05 A TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2075 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Earthquake Resistance Design of Structure *(Elective II) (CE76501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Use of IS 1893-2002(part I) is allowed.***
- ✓ *Assume suitable data if necessary.*

1. a) Briefly explain the plate tectonic theory. Define a magnitude of an earthquake. How is its different from intensity of an earthquake? [3+3]

   b) Estimate the moment magnitude of an earthquake with rupture length of 100 km rupture width of 50 km and slip of average fault slip of 3.20 m. Take modulus of rigidity as 3.5×10^{10} N/m^2. [6]

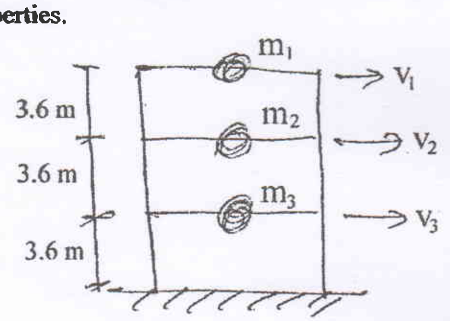
2. a) Lists the different Attenuation relationship model with mathematical expressions for PGA. [3]

   b) Using a appropriate Attenuation law, estimate PGA at a site which is 220 km from MCT(3.3) with a = 6.2, b = 0.8 having 10% probability of an exceedance in 50 years. [7]

   c) Explain the information required for Seismic Hazard Analysis. Also explain in stepwise how probabilistic seismic hazard analysis of a site is carried out. [9]

3. a) Compare the seismic coefficient method and response spectrum method in the design of multi storeyed buildings. [4]

   b) A three storey building as shown in figure below has the following vibration properties.



$m_1 = 21{,}000$ kg

$m_2 = 42{,}000$ kg

$m_3 = 58{,}000$ kg

$$[\phi] = \begin{bmatrix} 1.00 & 1.00 & 1.00 \\ 0.530 & -1.53 & -6.36 \\ 0.190 & -0.86 & 13.12 \end{bmatrix}$$

$$\{w\} = \begin{Bmatrix} 4.86 \\ 8.36 \\ 13.56 \end{Bmatrix} \text{rad/secs}$$

and

Pseudo velocity responses

$$\{Sv\} = \begin{Bmatrix} 0.64 \\ -0.23 \\ 0.35 \end{Bmatrix} \text{m/secs}$$

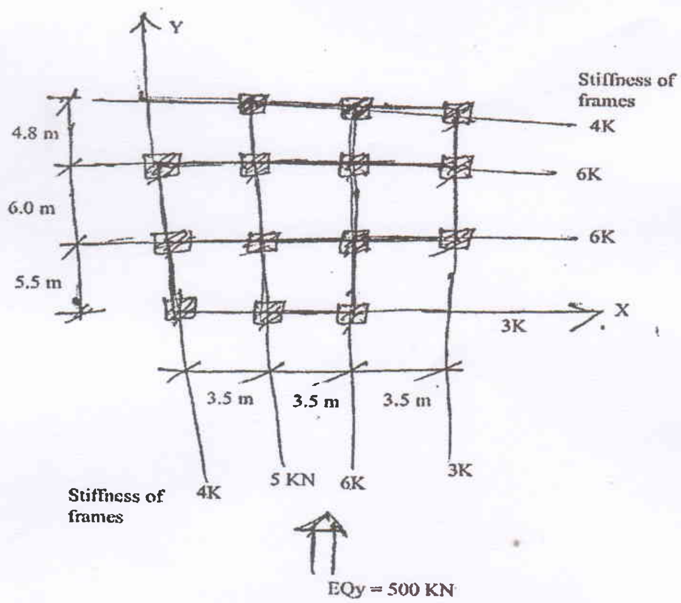
(i) Determine the displacement for each storey level due to all modes of vibrations

(ii) Determine the lateral load at each level for each mode of vibrations and also determine its maximum value due to all modes using SRSS method.

