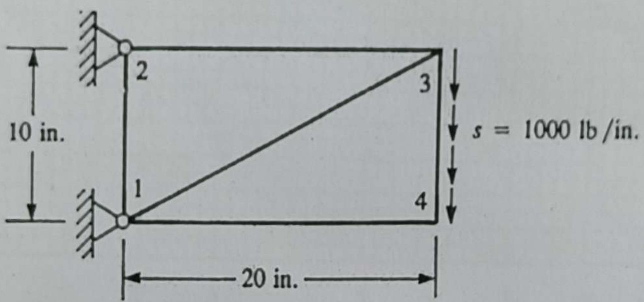
TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2080 Ashwin

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

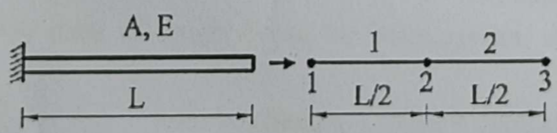
Subject: - Finite Element Analysis

- ✓ 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. Considering plane stresses, neglecting the horizontal displacements, find out the nodal displacements and stresses of the triangular elements as shown in Fig. below. $E = 30\times10^6$ psi, $t = 0.25$ in, $\gamma = 460 lb/in^3$, $\upsilon = 0.3$. [15]



2. Using finite element method, determine natural frequencies of the cantilever bar as shown in figure below. [8]



3. Describe the procedure of formulation for Midlin plate to derive stiffness matrix. [7]

4. Given strain tensor $\varepsilon_{ij} = \begin{bmatrix} 27 & -15 & 1 \\ -15 & 18 & 9 \\ 1 & 9 & 21 \end{bmatrix} x10^{-3}$, find [15]
   a) The principal strains and principal directions.
   b) The maximum shear and octahedral strains.
   c) The deviatoric strain tensor and its invariants.
   d) The dilatation.

5. With usual notations, calculate octahedral normal and shearing stresses for the given stress tensor. [7]

$$\sigma_{ij} = \begin{bmatrix} 6 & 0 & 3 \\ 0 & 9 & 2 \\ 3 & 2 & 3 \end{bmatrix}$$

6. If the value of E and G for an alloy are 2.1×10^6 and 7.5×10^5 N/mm^2. Find Lame's constants, [8]

$$\varepsilon_{ij} = \begin{bmatrix} 0.003 & 0.000 & -0.003 \\ 0.000 & -0.006 & 0.005 \\ -0.003 & 0.005 & 0.009 \end{bmatrix} \text{ Compute } \sigma_{ij}$$

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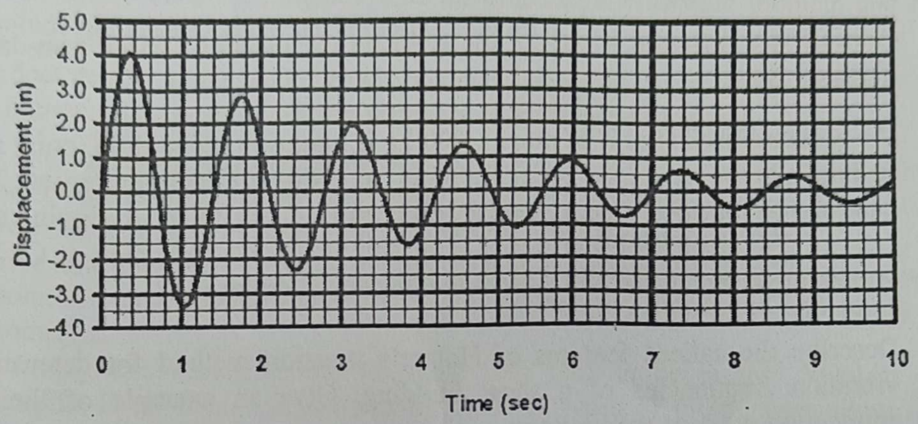
2080 Ashwin

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

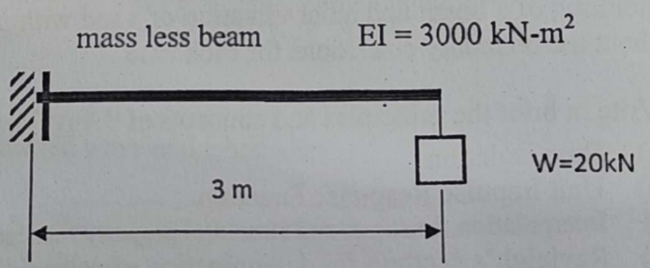
Subject: - Theory of Vibration

- ✓ 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) A viscously damped structure is set into free vibration with an initial velocity. The resulting damped oscillations are recorded and shown below. Determine the natural period of vibration and the damping ratio as fraction of the critical damping from the record. [4]



b) Consider a heavy mass of weight W on the beam system, shown in the figure below:

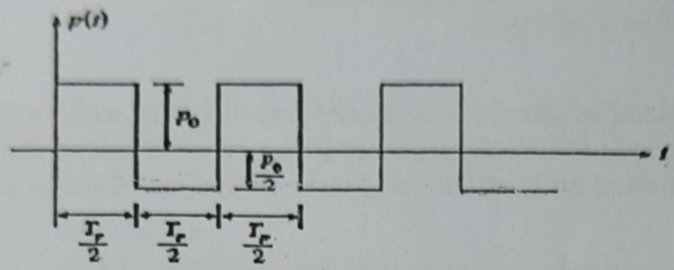


Assume the damping ratio of the beam is $\xi = 10\%$. If displacement, v, corresponds to the displacement of the beam at the location of the attached weight, and the system is given an initial displacement of 12.5 mm and initial velocity of 380 mm/sec, determine the following:

i) Write the equation of motion of the system – what type of system is it (i.e., under damped, critically damped, over- damped)?
ii) The undamped natural frequency (ω) and period (T) of the system
iii) The damped natural frequency (ω_D) and period (T_D) of the system
iv) The critical damping coefficient, c_c
v) Phase angle of the vibrating motion, θ
vi) The displacement at time $t = T_D + \theta/\omega_D$
vii) The displacement at time $t = 2T_D + \theta/\omega_D$, and
viii) The logarithmic decrement, δ. [8]

2. a) A reciprocating pump of mass 200 kg is driven through a belt by an electric motor of 3000 rpm (revolutions per minute). The pump is mounted on isolators with total stiffness 5×10^{3} kN/m and damping coefficient 3125 Ns/m. Determine the vibratory amplitude of the pump at the running speed due to fundamental harmonic force of excitation 1kN. Also determine the maximum vibratory amplitude when the pump is switched on and the motor speed passes through resonant condition. [8]

b) Express the periodic loading shown in the figure below as a Fourier series.



