TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2080 Chaitra

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

Subject: - Geotechnical Earthquake Engineering *(Elective II) (CE 76503)*

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

1. a) Differentiate Deterministic and Probability Seismic Hazard Analysis. Explain the processes involved in identifying and characterizing seismic sources. Provide an outline of the steps in both Deterministic Seismic Hazard Analysis (DSHA) and probabilistic Seismic Hazard Analysis (PSHA). [4+4+4]

   b) In a region where earthquake records span over a century, the distribution of earthquake occurrences is as follows. Calculate the Gutenberg-Richter parameters for this area. Additionally , determine the probability of experiencing at least one earthquake with a magnitude exceeding 7 over both 70 and 100 years. Include any relevant additional information for the calculations. [4]

Earthquake Magnitude	No. of Earthquakes
3-4	950
4-5	150
5-6	25
6-7	15
>7	1

2. a) Describe the failure mechanism associated with both shallow and deep-focus earthquakes. Also, explain the methods for calculating the magnitude of an earthquake and locating its epicenter. [6+6]

   b) Utilize Deterministic seismic Hazard Analysis (DSHA) to compute the Peak Horizontal Acceleration (PHA in g) for the given site. Apply the Attenuation Relationship provided by Cornell et al. (1979) for the calculations. Additionally, include any relevant data as necessary. [4]

   IN PHA (gals) = 6.74+0.859M-1.8In(R+25) (Note: R in km and M in Richter scale).

Fault	Distance to site R(km)	Length (km)	Mmax
1	30.0	45.0	7.5
2	35.0	30.0	6.9
3	20.0	25.0	7.0
4	15.0	25.0	6.8
5	10.0	15.0	6.6
6	20.0	20.0	6.7

3. a) Explore seismic soil-structure interaction and elucidate the methods used for analyzing this interaction. Discuss how the base isolation system contributes to mitigating the impact of earthquakes on buildings. Compare the effectiveness of base isolation and seismic dampers in mitigating seismic force. [8+2+2]

   b) Calculate the theoretical determination of Mmax for the entire Himalayas, including the Nepal Himalaya. Assume a recurrence period (T) of a approximately 50 years for the largest earthquakes with a magnitude of 8 (+) anywhere in the Himalaya. Take the shear modulus (μ) for Himalayan rocks as 3.4×10^{11}dyne/cm^2. Consider the long-term average of the slip rate (s) along the Himalayan detachment plane and the total rupture plane of the Himalaya. Include any additional relevant data as necessary. [4]

4. a) Differentiate limit equilibrium and stress deformation analysis methods concerning the progressive failure phenomena of the slopes. Describe the measures implemented to mitigate risks associated with landslides and slope failures. Indentify the key parameters that influence the stability of moraine dams and elaborate on potential failure modes leading to instability or breach. [4+4+4]

   b) Explain the process of determining various shear moduli damping ratios from dynamic stress and strain test results. In a cyclic triaxial test on a saturated clay specimen, the stress-strain loop exhibits the following coordinates (Strain in % Stress in kPa) : (0%, ±100kPa) ad (1.5%, ±250kPa). Calculate the secant shear modulus and damping ratio. Addititionally, assume a Poisson's ratio of 0.45 for saturated clay loaded under undrained condition. Consider the stress area of the hysteresis loop as 5.0kPa, with the corresponding triangle area being 1.5kPa. Include any other necessary data. [2+2]

5. a) Examine the various spread configurations or arrays used in microtremor measurements and their applications in seismic studies or seismic microzonation. Describe the types of data collected in a Microtremor survey and analysis. Can this method be considered a component of seismic ground response analysis for earthquake scenarios? [4+4+4]

   b) Determine the depth of the soil layer in seismic refraction testing based on sets of wave arrival times in seconds and the distance of geophones from the source. The wave travel times are 0.05,0.10,0.15,and 0.20 for geophone distance of 10,20,30 and 50m from the impact source. Include any other relevant data as necessary. [4]

6. a) Identify the ground motion parameters crucial for describing the significant characteristics of strong ground motion. Provide a list of a amplitude parameters. [4+4]

   b) Elaborate on the construction of response spectra and design spectra. Discuss how they are implemented in the field of Geotechnical Earthquake Engineering. [4+4]

7. a) Discuss the primary applcations of geotechnical centrifuge and explain the scaling law associated with geotechnical centrifuge experiments. Calculate and interpret the pressure and stresses at the base of a 1m deep model container subjected to a centrifugal acceleration of 200g on a geotechnical centrifuge. Consider the scale modeling aspects, especially for large-scale nonlinear problems where gravity is a primary driving force. Include any other relevant data if necessary. [4+4]

   b) In a down-hole test, seismic waves are generated outside the borehole and recorded by two geophones at varying depths within the same borehole. In a cross-hole test, seismic waves are produced in one borehole and detected by a single geophone in another borehole, both located at same depths. Compare the shear wave velocities using the following cases: [4+4]

   In the down-hole seismic test, data was collected with the source of impact located at a horizontal distance (H) of 20 meters from the borehole. The first geophone receiver was positioned vertically at a distance (z_1) of 20 meters from the borehole top, While the second geophone receiver was placed at a depth (z_2) of 40 meters from the borehole top. The travel time for seismic waves to reach the first geophone receiver (t_1) was recorded as 0.10 seconds, and for the second geophone receiver (t_2), it was measured at 0.15 seconds.

   In the cross-hole seismic test, data was obtained from a source borehole with a depth (h_1) of 30 meters and a receiver borehole where the geophone receiver was positioned at a depth (h_2) of 30 meters. The horizontal distance (h) from the source of impact to the borehole was 20 meters. The travel time for seismic waves to reach the geophone receiver (t) in the receiver borehole was measured at 0.15 seconds. Assume other data if necessary.

8. a) Provide a list of dynamic soil properties commonly employed in linear, equivalent linear, and nonlinear analyses. Explain seismic soil liquefaction and discuss methods for assessing in-situ liquefaction susceptibility. [4+4]

   b) Enumerate the effectiveness of 1D, 2D and 3D seismic ground response analyses. Distinguish equivalent linear and nonlinear analyses under different degrees of shaking (0.05g,0.2g and 0.5g), considering both stiff and weak soil conditions. [4+4]

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