(iii)Determine the base shear due to all modes using also SRSS method. Also determine the mode participation factor, effective modal masses and the number of modes upto which the analysis to be considered as defined in IS 1893-2002. [15]

4. a) A three storey RCC residential building with a total height of 9.0m and a storey height of 3.0m each has to be designed in SMRF. The proposed building is located in seismic zone - V and soil condition as soft soil. The lumped weight due to dead loads is 6 KN/m^2 on floors and 5.0 KN/m^2 on roof. The floors are subjected to live load of 2.0 KN/m^2 and the roof to 1.5 KN/m^2. If the floor and roof at each level have area of 120 sq.m, determine the design seismic load on the building as per IS 1893-2002 (Part-I) [8]

b) The figure given below shown the plan of an one storey buildings which could be considered as composed of 2-D frames along the orthogonal directions. The roof diapharm is rigid in its own plane and mass of the roof is uniformly distributed. The building is subjected to a lateral load of 500 KN due to earthquake in Y-direction and passing through the centre of mass of the building. Calculate the lateral forces in the 2-D frames. [12]



5. a) What are advantages of SMRF over OMRF in the design of multi-storeyed building? What is the provision for drift evaluation in IS 1893-2002. [4]

b) Describe in a brief the Global stiffness matrix for a 3 - D moment resisting frames in reference with local stiffness matrix of plane frames of the same building. [6]

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05A TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Earthquake Resistant Design of Structures *(Elective II) (CE76501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt* ***All*** *questions.*
- ✓ *The figures in the margin indicate* ***Full Marks****.*
- ✓ *Assume suitable data if necessary.*

1 (a) What is tectonic theory? Explain in brief the elastic rebound theory. Define the magnitude of an earthquake as given by Charles Richter. (6)

(b) Calculate the moment magnitude of an earthquake with the rupture area dimensions of length 35km, width 15km and slip 1meter. Assume modulus of rigidity, $\mu = 3.5 \times 10^{10}$ N/m^2. (6)

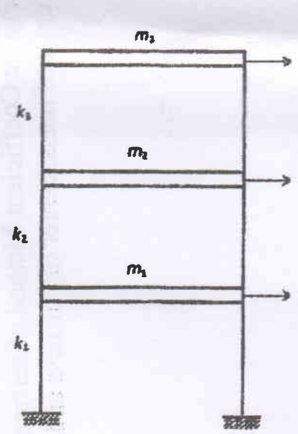
(c) What are the major steps of the Deterministic Seismic Hazard Analysis (DSHA)? What is the principle of Probabilistic Seismic Hazard Analysis (PSHA)? (4)

2 (a) What is response spectrum? Write down the relationship among pseudo velocity response, spectral displacement and pseudo acceleration response. (6)

(b) A three-story building is modeled as 3-DOF system and rigid floors as shown in Figure shown below. Determine the top floor maximum displacement and base shear due to El-Centro, 1940 earthquake ground motion using the response spectrum method. The El-Centro earthquake response spectrum is presented in the figure below. Take the inter-story lateral stiffness of floors i.e. $k_1 = k_2 = k_3 = 16357.5 \times 10^3$ N/m and the floor mass $m_1 = m_2 = 10000$ kg and $m_3 = 5000$ kg. The results of the free vibration analysis are also given below. (10)

$$\{\phi_1\} = \begin{Bmatrix} 1 \\ 1.732 \\ 2.0 \end{Bmatrix} \quad \{\phi_2\} = \begin{Bmatrix} 1 \\ 0 \\ 1 \end{Bmatrix} \quad \{\phi_3\} = \begin{Bmatrix} 1 \\ -1.733 \\ 2.0 \end{Bmatrix}$$

$$\omega_1 = 20.937\, rad/sec \quad \omega_2 = 57.2\, rad/sec \quad \omega_3 = 78.13\, rad/sec$$



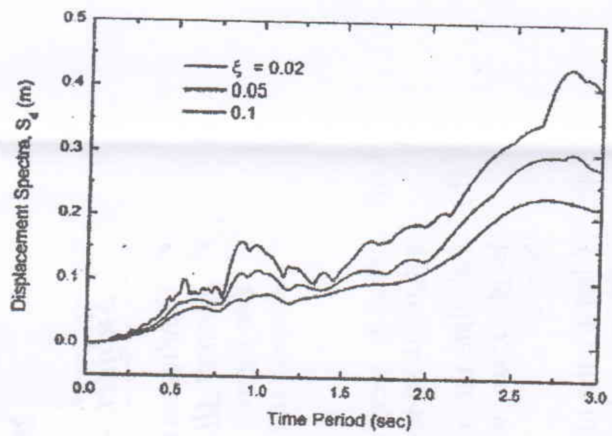
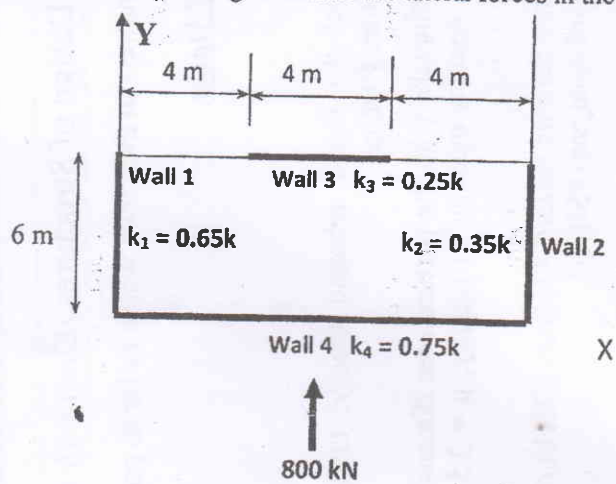