[4

3. a) Write down the expressions for the resonant response of a SDOF: un-damped and damped systems [

b) An air conditioning unit of mass 1,600 kg is placed in the middle (point C) of an 8 m long simply supported beam (EI = 8×10^3 kNm^2) of negligible mass. The motor runs at 300 rpm and produces an unbalanced load of 120 kg. Assuming a damping ratio of 5%, determine the steady-state amplitude and deflection at C. What rpm will result in resonance and what is the associated deflection? [

4. a) Describe the salient features of Holzer's iteration method for determination of vibration frequencies of a shear building. Give an example of the method's application without calculations. [

b) Write down the equations of motion for transverse vibration of a string, transverse vibration of a beam and axial vibration of a rod with proper notations. Also explain about the boundary conditions for each case. [

5. Write in brief the principles and concepts of (Any Three) [

a) Base isolation
b) Unit Impulse Response Function
c) Interpolation functions and structural property matrices
d) Rayleigh's Method for determination of natural time period
e) Complex Frequency Response Function

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2080 Ashwin

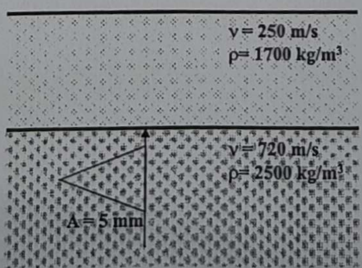
Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Seismology

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

1. Show how can a unit difference in magnitude results in 28 to 32 times difference in energy released. During the Feb 2023 Turkey-Syria Earthquake, one fault segment 175 km x 30 km in dimension slipped 4.96 m. Calculate the seismic moment and moment magnitude of the earthquake assuming the rigidity of rock material as $3x10^{10}$ N/m^2. [4+6]
2. How does density and seismic velocity change with depth from crust to the core? Explain with figures. Discuss about seismo-tectonics of the Nepal Himalaya. [4+6]
3. What is the meaning and significance of Gutenberg-Richter parameters 'a' and 'b'? How 'a' and 'b' values in Nepal Himalaya would have changed in few years before, during and few years after 2015 Gorkha Earthquake? Give reasons for your answer. [4+6]
4. Describe how does one determine the epicentre of an earthquake? Explain the principle of seismometer using suitable figures. Differentiate between broadband and strong-motion seismometers. [2+4+4]
5. Why earthquakes occurring due to thrust fault tend to be larger? What is a focal mechanism? Draw focal mechanisms for different types of faults. Also show P and T axis. [4+6]
6. Show why is amplitude of a shear wave doubled at the surface. In a layered soil profile shown below, a vertically propagating shear wave with an amplitude of 5 mm is traveling upward. Calculate the [4+6]

   i) impedance ratio,
   ii) amplitude of reflected wave and
   iii) amplitude of the transmitted wave at the boundary.



7. Write short notes on: (Any Five) [5×2]

   a) Peak Ground Acceleration (PGA)
   b) Quality factor (Q)
   c) Response spectra
   d) Basin edge effect
   e) Body waves
   f) Design earthquake
   g) Earthquake Intensity

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Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Geotechnical Earthquake Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Six** questions.*
- ✓ ***All** questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) Outline the typical steps involved in seismic hazard mapping. Additionally, provide a list of the techniques and tools utilized for seismic hazard assessment. [2+3]

   b) Estimate the theoretical determination of Mmax for the entire Himalayas, including the Nepal Himalaya, assuming that the recurrence period (T) for the largest earthquakes with a magnitude of 8(+) anywhere in the Himalaya is approximately 40 years. The shear modulus (μ) for the Himalayan rocks can be taken 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. Also, consider any additional relevant data if necessary. [5]

2. a) Differentiate deterministic and probabilistic seismic hazard analysis. Write down the primary steps of deterministic and probabilistic seismic hazard analysis. [2+3]

   b) In a region where earthquake records have been documented over a century, we have observed the following earthquake distribution. Calculate the Gutenberg-Richter parameters for this area. Furthermore, determine the probability of earthquake occurrence of at least one earthquake with a magnitude exceeding 7 over both 20 and 100 years. Please take into account any additional pertinent information if needed. [5]

Earthquake Magnitude	No. of Earthquakes
3-4	850
4-5	120
5-6	15
6-7	5
>7	1

3. a) Distinguish between shallow and deep-focus earthquake phenomena. Is earthquake prediction possible? What is your perspective on the feasibility of earthquake prediction? [3+1+1]

   b) Use Deterministic Seismic Hazard Analysis (DSHA) to compute the Peak Horizontal Acceleration (PHA in g) for the site below. Employ the following attenuation relationship given by Cornell et al. (1979) for the calculations. Also, assure any relevant data if necessary. [5]
   1n PHA (gals) = 6.74 + 0.859 M – 1.8 ln (R+25) (note :R in km and M in Richter scale).s

Fault	Distance to site R (km)	Length (km)	Mmax
A	30.0	50.0	7.4
B	35.0	20.0	6.8
C	20.0	30.0	6.9
D	15.0	25.0	6.7
E	5.0	10.0	6.5
F	20.0	30.0	6.6

4. a) What instruments and monitoring techniques are frequently employed in slope instability analysis? Describe typical measures taken to mitigate the risks associated with landslides and slope failures. Identify the critical parameters influencing the stability of moraine dams, as well as the potential failure modes that lead to instability or breach. [1+1+2+2]

b) How can one determine various shear moduli and damping ratios from dynamic [illegible] and strain test results, and what is the procedure for constructing a shear modulus reduction curve for different shear moduli? [1+1]

c) In a cyclic triaxial test on a saturated clay specimen, the stress-strain loop produces the following coordinates (Strain in %, Stress in kPa): (0%, ±100kPa) and (1.4%, ±236kPa). Determine the secant shear modulus and damping ratio. Additionally, consider a Poisson's ratio of 0.5 for saturated clay loaded under undrained conditions. Also, take into account that the stress area of the hysteresis loop is 4.52kPa, and the corresponding triangle area is 1.65kPa. Assume other data if necessary. [2]

OR

In a Geotechnical centrifuge test, a scaled test model is created by reducing its dimensions by a factor of N, increasing the acceleration due to gravity by 150g, and maintaining the same material density as the prototype model. How many times does the scaled-down model in the Geotechnical centrifuge represent the conditions in a real-world field model? Consider other data if necessary. [2]

5. a) What are the possible configurations for microtremor measurements, and how are they employed in seismic studies or microzonation? Can this method be regarded as part of seismic ground response analysis for earthquake scenarios? [3+2]

b) In a seismic refraction test, seismic waves were generated and recorded at different geophone locations. The travel time (in seconds) versus the distance (in meters) from the source was measured, and it is observed that there are two distinct slopes on the travel time versus distance graph. These slopes correspond to different layers in the subsurface. Estimate shear wave velocities. Calculate the depth of the rock layer using the seismic refraction test data. Graph paper is not required to estimate the slopes and point of changing the slopes. Assume other data if necessary. [5]

Geophone locations (m)	Travel Time (Seconds)
0	0
10	0.001
20	0.002
30	0.003
40	0.004
50	0.0045
60	0.005
70	0.0055
80	0.006
90	0.0065
100	0.007

6. a) Discuss the significance of soil-structure interaction in earthquake resistant design of substructure. What are the possible support systems for near and far-field boundaries in 2-dimensional domain? [2+2]

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 different depths. Compare the shear wave velocities using following data:

Down-hole seismic test data:

Horizontal distance from source of impact to borehole (H): 30 meters

Vertical distance from borehole top to the first geophone receiver (z1): 25 meters

Vertical distance from borehole top to the second geophone receiver (z2): 50 meters

Travel time to the first geophone receiver (t1): 0.10 seconds

Travel time to the second geophone receiver (t2): 0.13 seconds

Cross-hole seismic test data:
For Source Borehole: Depth of the source (h1): 30 meters
For Receiver Borehole: Depth to the geophone receiver (h2): 50 meters
Horizontal distance from source of impact to borehole (H): 30 meters
Travel time to the geophone receiver (t): 0.12 seconds
Assume other data if necessary. [3+3]

7. a) What are the key distinctions in the methodologies employed for conducting 1D, 2D, and 3D seismic ground response analyses? Additionally, elaborate on their specific applications. Also, outline the scenarios in which different modeling methods, such as linear elastic, equivalent linear, and non-linear approaches, are utilized in seismic ground response analysis. [3+2+2]

b) A 2-m thick layer of sand (e=0.87; phi=33 degrees) is overlain by 4m of compacted fill (unit weight=21kN/m^3). The water table is at the bottom of the fill. Using the Cyclic Triaxial test results, estimate the maximum cyclic shear stress required to initiate liquefaction in the sand in a magnitude 7.5 earthquake. A magnitude 7.5 earthquake would be expected to produce uniform stress cycles (at 65% of the maximum value). The corresponding field cyclic stress ratio can be estimated as 0.128. [3]

