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**

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| **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<br>1. Strength<br>2. Stiffness<br>3. Ductility<br>4. Energy absorption capacity<br>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 :**<br>1. Numbers of intra-plate earthquakes in world are more than numbers of inter-plate earthquakes.<br>2. Kochi is having maximum earthquake risk.<br>3. Peak ground acceleration (PGA) & Zero period acceleration (ZPA) are same.<br>4. Performance of shear walls which are located near geometric centre of building is better than the identical shear wall located on periphery.<br>5. A building is located on the boundary of zone IV & V. It will be designed as if it is in zone IV.<br>6. Code specifies higher value of R for building having better performance.<br>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.<br>$L_{AB} = 0.5\ L_{CD} = 0.25\ L_{EF} = 2$ 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.<br>**OR** | **07** |
| | **(b)** | Explain the phenomenon of resonance.<br>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** |

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| | | (a) No. of storey = 15 (b) No. of bay in x direction = 2<br>I No. of bay in y direction = 5 (d) storey height = 4.0 m<br>(e) Width of each bay = 5 m (f) Size of beam = 300 x 450 mm<br>(g) size of column = 600 x 300 m (h) LL = 3 kN/m$^2$<br>(i) Thickness of slab = 150 mm (j) Damping = 9% of critical damping<br>(k) Type of soil = Soft soil<br>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**<br>1. Philosophy of Earthquake resistant design. Give four virtue of good earthquake resistant design.<br>2. Differentiate Static DOF & Dynamic DOF.<br>Explain assumptions to reduce dynamic DOF of multi-storey building.<br>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**<br>1. Explain mathematical modeling in detail. Draw mathematical model for any two structural system.<br>2. Enlist various codes of practice along with correct name related to earthquake engineering.<br>3. Elastic rebound theory | **07** |
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| **Q.4** | **(a)** | **Attempt any two**<br>1. Explain various irregularities found in the civil engineering structures from earthquake point of view.<br>2. Enlist two major/great Indian intra-plate & two interpolate earthquake with usual details.<br>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**<br>1. Explain soft storey & discuss its performance of soft storey building in past earthquakes. How will you avoid soft storey?<br>2. Explain the concept of base isolation. Discuss its suitability.<br>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** |
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| **Q.5** | **(a)** | Explain ductile detailing of column as per IS 13920 – 1993. Also give limitation of this code. | **07** |

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| | **(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.<br>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**<br>1. Earthquake resistant feature of masonry structure.<br>2. Liquefaction and give remedial measures for it. | **07** |
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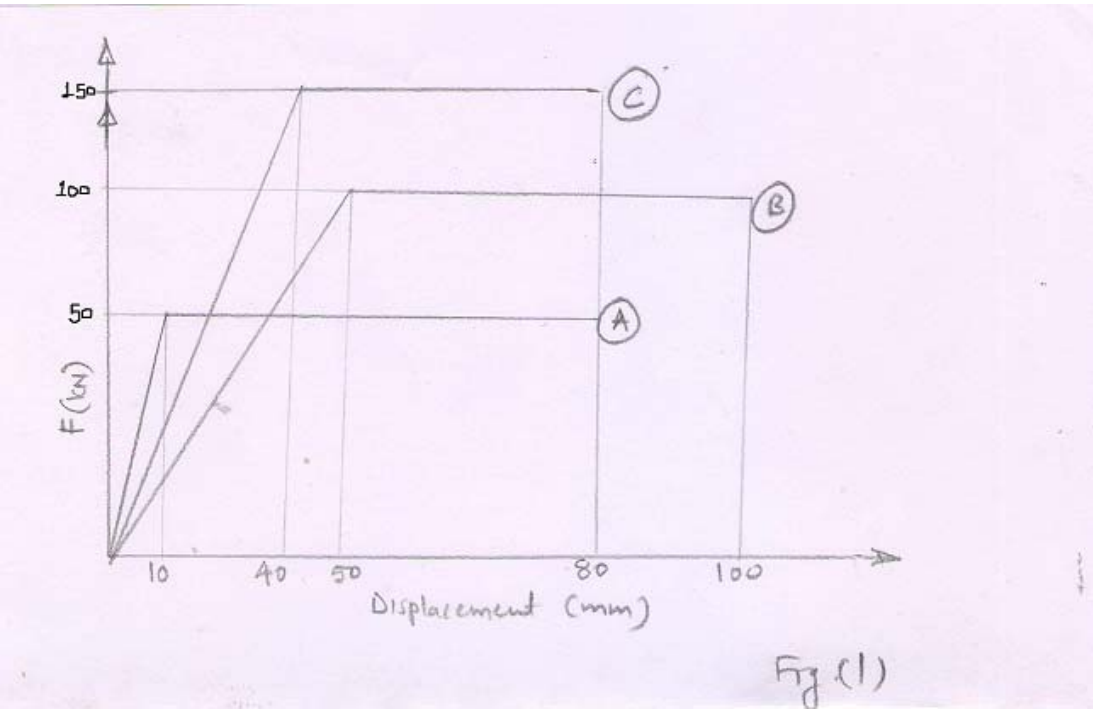

Fig (1)