detail of the beam as per recommendation of IS: 13920, 1993.

(11)

9. Consider a simple one storey building having two shear wall in each direction shown in Fig.Q9. It has some gravity columns that are not shown. All four walls are in M25 grade of concrete, 200 mm thick and 3.5m long. Storey height is 4.3m. Floor consists of cast-in-situ reinforced concrete. Design shear force on the building is 150 kN in either direction. Compute design lateral forces on different shear walls using the torsion provisions of IS: 1893 (Part-I), 2002.

(11)

10. a) Enumerate the advantage and disadvantage of brick masonry structures.
    b) What are the various components of a typical masonry building?
    c) What do you mean by in-plane and out of plane wall?

(5+3+3=11)

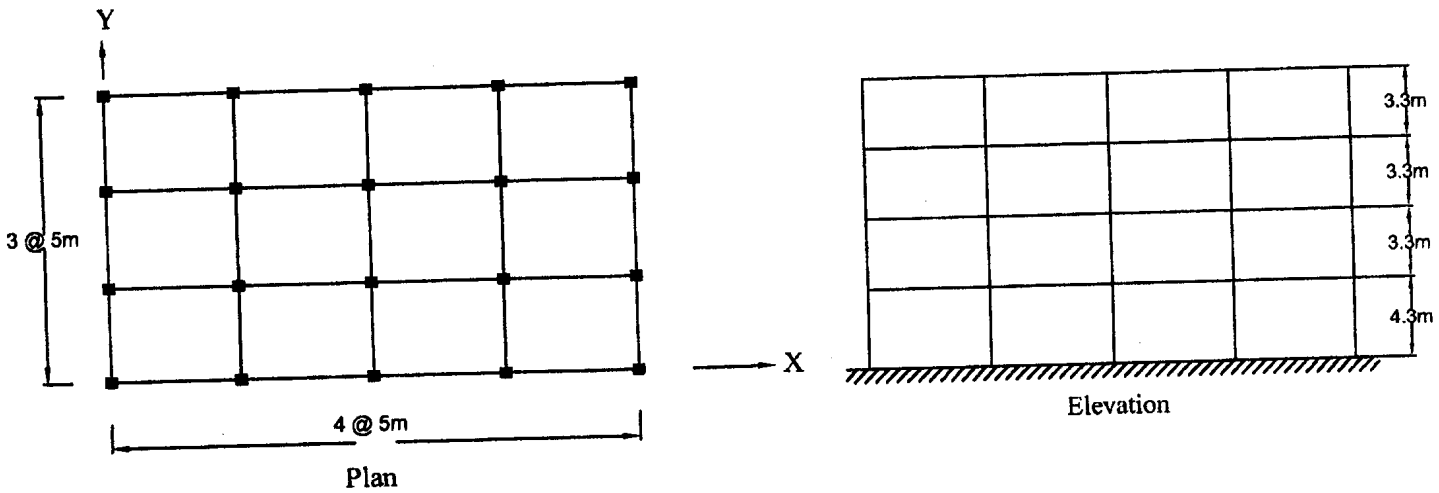

Fig. Q6 Plan and Elevation of four storeyed building

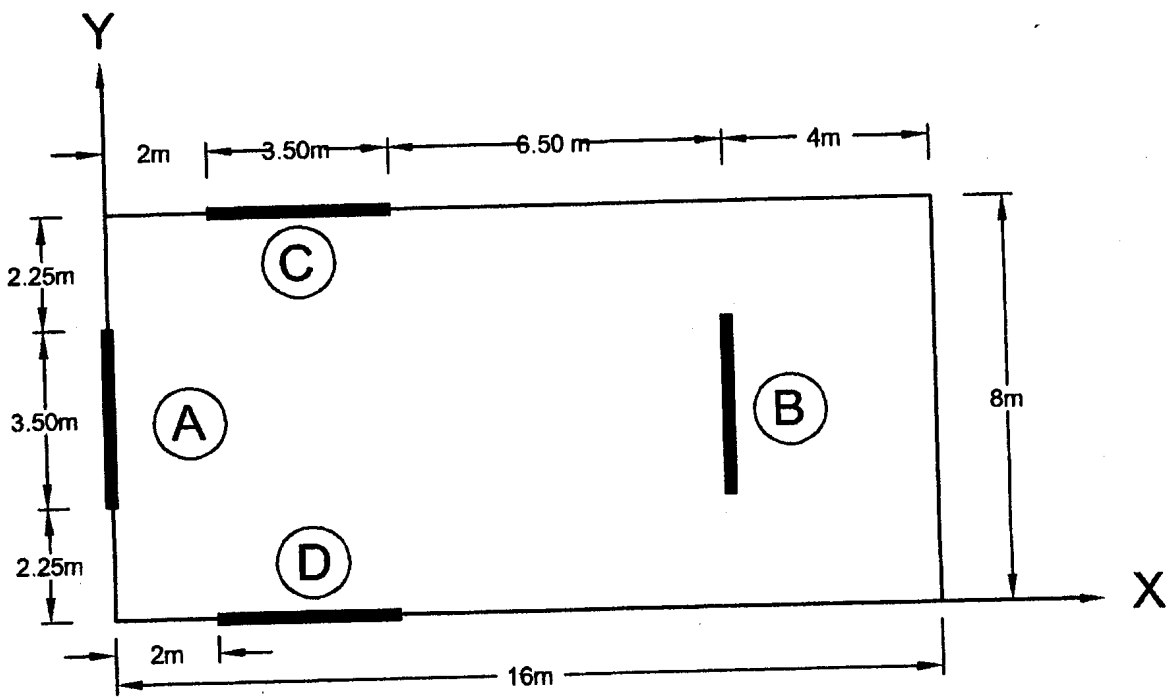

Fig. Q9