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2080 Jestha

Exam.	Regular		
Level	M.Sc	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Geotechnical Earthquake Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any __Six__ questions.*
- ✓ *__All__ questions carry equal marks.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain the principles of earthquake mechanics and their importance in geotechnical earthquake engineering. [5]

   b) Can you explain the differences between shallow and deep focus earthquakes and their mechanics of origin? [5]

2. a) Discuss the estimation of ground motion parameters and their use in seismic hazard analysis. [5]

   b) Explain the applicability of ground motion prediction equations (GMPEs) in Himalayan regions. [5]

3. a) Describe the dynamic soil properties and their measurement methods. [5]

   b) Explain the factors influencing soil liquefaction and the different methods used for its analysis. [5]

4. a) Explain the concept of seismic soil-structure interaction and its importance in earthquake-resistant design. [5]

   b) Discuss the different methods used for the seismic design of retaining walls and embankments. [5]

5. a) Discuss the different seismic design techniques for shallow and deep foundations. [5]

   b) Explain the factors influencing the seismic response of underground structures and the methods used for their design. [5]

6. a) How are base isolation, seismic shielding methods, and seismic dampers utilized in improving seismic performance? Please provide a detailed explanation of each technique and their advantages in enhancing structural safety during earthquakes. [5]

   b) Explain the shake-table testing and dynamic centrifuge modeling methods used for soil structure interaction testing. [5]

7. a) Describe the different types of non-destructive testing and evaluation methods used in earthquake engineering. [5]

   b) Discuss the different seismic hazard mitigation strategies and their effectiveness. Describe the case studies of major earthquakes and their impacts on geotechnical infrastructure. [2+3]

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2080 Jestha

Exam.	Regular		
Level	M.Sc	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Theory of Vibrations

- ✓ 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 3 m high, 8 m wide single-bay single-story frame is rigidly jointed with a beam of mass 5,000 kg and columns of negligible mass and stiffness of Elc = 4.5 ×103 kMm^2.

   a) Calculate the natural frequency in lateral vibration and its period.
   b) Find the force required to deflect the frame 25 mm laterally.

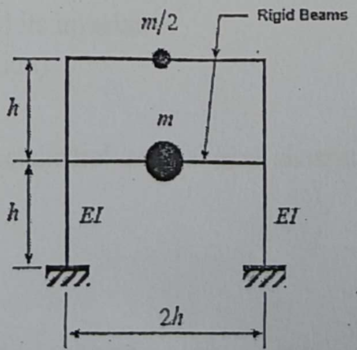
   For the frame, a jack applied a load of 100 kN and then instantaneously released. On the first return swing a deflection of 19.44 mm was noted. Assuming that the stiffness of the columns cannot change, find [12]

   c) The damping ratio,
   d) The coefficient of damping
   e) The un-damped frequency and period, and
   f) The amplitude after 5 cycles.

2. a) Write down the expressions for the resonant response of a SDOF: un-damped and damped systems. [4]

   b) An air conditioning unit of mass 1,600 kg is placed in the middle (point C) of an 8 m long simply supported beam (EI = 8×10^3 kNm^2) of negligible mass. The motor runs at 300 rpm and produces an unbalanced load of 120 kg. Assuming a damping ratio of 5%, determine the steady-state amplitude and deflection at C. What rpm will result in resonance and what is the associated deflection? [8]

3. a) Formulate the coupled equations of motion for the shear building system shown in the figure below. Determine the natural vibration frequencies and mode shapes. Express the frequencies in terms of m, EI, and h. Sketch the mode shapes and identify the associated natural frequencies. Illustrate that the mode shapes computed satisfy the orthogonality property. [8]



   b) Determine the modal responses (Steady – state responses) of the above system if a harmonic force p(t) = P_0 sin ωt is applied horizontally at the first floor level of the frame. [4]

   a) Describe the salient features of Holzer's iteration method for determination of vibration frequencies of a shear building. Give an example of the method's application without calculations. [6]

b) Write down the equations of motion for transverse vibration of a string, transverse vibration of a beam and axial vibration of a rod with proper notations. Also explain about the boundary conditions for each case.

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

a) Periodic loading in terms of Fourier Series
b) SDOF response to support excitation
c) Resonant response amplitude of a SDOF subjected to a harmonic loading
d) Convolution Integral and Duhamel Integral
e) Response of a SDOF to a triangular impulse

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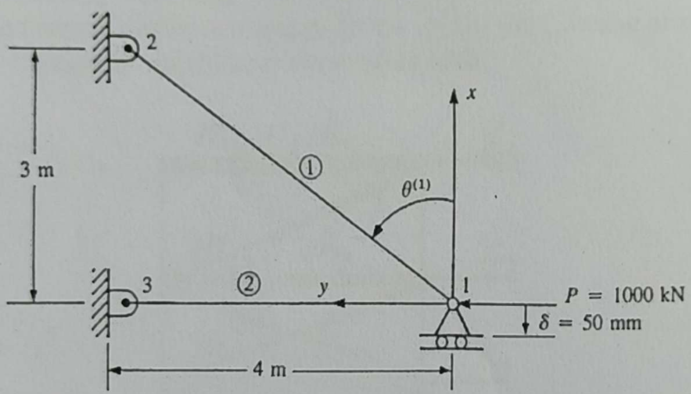
2080 Jestha

Exam.	Back		
Level	M.Sc	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Finite Element Analysis

- ✓ 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. For the truss shown in the fig. below, determine the displacement in the y direction of node 1 and the axial force in each element. A force of P = 1000 kN is applied at node 1 in the positive y direction while node 1 settles an amount d = 50 mm in the negative x direction. Let E = 210
GPa and A = 6 x 10^{-4} m^2 for each element. [15]



2. Describe the step by step procedure of isoperimetric formulation of axi-symmetric element to derive stiffness matrix. [10]
3. Derive an expression for stiffness matrix formulation for constant strain triangular areal element. [10]
4. Given strain tensor $\varepsilon_{ij} = \begin{bmatrix} 27 & -15 & 1 \\ -15 & 18 & 9 \\ 1 & 9 & 21 \end{bmatrix} x10^{-3}$, find [10]
   a) The principal strains and principal directions
   b) The maximum shear and octahedral strains
   c) The deviatoric strain tensor and its invariants
   d) The volumetric change (dilatation)
   e) Strain invariants
5. With usual notations, calculate octahedral normal and shearing stresses for the given stress tensor. [7]

$$\sigma_{ij} = \begin{bmatrix} 6 & 0 & 3 \\ 0 & 9 & 2 \\ 3 & 2 & 3 \end{bmatrix}$$

6. If the value of E and G for an alloy are 2.18 × 10^6 and 7.2 × 10^5 N/mm^2. Find Lame's constants, if [8]

$$\varepsilon_{ij} = \begin{bmatrix} 0.003 & 0.000 & -0.003 \\ 0.000 & -0.006 & 0.005 \\ -0.003 & 0.005 & 0.009 \end{bmatrix} \text{ Compute } \sigma_{ij}$$

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Bhadra

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

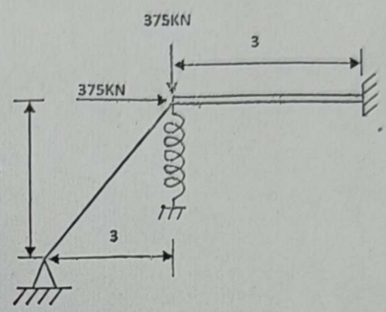
Subject: - Finite Element Method *(CE 808-C02)*

- ✓ 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) Derive Hermite shape function for a beam element and sketch the variation of length over the element. [7]