Figure: Displacement response spectra of El-Centro, 1940 earthquake ground motion.

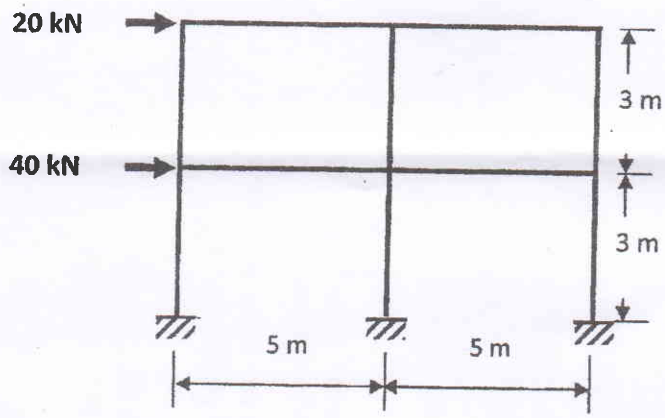
3 (a) Define rigid floor diaphragm. What is center of stiffness? Describe how the center of stiffness is determined with a simple example. (6)

(b) The figure given below shows the plan of a one-storey building, supported on four shear walls with the lateral stiffnesses as indicated, and oriented as shown. The roof diaphragm is rigid in its own plane, and the mass of the roof is uniformly distributed. The building is subjected to a lateral load of 800 kN, due to earthquake, in y-direction and passing through the center of mass of the building. Calculate the lateral forces in the walls. (10)



4(a). What is a moment resisting frame? Describe in brief the Global stiffness matrix for a 3-D moment resisting frame in reference with Local stiffness matrices of plane frames of the same building. (6)

(b) Analyze the frame shown in the figure given below using Portal method and construct Bending Moment diagram. Give the assumptions made in the analysis. All columns are of same cross section 300 x 300 mm. (10)



5. Write in brief the principles and concepts of (any three only) (4x4)

(a) Types of faults
(b) DOF and global stiffness matrix of 3-D moment resisting frames
(c) Lateral stiffness matrix of a solid shear wall with consideration of rocking of footing.
(d) Response spectrum analysis of a MDOF frame.
(e) Seismic Coefficient Method of seismic analysis
(f) Center of mass, center of stiffness and torsionally coupled system

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5 A TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Earthquake Resistance Design of Structure *(Elective II) (CE76501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Use of IS 1893-2002 (part-I) is allowed.***
- ✓ *Assume suitable data if necessary.*

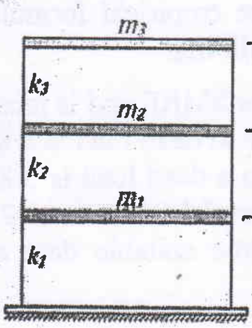
1. a) Discuss about the seismic hazards with suitable examples. [6]

   b) Define Richter scale. [2]

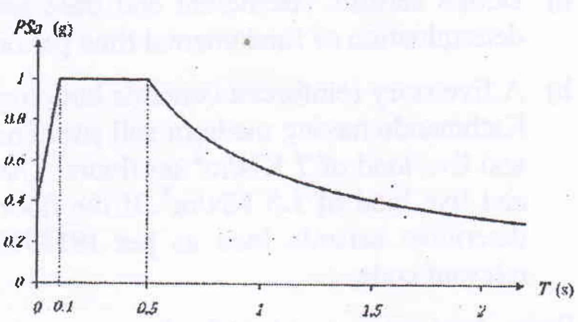
   c) Find the spectral pseudo-velocity and spectral displacement of a structure, which has a natural frequency of vibration 7 Hz and a damping ratio of $\xi = 0.03$, corresponding to a spectral acceleration of 14 m/sec^2. [4]

   d) An Earthquake causes an average of 4m strike-slip displacement over 120 km long, 40 km deep portion of a transform fault. Assuming that the rock along faulty had average rupture strength of 180 kpa, estimate the seismic moment and moment magnitude of the Earthquake. [4]

