Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI • EXAMINATION – SUMMER 2013

Subject Code: 160605 Date: 30-05-2013

Subject Name: Earthquake Engineering

Time: 10.30 am - 01.00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **IS 1893 Part 1 2002 & IS 13920 – 1993 are allowed in the examinations**

Q.1	**(a)**	Derive expression for the response of free damped SDOF structural system.	**07**
	(b)	Force-Displacement relationships are shown in fig (1) for three different materials. Arrange these materials in descending order with proper calculation for following criteria 1. Strength 2. Stiffness 3. Ductility 4. Energy absorption capacity Also give your opinion about material which is the best among all with respect to above criteria.	
Q.2	**(a)**	**State whether following statements are true or false. Give logical reason for your answer :** 1. Numbers of intra-plate earthquakes in world are more than numbers of inter-plate earthquakes. 2. Kochi is having maximum earthquake risk. 3. Peak ground acceleration (PGA) & Zero period acceleration (ZPA) are same. 4. Performance of shear walls which are located near geometric centre of building is better than the identical shear wall located on periphery. 5. A building is located on the boundary of zone IV & V. It will be designed as if it is in zone IV. 6. Code specifies higher value of R for building having better performance. 7. Two identical building to be constructed in zone IV & V. Building in zone V should be designed for lower lateral load than building in zone IV.	**07**
	(b)	A two bay single storey RCC plane frame in which lumped mass of 20 tonne is supported on three columns (AB, CD & EF) having fixed support. $L_{AB} = 0.5\ L_{CD} = 0.25\ L_{EF} = 2$ m Calculate (i) (i) Natural frequency of damped vibration (ii) BM & SF at support for the RCC frame after five cycles of vibration if floor is displaced horizontally by 300mm & suddenly released. Assume rigid diaphragm action. Take fck = 25 MPa & size of column 600 mm x 600 mm. Assume 8% damping.	**07**
		OR	
	(b)	Explain the phenomenon of resonance. A SDOF system consists of 5 m high column of 300 mm diameter which supports the heavy mass of 20 tonne at its top. The system is subjected to a harmonic force of 200 Sin 50t kN. Consider 20% damping & E = 2.1 x 10^5 N/mm^2. Calculate the maximum dynamic amplitude. Also state whether system will have resonance or not?	**07**
Q.3	**(a)**	Calculate base shear for hotel of Gujarat Tourism (100 rooms) in Mount Abu with following data by static coefficient method.	**07**

		(a) No. of storey = 15 (b) No. of bay in x direction = 2 I No. of bay in y direction = 5 (d) storey height = 4.0 m (e) Width of each bay = 5 m (f) Size of beam = 300 x 450 mm (g) size of column = 600 x 300 m (h) LL = 3 kN/m^2 (i) Thickness of slab = 150 mm (j) Damping = 9% of critical damping (k) Type of soil = Soft soil Assume suitable data if required. Write all your assumptions & clauses of IS 1893 (2002).	
	(b)	Ref Q 3 (a) Calculate lateral forces at each floor level. Also draw distribution of lateral force at each floor level.	**07**
		OR	
Q.3	**(a)**	**Explain any two** 1. Philosophy of Earthquake resistant design. Give four virtue of good earthquake resistant design. 2. Differentiate Static DOF & Dynamic DOF. Explain assumptions to reduce dynamic DOF of multi-storey building. 3. Differentiate (i) Magnitude & Intensity (ii) Seismograph Vs Seismogram (iii) S wave & Love wave (iv) center of mass & center of stiffness	**07**
	(b)	**Attempt any two** 1. Explain mathematical modeling in detail. Draw mathematical model for any two structural system. 2. Enlist various codes of practice along with correct name related to earthquake engineering. 3. Elastic rebound theory	**07**
Q.4	**(a)**	**Attempt any two** 1. Explain various irregularities found in the civil engineering structures from earthquake point of view. 2. Enlist two major/great Indian intra-plate & two interpolate earthquake with usual details. 3. Two pendulums are hanging on an ideal spring. The frequency of first pendulum is twice the frequency of second pendulum & the mass of first pendulum is four times the mass of second pendulum. What is the stiffness of the second pendulum with respect to first?	**07**
	(b)	Analyze the 4 bay two storey RC frame by any appropriate approximate method of analysis if 400 kN & 200 kN forces are acting at first & ground storey. Draw axial force, shear force & bending moment diagram. Height of floor = 5 m & bay width is 4 m.	**07**
		OR	
Q.4	**(a)**	**Attempt any two** 1. Explain soft storey & discuss its performance of soft storey building in past earthquakes. How will you avoid soft storey? 2. Explain the concept of base isolation. Discuss its suitability. 3. A spring mass (k1, m1) system has a natural frequency f1. Calculate the value of stiffness of other spring which when connected to k1 in series decreases the frequency by 50%.	**07**
Q.4	**(b)**	A 10 m high single storey industrial RC building (SDOF) having plan dimension 20 m x 15 m is located in Delhi. Floor slab of the building is supported on four corner columns. Calculate the eccentricity & carry out lateral load distribution as per IS 1893 Part I 2002 if 2700 kN force is acting at floor level. Size of columns are 300 mm x 300 mm	**07**
Q.5	**(a)**	Explain ductile detailing of column as per IS 13920 – 1993. Also give limitation of this code.	**07**