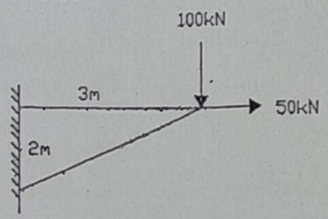
   b) Obtain the displacement, reaction force and internal forces of the following structure given that [8]

   Bar: $A = 2\times10^{-3}\ m^2$
   Spring constant: 1000 KN/m
   Beam: $A = 1\times10^{-3}\ m^2$ $I = 5\times10^{-3}\ m^4$
   E = 210 GPA (for both)



2. a) Discuss different types of non linearity's encountered in structural analysis. Explain Modified Newton Raphson's method for solving non linearity's. [7]

   b) Calculate displacements, strain and stress in the given triangular plate, fixed along one edge and subjected to load as shown in figure. Take E = 70GPa, thickness of the plate = 10mm and Poisson's ratio = 0.3. [8]



3. a) Explain the contraction convention of indices an example. [5]

   b) Calculate the values of principal stresses and their directions if the state of stress at a point is given by:
   Also prove that principal directions are orthogonal to each other. [10]

$$\sigma_{ij} = \begin{bmatrix} 1 & 0 & 3 \\ 0 & -5 & 4 \\ 3 & 4 & 4 \end{bmatrix} \text{MPa}$$

4. a) Explain with example the basic equations of solid mechanics for equilibrium, kinematics and constitutive relation. [5]

   b) Given the strain tensor [10]

$$\varepsilon_{ij} = \begin{bmatrix} 77 & -30 & 21 \\ -30 & 9 & 18 \\ 21 & 18 & 13 \end{bmatrix} * 10^{-3} \text{units}$$

   Find
   (i) Principal strains
   (ii) Maximum shear strains
   (iii)Octahedral strains
   (iv)Deviatoric strain tensor and its invariants

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2076 Bhadra

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Theory of Vibrations *(CE 808-C04)*

- ✓ 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.*

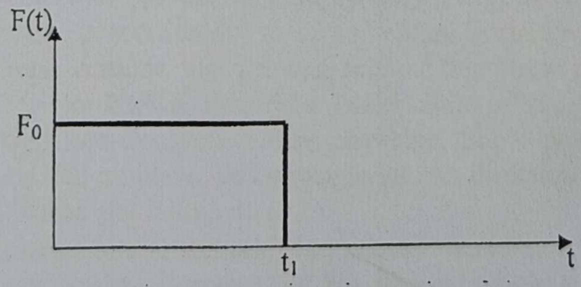
1. a) A system vibrating with a natural frequency of 8 cycles per second starts with an initial amplitude (v_0) of 3 cms and initial velocity of 40 cm/sec. Find out the following:

   (i) Natural period, T and angular frequency, ω.
   (ii) Amplitude of the motion, ρ.
   (iii) Maximum velocity
   (iv) Maximum acceleration.
   (v) Phase angle, φ.
   (vi) Static deflection, v_{st}. [6]

   b) A vibrating system consists of a mass of 4 kg and a spring of stiffness of 150 N/m and a damper of coefficient of 5 N-s/m. Determine:

   (i) Damping factor
   (ii) Natural frequency of vibration
   (iii) Damped vinration frequency
   (iv) Logarithmic decrement
   (v) Ratio of two successive amplitude
   (vi) Number of cycles after which the initial amplitude is reduced to 25%. [6]

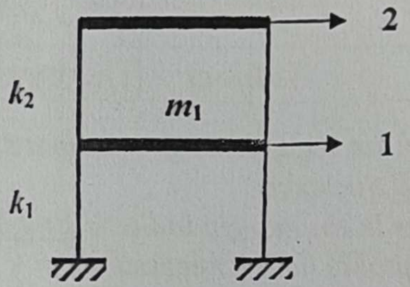
2. a) Determine the response for a spring-mass system during forced vibration and free vibration phase, when it is subjected to a rectangular force as shown in the figure given below. [6]



   b) A damped SDOF system has a mass of 50 kg, a damping ratio of 0.1, a natural frequency of 10 rad/sec, and is subjected to a harmonic excitation of amplitude 2500 N and frequency of 150 rad/sec. Determine the steady-state amplitude and phase angle of the response. [6]

3. a) Determine the natural frequencies and mode shapes of the two-storied shear frame shown in the figure given below. Sketch the mode shapes, and also illustrate that the modes shapes satisfy the orthogonality conditions. [8]

$m_1 = 1360$ kg;
$m_2 = 660$ kg;
$k_1 = 11.11 \times 10^{-3}$ N/m;
$k_2 = 19.2 \times 10^{-3}$ N/m;



b) Write down the uncoupled equations of motion for the structure of No. 3(a) above, and determine the response of the structure for the force vector: [4]

$$\{P(t)\} = \begin{Bmatrix} 0 \\ 300\sin 20t \end{Bmatrix} N$$

4. a) Describe the salient features of Stodola's iteration method for determination of vibration frequencies of a shear building. Give an example of the method's application without calculations. [6]

b) Write down the partial differential equation of motion for transverse vibration of a beam. Describe the process of determining natural frequencies and mode shapes of a simply supported beam. [6]

5. Write in brief the principles and concepts of (any three only) [3×4]

a) Base isolation
b) Unit Impulse Response Function
c) Response due to periodic loading expressed in Fourier series
d) Response of a SDOF system subjected to support motion
e) Complex Frequency Response Function

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Bhadra

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Geotechnical Earthquake Engineering *(CE 808-C03)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any Nine questions selecting Seven from Group A and Two from Group B.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

Group A

1. Name the most important seismic hazards in brief. Describe the internal structure of the earth along with Moho's discontinuity, Gutenberg discontinuity and the influence of earth's structure on the distribution of seismic waves during earthquake. [2+4]

2. Describe in brief different types of plate boundaries and mention which plate boundary is more prone to earthquake. Explain different types of fault movement. [4+2]

3. Briefly describe its relationship of elastic rebound theory with Earthquake Recurrence and Tectonic Environment. Explain the process of finding Factor of Safety against Liquefaction. [3+3]

4. Distinguish earthquake intensity from earthquake magnitude? Briefly explain different types of earthquake magnitude and explain the saturation term used in the earthquake magnitude representation. [2+2+2]

5. Name different types of slope and slope stability analysis methods. How do you obtain static and Pseudostatic factor of safety for Wedge failure and circular arc failure? [2+4]

6. How do you obtain static and Pseudostatic factor of safety for Wedge failure and circular arc failure? What is yield coefficient and yield acceleration used in Newmark's sliding block analysis method. [4+2]

7. Name different methods used to estimate lateral earth pressure. Explain Coulomb's method for estimating actual and passive earth pressure in static condition. [2+4]

8. Let us assume that the soil specimen fails when its stresses acting on its orthogonal planes reach R_1 (σ_y and τ_{xy}) and R_2 (σ_x and τ_{yx}), respectively. Here, σ_y and σ_x are compressive stresses and the direction of rotation due to τ_{yx} and τ_{xy} are in clockwise and anticlockwise directions, respectively. Assume that the soil fails at this stress condition. If strength parameters of this soil are known, then draw Mohr circle of stresses for at this failure condition along with Mohr-Coulomb failure envelope. Show pole, stresses acting on orthogonal planes and failure plane, failure angle and its direction and draw also major and minor principal planes and failure plane.
What happens in Mohr's Cicle of stresses, if additional shear stress, $\Delta\tau$ acts on the planes where R_1 and R_2 are acting. Consider the incremental shear stress acts along both clockwise and anti-clockwise consideration. [5+1]