2. A three story building is modeled as 3-DOF system with rigid floors as shown in the figure (a). Determine the top floor maximum displacement and shear due to the earthquake ground motion using the response spectrum (given in figure b) method. Assume $K_3=K_2=3K_1$ and $m_3=1.5m_2=m_1$, where K_1=200 kN/m and m_1=2500 kg. [16]



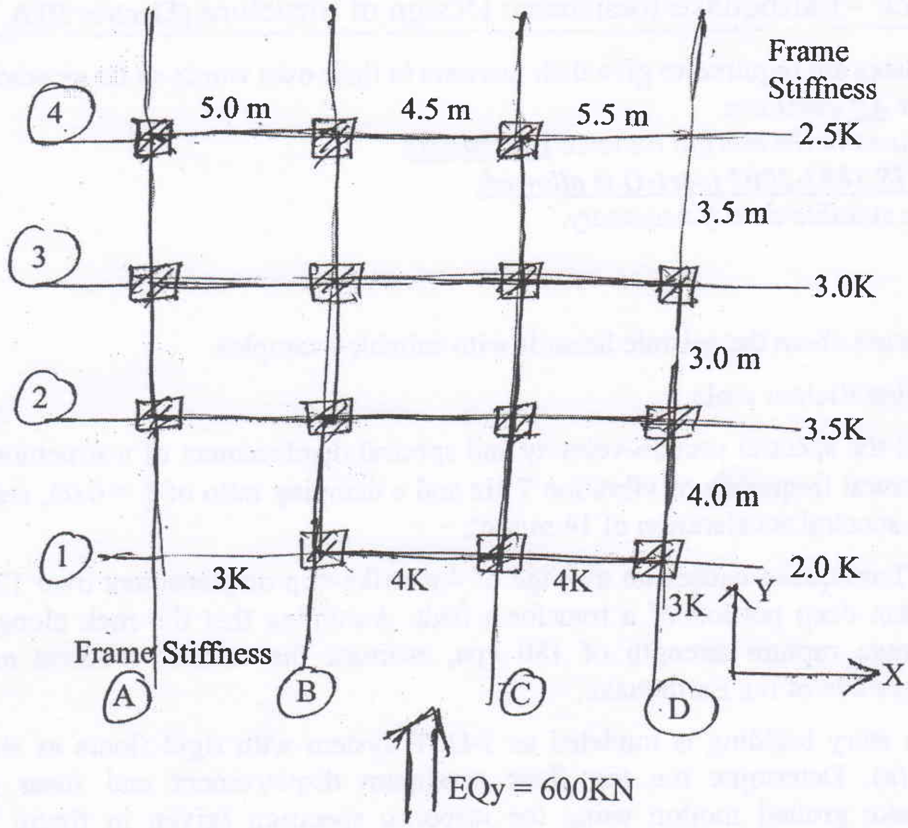
(a)



(b)

3. a) Define the torsionally uncoupled and torsionally coupled system of buildings. Also described how the lateral loads are distributed among the vertical members. [4]

b) For one storey building with rigid floor diagram. 600 KM lateral load acts at storey level along Y-direction as shown in figure. All the column of equal sizes as square type. Distribution of frame stiffness are as shown and assume uniform distribution of load in the floor, calculate the lateral force in the individual frames and sketches the 2-D frame along Y-direction. [12]



4. a) Define seismic coefficient and base shear. Write down the empirical formulae for determination of fundamental time period of a RC framed building. [4]

b) A five story reinforced concrete building is to be designed as SMRF and is located to Kathmandu having medium soil site. The lumped weight due to dead load is 8 KN/m^2 and live load of 7 KN/m^2 on floors. The roof is subjected to a dead load is 5 KN/m^2 and live load of 1.5 KN/m^2. If the floor and roof at each level have area of 250m^2, determine seismic load as per IS1893(part I)-2002. Assume suitable data as per relevant code. [12]

5. Write short notes on: (Any four) [4×4]

a) Approximate method for lateral load analysis of plane frame structures
b) Concept of Moment resisting frames
c) Ductile detailing of RCC structures
d) Failure Mechanisms of Masonry buildings
e) Seismic waves