	(b)	a. A SDOF system having the amplitude of vibration in successive cycle are 0.90, 0.45, 0.23, 0.11 units respectively. Determine damping ratio of the system. b. Earthquake force acting in horizontal direction at the top of a single storey building frame is 2000 kN. & slab is supported on three columns. What is the shear force distribution in the column if column having different moment of inertia? Take $(I)_1 = 0.5(I)_2 = 0.25(I)_3$	**07**
		OR	
Q.5	**(a)**	For the two storey building frame having lumped masses 20 tonne at floor levels having first storey stiffness 60 kN/m & second storey stiffness is 90 kN/m. Perform free vibration analysis & draw all mode shapes. Also calculate the length of 300 mm thick shear wall at ground storey to avoid soft storey effect.	**07**
	(b)	**Explain following** 1. Earthquake resistant feature of masonry structure. 2. Liquefaction and give remedial measures for it.	**07**

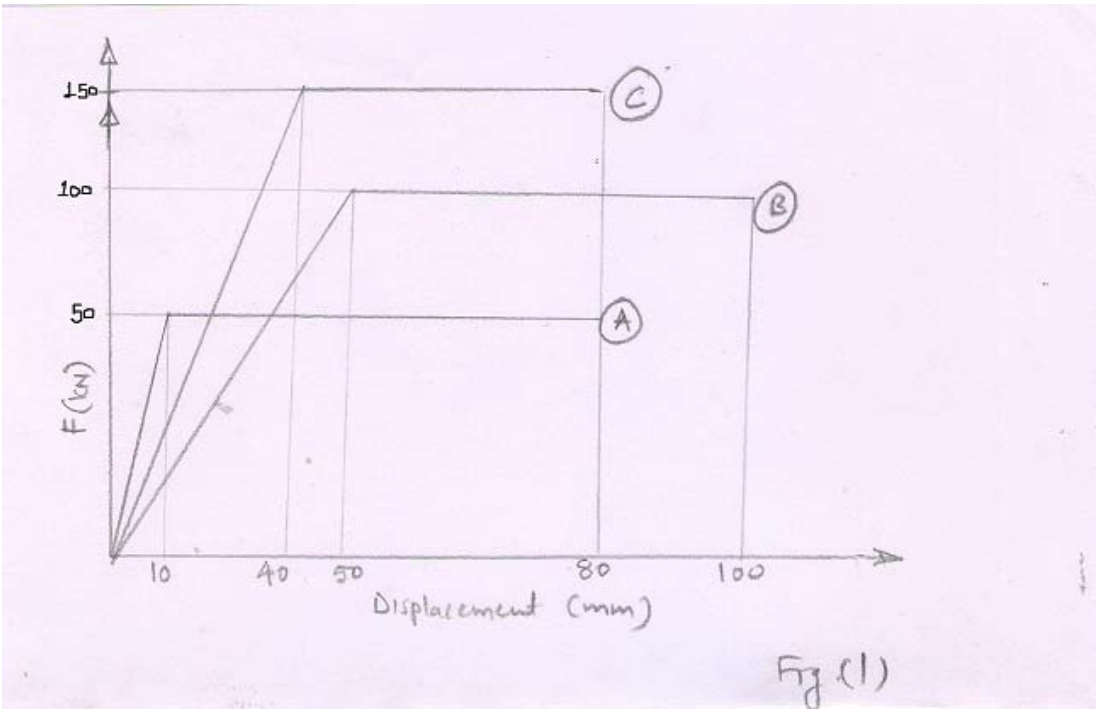

Fig (1)