9. Differentiate DSHA from PSHA. Also, write down the steps to be followed in DSHA. [4+2]

10. Explain Mononobe-Okada's method for estimating lateral earth pressure force per unit length of the retaining wall. Show the values and line of actions for total, static and dynamic components of active thrusts acting on the wall. [6]

Group B

11. Draw pressure diagrams for Minimum Rankine active earth pressure distribution on retaining walls due to backfills with only frictional soil (cohesion = 0), purely cohesive soil (ϕ= 0) and cohesive soil (c,ϕ). Show the values of active earth pressure coefficients, active earth pressure at the bottom of the wall and active pressure force per unit length of the wall in each case. Take the height of the wall as H unit and bulk unit weight of backfill as γ_t. Also, show failure plane of the backfill. [9]

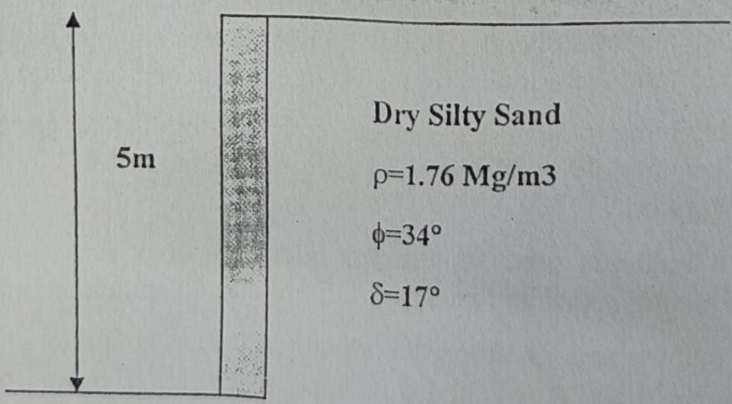
12. a) The site is located in the vicinity of three independent seismic sources, S1 (Line source), S2 (Areal Source) and S3(Point source) having maximum magnitudes of 7.3, 7.7, and 5.0 respectively. Also, the minimum distances of S1, S2 and S3 sources from the site are 23.7 km, 25.0 km and 60.0 km respectively. Using deterministic seismic hazard analysis, compute the peak accelerations. Use the predictive relation given below and comment on the accelerations computed.

$$\ln PHA(ms^{-2}) = 0.01[6.74 + 0.859M - 1.80\ln(R(km) + 25)]$$

b) Using Guntenberg-Richter recurrence law (**$\log \lambda_m = 4.0 - 0.7\,M$**) and Poisson Model (**$P[N \geq 1] = 1 - e^{-\lambda m.t}$**), find the probability that at least one earthquake of magnitude greater than 7.0 will occur in a 10-year, 50-year and 250-year period? [5+4]

13. a) Estimate the seismic moment and moment magnitude of an earthquake which causes an average of 2.5 m strike-slip displacement over an 80 km long, 23 km deep portion of a transform fault. Take average rupture strength of this rock along the fault plane as 175 kPa.

b) Compute the overturning moment about the base of the wall shown in figure below for $k_h = 0.15$ and $k_v = 0.075$. Take $k_A = 0.256$ and $k_{AE} = 0.362$. [4+5]



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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Bhadra

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Seismology *(CE 808-C01)*

- ✓ 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. What is plate tectonic theory? What evidence supports the theory of plate tectonics? [3+3]
2. Describe the plate motions along the Himalayan Mountains. Do you think these mountains are getting larger, smaller or staying the same? Explain your answer. [3+3]
3. What is a fault? List and describe different types of fault with neat sketches. [2+4]
4. What are the major ground motion parameters? Describe in brief how they are determined or represented. Also, describe factors influencing ground motion parameters at a site. [2+4+2]
5. Differentiate between earthquake magnitude and intensity. Describe various types of earthquake magnitude scale. Why don't magnitude scales agree? [2+4+2]
6. An earthquake causes an average of 3m strike-slip displacement over an 85 Km long, 25 Km deep portion of a transform fault. Assuming that the rock along the fault has an average rupture strength of 180 kPa, estimate the seismic moment (Mo) and moment magnitude (Mw) of the earthquake. [4]
7. At a recording station a difference in time of arrival between P waves and S waves was observed to be 2.2 seconds. What is the approximate distance from the station at which the event occurred? Assume P wave velocity as 8 km/sec and S wave velocity as 5 km/sec. [2]
8. Define seismoscope, seismometer, accelerometer and seismograph. What are the types of seismograph? Describe them in brief. [2+4]
9. What are the methods of earthquake prediction? List and explain precursors for earthquake prediction. [2+4]
10. Write short notes on: [2×4]
    a) Moho's discontinuity and Gutenberg discontinuity
    b) Subduction zone, divergent zone and transform fault
    c) ontinental and oceanic crust
    d) analog and digital accelerograph

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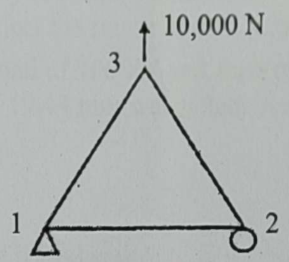
TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Jestha

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Finite Element Method

- ✓ 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. Obtain stress in one element constant strain structure as shown in figure below, having length 1000 mm, thickness 2 mm. The modulus of elasticity of plate E = 70,000 N/mm², $\upsilon = 0.2$. [15]



2. a) Describe the step by step procedure of isoperimetric formulation for 4 nodes Midlin plate to derive stiffness matrix. [10]

   b) Derive stiffness matrix for an inclined truss element. [10]

3. Given strain tensor $\varepsilon_{ij} = \begin{bmatrix} 27 & -18 & 3 \\ -18 & 15 & 9 \\ 3 & 9 & 21 \end{bmatrix} x10^{-3}$. Find [10]

   a) The principal strains and principal directions
   b) The maximum shear and octahedral strains
   c) The deviatoric strain tensor and its invariants
   d) The volumetric change (dilatation)
   e) Strain invariants

4. With usual notations prove that $J_3 = I_3 - \frac{1}{3}I_1I_2 + \frac{2}{27}I_1^3$. [7]

5. If the value of E and G for an alloy are 2.20×10^6 and 8.2×10^5 N/mm². Find Lame's constants. If $\varepsilon_{ij} = \begin{bmatrix} 0.002 & 0.000 & -0.003 \\ 0.000 & -0.006 & 0.005 \\ -0.003 & 0.010 & 0.001 \end{bmatrix}$ Compute σ_{ij}. [8]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Jestha

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Theory of Vibrations

- ✓ 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.*

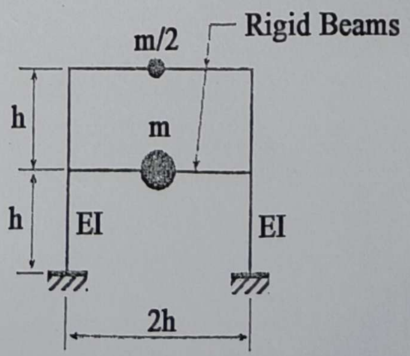
1. A 3 m high, 8 m wide single-story frame is rigidly jointed with a beam of mass 5,000 kg and columns of negligible mass and stiffness of $EIc = 4.5 \times 10^3$ kNm^2. [12]
   a) Calculate the natural frequency in lateral vibration and its period.
   b) Find the force required to deflect the frame 25 mm laterally.