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2073 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Earthquake Resistance Design of Structure *(Elective II) (CE76501)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
  Use of IS 1893-2002 (part-I) is allowed.
- ✓ *Assume suitable data if necessary.*

1. a) What is a fault? Explain each type of fault with a neat figure. [4]

   b) Estimate the moment magnitude of an event with rupture length of 120 km, rupture width of 40 km and slip of average fault slip of 3m. Take modulus of rigidity, as 3.5×10^{10} N/m^2. [8]

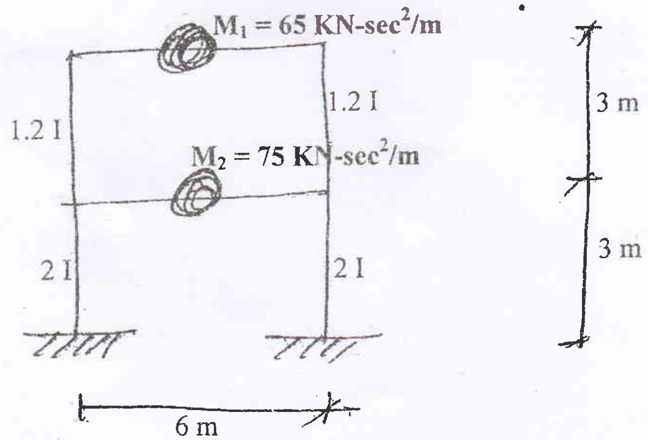
   c) What is an attenuation relationship? What are the main parameters of earthquake sources on which attenuation of the ground motion parameter depends? [4]

2. a) Define Seismic Hazard at a site. Explain in stepwise how deterministic seismic Hazard analysis of a site is carried out. [8]

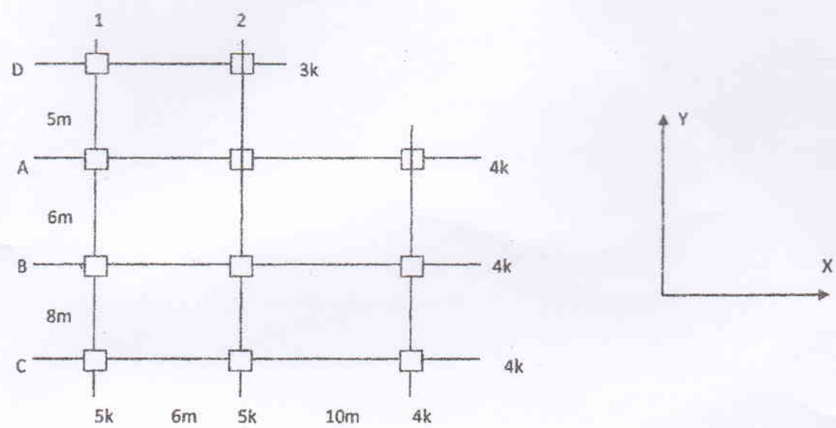
   b) Write down the Rienter- Gutenberg Recurrence law. Explain how probabilistic density function of magnitude is obtained. [3]

   c) The main central Thrust (MCT-3.0) having a = 6.2 and b = 1.0 can produce maximum size of earthquake magnitude of 6.0 Richter scale. Calculate the Return period of the earthquake. [5]

3. The acceleration response spectrum values for a two storey shear building, as shown in the figure below, are given as $S_a = \begin{Bmatrix} 0.546 \\ 0.835 \end{Bmatrix} m/sec^2$. Calculate for each mode of vibration, the maximum displacement, shear force and over turning moment at each storey level. Also determine total manimums for each of the response quantities of the above. [16]



4. a) The figure shown below shows the plan of one-storey buildings, which may be considered as composed of 2-D frames along the orthogonal directions. The roof diaphragm is rigid in its own plane, and the mass of the roof is uniformly distributed. The building is subjected to a lateral load of 800 KN, due to earthquake, in Y-direction and passing through the centre of mass of the building. Calculate the lateral forces in the 2-D frames. [11]



b) Describe in brief the portal method of lateral load analysis of frame. [5]

5. Write short notes on: (Any four) [4×4]

a) Rigid Diaphragm effect
b) Probabilistic Seismic Hazard Analysis (PSHA)
c) Ground motion parameters
d) Seismic zoning
e) Failure mechanisms of masonry wall

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