   For the frame, a jack applied a load of 100 kN and then instantaneously released. On the first return swing a deflection of 19.44 mm was noted. Assuming that the stiffness of the columns cannot change, find
   c) the damping ratio;
   d) the coefficient of damping
   e) the un-damped frequency and period and
   f) the amplitude after 5 cycles

2. a) Write down the expressions for the resonant response of a SDOF: un-damped and damped systems. [4]

   b) An air conditioning unit of mass 1,600 kg is placed in the middle (point C) of an 8 m long simply supported beam ($EI = 8 \times 10^3$ kNm^2) of negligible mass. The motor runs at 300 rpm and produces an unbalanced load of 120 kg. Assuming a damping ratio of 5%, determine the steady-state amplitude and deflection at C. What rpm will result in resonance and what is the associated deflection? [8]

3. a) Formulate the coupled equations of motion for the shear building system shown in the figure given below. Determine the natural vibration frequencies and mode shapes. Express the frequencies in terms of m, EI and h. Sketch the mode shapes and identify the associated natural frequencies. Illustrate that the mode shapes computed satisfy the orthogonality property. [8]



   b) Determine the modal responses (steady-state responses) of the above system if a harmonic force $p(t) = p_0 \sin\omega t$ is applied horizontally at the first floor level of the frame. [4]

4. a) Describe the salient features of Holzer's iteration method for determination of vibration frequencies of a shear building. Give an example of the method's application without calculations. [6]

b) Write down the equations of motion for transverse vibration of a string, transverse vibration of a beam and axial vibration of a rod with proper notations. Also explain about the boundary conditions for each case. [6]

5. Write in brief the principles and concepts of (any three only) [3×4]

a) Periodic loading in terms of Fourier Series
b) SDOF response to support excitation
c) Resonant response amplitude of a SDOF subjected to a harmonic loading
d) Convolution Integral and Duhamel Integral
e) Response of a SDOF to a triangular impulse

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Jestha

Exam.	**Regular**		
Level	M.Sc.	**Full Marks**	60
Programme	MSEqE	**Pass Marks**	30
Year / Part	I / I	**Time**	3 hrs.

Subject: - Engineering Seismology

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Six** questions.*
- ✓ ***All** questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. Derive: $\ddot{s} = 2\beta\omega_0 \dot{s} + \omega_0^2 s = -\ddot{u}$, where the symbols have their usual meanings. Discuss the fast- and slow- motion scenarios in a seismometer.
2. Distinguish between intensity and magnitude of an earthquake. Describe various types of earthquake magnitudes together with their interrelationships.
3. Numerically show that the energy released by 1 magnitude greater earthquake would be 28 and 32 folds per Bath and Gutehberg-Ritcher approach respectively.
4. Elucidate power and Fourier spectra mentioning their applications.
5. Discuss local site response, basin effects, topographical effect and site amplification in typical alluvial deposits with examples.
6. Write an algorithm to construct Newmark design spectra.
7. Write a MATLAB/python code to deploy second order Butterworth filter for an arbitrary harmonic wave record.

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Jestha

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	MSEqE	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Geotechnical Earthquake Engineering

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

1. a) An earthquake fault is considered to be simple system with the elastic and damping constants for the fault material. Initially, elastic strain energy accumulates until the shear force reaches its peak. Suddenly brittle fracture occurs releasing tremendous energy in the form of waves. Shear force drops down to its residual after the event. Define this phenomenon based on the relationship between stress and displacement for initial shear failure and subsequent unstable shear movement on the fault surface (i.e., energy storing and releasing mechanism). Write down the earthquake focal mechanisms (i.e.' elastic rebound, wavefront and volumetric theory). Write down the tentative fault segment modeling in 1D. [2+3+1]

   b) Write down the focal mechanism of shallow and deep earthquakes. Can earthquakes be predicted? What is your view on predictability? [2+1+1]

2. a) How do you generate response spectra? What are the most useful measures of ground motion? What factors control the level of ground motion? [2+2+2]

   b) Differentiate low and high strain tests. A loose deposit of over consolidated clay is underlain by bedrock. Previous subsurface investigations in the area suggest that the bedrock surface is nearly horizontal. A seismic reflection survey shows the arrival of distance p-waves at a geophone 40 m/sec and 200 m/sec after an impulsive load is applied at a point 25m from the geophone. Determine the thickness and the p-wave velocity of the clay deposit. [1+1+2]

3. a) Stress-strain curves corresponding to Mohr-circle envelope experimentally defined by faulting (failure) in identical rock samples at various confining pressures. What happens with higher confining pressures? The von Mises criterion describes deformational behavior above the brittle-ductile transition. Griffiths parabola can also be constructed similarly. How do you accommodate all three failure envelopes in Mohr-circle? How do you construct the orientation of new conjugate faults fitting the Mohr-coulomb criterion in a Mohr diagram that represents successive states of stress without faulting? [2+2+1]

   b) Write down the scaling factors for converting the measured data to prototype units under a gravitation acceleration of N g in Geotechnical centrifuge modeling. If a 1m deep model container is filled with soil, placed on the end of a centrifuge and subjected to a centrifugal acceleration of 100g. At what factor the pressures and stresses would be increased? At what depth below the ground surface on earth is equivalent to the vertical stresses developed at the base of the model container under the 100g centrifugal loading? At what depth of the prototype soil represent the 1m deep model prepared for Geotechnical centrifuge under the same level of centrifugal acceleration? [2+1+1+1]

4. a) Write down the seismic design philosophy of walls, slopes, embankments and dams. Write down the different modes of failure. [4+2]

b) What do you know about soil-structure interaction under seismic loading? What would be the suitable configuration for interface elements? [2+2]

5. a) In a valley or an alluvial basin, ground amplification arises as a result of diffraction and scattering phenomena with the generation of surface waves. The propagation of waves is in comples geological configurations with arbitrary orientation of incident waves and generation of diffractive/scattering phenomena. In this situation, suggest a suitable method for seismic ground response analysis. Also suggest the method of analyses for localized structures (e.g., complex soil conditions).

When are one-dimensional analyses appropriate? How should ground motions be applied in 1D site response analyses? For linear systems, the transfer function permits the direct calculation of ground response in the frequency domain. How is it possible in frequency domain analysis? Differentiate FFT and IFFT.

Also, suggest a suitable method of seismic ground response analysis in the inclined ground surface and / or non-horizontal boundaries. [2+4+1]

b) Consider columns supported on a rocking shallow foundation in a large-scale shake table test. What would be the foundation moment versus foundation rotation with different levels of excitation? Interpret the results in the form of drift and ductility ratio. Differentiate shake and shock table tests. [1+1+1]

6. a) Draw a typical stress-strain behavior of cyclically loaded soils (i.e., viscoelastic materials) and identify the appropriate stress and strain measures that represent the response of materials under cyclic loading. How do you capture the most significant behaviors in analysis (e.g., linear, equivalent linear, cyclic non-linear and advanced constitutive modeling) based on cyclic plots? Can we capture important effects of non linearity with the equivalent linear model? Define shear modulus and hysteretic damping. Draw shears stiffness (equivalent shear modulus) and damping ratio degradation curves (equivalent damping ratio). [2+3+1+1+1]

b) The nonlinear, inelastic stress-strain behavior of cyclically loaded soils can be approximated by equivalent linear properties. How much difference does it make between equivalent linear vs nonlinear analysis in case of very strong motion 1g and for stiff soils? Differentiate limit equilibrium and stress deformation analysis with relation to slope stability analysis. [1+1]

7. a) Differentiate pile/pier/shaft static and dynamic tests. Also differentiate cross-hole sonic logging (CSL), thermal integrity profiling (TIP) and pile integrity test (PIT) tests. [2+1+1+1]

b) Write down the types of the waveform that can be used in cyclic Triaxial testing. What would be the most common type of waveform applied to cyclic loading? How do you apply cyclic load to the soil sample? What would be the typical frequencies used in a cyclic Triaxial test based on the simulated application? [2+1+1+1]

OR

Write down the different methods of simulating the seismic soil liquefaction. Make a plot related to sand behavior during cyclic loading under undrained/fast loading. How dynamic loading is applied to models related to soil liquefaction? What would be the basis of seismic retrofitting? Differentiate traditional (old) and innovative (new) damage control systems employed for seismic retrofitting. [1+1+1+1+1]

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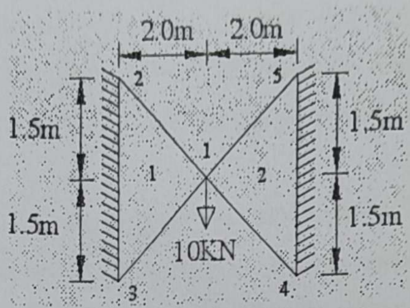
TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Bhadra

Exam.	Regular / Back		
Level	M.Sc.	Full Marks	60
Programme	Earthquake Engineering	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

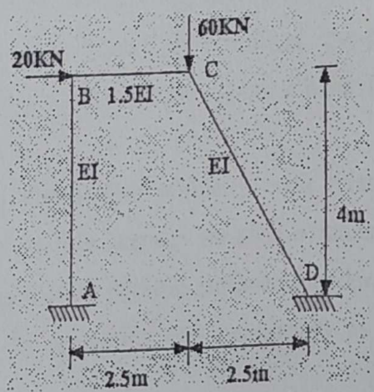
Subject: - Finite Element Analysis *(CE808-C02)*

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

1. Considering plane stresses, find out the nodal displacements and stresses of the triangular elements as shown in figure below $E = 30 \times 10^6$ psi, $t = 0.3$in, $\gamma = 460$lb/in^3, $\upsilon = 0.3$. [8]



2. Neglecting axial deformations draw bending moment diagram for the frame shown in the figure below. $E = 25 \times 10^6$ KN/m^2, $A = 0.09$ m^2 and $I = 0.000675$ m^4. [8]



3. Derive stiffness matric for thick plate. [8]
4. With necessary equations and figures explain how to calculate material non linearity using bilinear stiffness degradation model by Network-Raphson Method. Also mention algorithm and flow chart. [8]
5. Express the product of permutation symbol in the form of Kronecher delta. [5]
6. Find the principal stresses, and calculate octahedral normal and shearing stresses for the given stress tensor. [8]

$$\sigma_{ij} = \begin{bmatrix} 5 & 0 & 3 \\ 0 & 0 & 2 \\ 3 & 2 & 0 \end{bmatrix}$$

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INSTITUTE OF ENGINEERING

Examination Control Division

2074 Bhadra

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	Earthquake Engg.	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Theory of Vibrations *(CE837)*

- ✓ 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.*

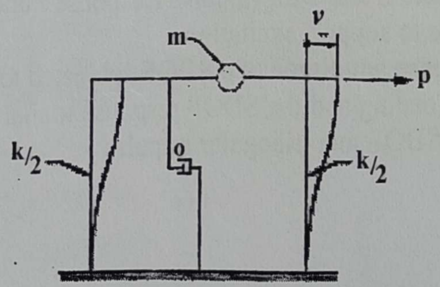
1 (a) The frame shown in the figure below is rigidly jointed, and the columns may be assumed as massless. The columns can be considered flexible laterally but rigid axially. The mass of the columns is negligible when compared to the total mass m = 1941 kg which is concentrated at the level of the roof. To determine the dynamic properties of the structure, a free vibration test is performed by moving the roof by 20mm with a cable and a winch. The cable is suddenly cut to set the structure in free vibration. The maximum displacement is 15mm after one complete cycle which takes place in 0.2 s. Determine:

(i) the damping ratio ξ,

(ii) the damping coefficient c,

(iii) the lateral stiffness of the structure, and (8)

(iv) the amplitude of the motion after 10 cycles.

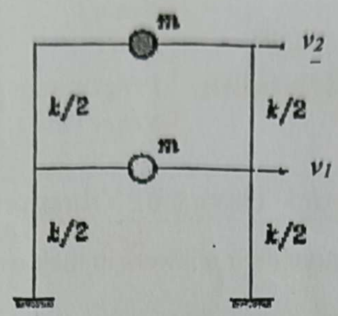


(b) For a system, the transmissibility required is 0.12, and its forcing frequency is 15 cycles per second. Assuming small damping, determine the static deflection. (4)

2 (a) A rotating machine having a total mass of 200 kg is supported by four isolators on a rigid floor. The total stiffness of the isolators is 1000×10^3 N/m. When operating, the machine generates a vertical harmonic force with an amplitude of 450N at a rotation frequency of 50 Hz. Assuming that the damping is $\xi = 0.20$, determine the steady-state amplitude, and the force transmitted to the floor. (8)

(b) What is complex frequency response function H(ω)? Give an example of its application in determination of response of a SDOF. (4)

3 (a) Determine the natural vibration frequencies and natural vibration mode shapes of the structure shown in the figure below. Sketch the mode shapes, and prove that the obtained mode shapes satisfy the orthogonality conditions. Take the value of mass m and lateral storey stiffness k as 20,000 kg and 18×10^6 N/m respectively. (8)



(b) Determine, by modal superposition, the free-vibration response of the two-storey building of # 3(a) above. The initial conditions are as follows: $v_1 = 0.02$m and $v_2 = 0.02$ m. Assume that the system is undamped. (4)

4 (a) Describe the salient features of Stodola's iteration method for determination of vibration frequencies of a shear building. Give an example of the method's application without calculations. (8)

(b) Write down the partial differential equation of motion for transverse vibration of a beam. Describe the process of determining natural frequencies and mode shapes of a simply supported beam. (4)

5 Write in brief the principles and concepts of (any three only) (3x4)

(a) Dirac-delta function and Unit Impulse Response Function
(b) SDOF response to support excitation
(c) Resonant response amplitude of a SDOF subjected to a harmonic loading
(d) Fourier series loading and the SDOF response to that
(e) Response of a SDOF to a triangular impulse

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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2074 Bhadra

Exam.	**Regular**		
Level	M.Sc.	**Full Marks**	60
Programme	Earthquake Engineering	**Pass Marks**	30
Year / Part	I / I	**Time**	3 hrs.

Subject: - Engineering Seismology *(CE836)*

- ✓ 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. Discuss the mechanism of earthquake with differentiation of earthquake magnitude and intensity. (8)
2. Describe the velocity and pattern of body waves in the different layers of the earth. (7)
3. Explain the process of earthquake measurement focusing on magnitude and intensity. (8)
4. What is plate tectonics? Discuss in detail about different types of plate boundaries. (7)
5. Difference between earthquake return period and Probability of exceedence. Explain how you calculate the earthquake return period with example in the Himalaya. (10)
6. Gorkha earthquake-2015, Nepal is unique in the Himalaya. Discuss the origin and mechanism of this earthquake in detail. (10)
7. Write Short note (any two) (2*5=10)
    a. Travel time earthquake
    b. Co-seismic landslides
    c. Liquefaction

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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2075 Bhadra

Exam.	Regular / Back		
Level	M.Sc.	Full Marks	60
Programme	Earthquake Engineering	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Seismology *(CE808-C01)*

- ✓ 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 Describe ground motion parameters. What is GMPE? Describe in detail of the procedure to derive a GMPE. [10]

2 Briefly discuss about the seismic waves. Derive the wave equation of torsional wave in infinitely long rod. Calculate the shear wave velocity of rock with shear modulus of 24 GPa and specific gravity of 2.64, assume necessary data. [12]

3 Discuss on the damage scenario of The 2015 Gorkha earthquake inside the Kathmandu valley from the aspect of ground motion parameters and structures. [10]

4 What is Elastic rebound theory? Discuss briefly on the return period and frequency of earthquake event. [10]

5 Briefly discuss on earthquake energy, earthquake intensity and magnitude. [10]

6 Discuss about the national and international seismic protection practices. [8]

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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2075 Bhadra

Exam.	Regular / Back		
Level	M.Sc.	Full Marks	60
Programme	Earthquake Engineering	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Theory of Vibrations *(CE808-C04)*

- ✓ 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 damped free vibration test is conducted to determine the dynamic properties of a one storey building. The mass of the building is 10,000 kg. Initial displacement of the building is 0.702 cm. Maximum displacement on the first cycle is 0.53 cm and period of this displacement cycle is 1.7 second. Determine:

   a) the undamped natural frequency,
   b) the logarithmic decrement,
   c) the damping ratio;
   d) the coefficient of damping
   e) the damped frequency and period; and
   f) the amplitude after 6 cycles. [12]

2. a) Show that the steady-state response of an SDOF system to a cosine force, $p(t) = p_0 \cos \varpi t$, is given by

$$v(t) = \frac{p_0}{k} \frac{\left[1-(\varpi/\omega)^2\right]\cos \varpi t + \left[2\xi(\varpi/\omega)\right]\sin \varpi t}{\left[1-(\varpi/\omega)^2\right]^2 + \left[2\xi(\varpi/\omega)\right]^2}$$

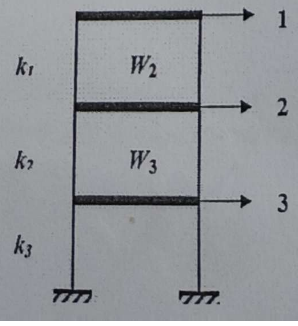
[8]

   b) Show that the maximum deformation due to cosine force is the same as that due to sinusoidal force. [4]

3. a) A machine part having a mass of 2.5kg vibrates in a viscous medium. a harmonic exciting force of 30N acts on the part and causes resonant amplitude of 14mm with a period of 0.22s. Find the damping coefficient. If the frequency of the exciting force is changed to 4Hz, also determine the increase in the amplitude of the forced vibration upon the removal of the damper. [8]

   b) Write down the expressions for the Fourier Series in terms of trigonometrical functions as well as in terms of complex exponential functions. Define the coefficients of the terms also. [4]

4. a) Determine the natural frequencies and natural vibration mode shapes for the three-storied shear frame shown in the figure given below. Sketch the mode shapes, and also illustrate that the modes shapes satisfy the orthogonality conditions. The weight of each storey of the structure from top to bottom is $W_1 = W_2 = W_3 = W = 9800$ kN, each storey stiffness is $k_1 = 3k$, $k_2 = 5k$ and $k_3 = 6k$, where $k = 200$ kN/cm. [8]



b) Write down the uncoupled equations of motion for the above structure. Describe systematically the procedure how the response of the structure is determined, if it was initially at rest, and subjected to a force vector: (exact calculation is not necessary) [

$$\{P(t)\} = \begin{Bmatrix} 0 \\ 0 \\ 200\sin 2t \end{Bmatrix}$$

5. Write in brief the principles and concepts of (any three only) [3×

a) Base isolation and Transmissibility Ratio

b) Duhamel Integral for damped SDOF system

c) Resonant response amplitude of an undamped SDOF system

d) Interpolation functions and structural property matrices

e) Partial differential equations for transverse vibration of a string, transverse vibration of a beam, and axial vibration of a rod with associated boundary conditions

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63 TRIBHUVAN UNIVERSITY	Exam.	Regular / Back		
INSTITUTE OF ENGINEERING	Level	M.Sc.	Full Marks	60
Examination Control Division	Programme	Earthquake Engineering	Pass Marks	30
2075 Bhadra	Year / Part	I / I	Time	3 hrs.

Subject: - Geotechnical Earthquake Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions from __Group A__ and any __Four__ from __Group B__.*
- ✓ *__All__ questions carry equal marks.*
- ✓ *Answer in your own language. Draw diagrams/figures wherever necessary.*

Section A

1. Describe Hazard? Explain Seismic hazard and its importance.
   During the occurrence of earthquake different types of seismic waves are produced. Describe different types of seismic waves.

2. How do you differentiate continental drift theory and plate tectonics?
   Explain different types of plate boundaries, especially from the view point of earthquake.
   Draw earth's internal structure showing different layers and discontinuities. Explain each layer and discontinuity.

3. What is fault? Describe different features of a fault. From the view point of fault movement, explain different types of faults. Draw neat and clear diagrams for each fault.
   What is Moment magnitude? How do you calculate this magnitude and why it is different from other magnitudes?

4. Explain Elastic Rebound Theory. Also, describe in brief the relationship of elastic rebound theory with earthquake recurrence and tectonic environments.
   What are the possible sources of seismic activity? Mention them.

5. Explain the mechanism of liquefaction. What are the conditions those must be satisfied to occur liquefaction? Point out the factors that affect liquefaction and measures to prevent liquefaction.

6. What is seismic hazard analysis?
   How do you identify and evaluate earthquake sources?
   What is the basic concept of Deterministic Seismic Hazard Analysis (DSHA)? Explain the steps followed in this analysis.

7. What are dynamic soil properties?
   If major and minor principal stresses act on a cylindrical soil specimen such that the specimen fails making theta angle with major principal plane, then write down the equations for normal and shear stresses that act on the failure plane. Also, draw Mohr's circle of stresses for this condition.
   What changes will be there in Mohr's circle of stresses and stress path if seismic wave acts?

8. Why do you need to study dynamic soil properties of soils?
   What is effective stress path? Explain different stress paths depending on the condition of consolidation and shearing stages of shear test.
   Mention the tests done to measure the dynamic soil property.

9. Mention the types of slopes?. Why the study of slope stability is important? Differentiate between static and pseudo-static slope stability analysis?
   How do you find dynamic factor of safety for planar failure and circular arc failure based on pseudo-static stability analysis?

Section B

10. The exploratory borings at a project site show that there is a deposit 5 m thick of saturated sand with a SPT value to 15 overlying a 20 m thick deposit of clay in bed rock. If the maximum horizontal acceleration in bed rock due to an earthquake (M=7.5) is estimated as 0.06 g. Is there any possibility of liquefaction in the sand deposit? Take scaling factor, $\psi = 0.65$.

11. (a) Estimate the energy released by an earthquake of magnitude 8 using the relationship given below by Richter and compare this with the energy released by the Hiroshima atomic bomb (8×10^{20} ergs).

(b) If Gutenberg-Richter relationship ($M = 0.6 \times I_o + 1.3$) for earthquake magnitude (M) and earthquake intensity [I_o (in MMI scale)] is used, then estimate the Earthquake Intensity of above case.

(c) Also, find the maximum ground acceleration in terms of gravitation acceleration, g if following relationship is given where a (cm/s^2):

$$\log_{10} a = \frac{1}{3} I_o - 0.5$$

12. An earthquake causes an average of 3 m strike-slip displacement over an 80 km long, 40 km deep portion of a transform fault. Estimate the seismic moment and moment magnitude of the earthquake. Assume that the average rupture strength of this rock along the fault plane as 180 kPa.

13. The seismicity of a particular region is described by the Guntenberg-Richter recurrence law: $\log \lambda_m = 4.0 - 0.7$ M. What is the probability that at least one earthquake of magnitude greater than 7.0 will occur in a 10-year period? In a 50-year period? In a 250-year period? Use Poisson Model Equation. Comment on this probability.

14. The site is located in the vicinity of three independent seismic sources represented by source zones A, B, and C. Magnitude and minimum source-to-site distance for each site obtained is shown below:

Source Zone Distance	R (km)	Magnitude
A	23.7	7.3
B	25.0	7.7
C	60.0	5.0

Using a deterministic seismic hazard analysis, compute the peak acceleration. For simplicity, use following Cornell's relationship for estimating Peak Horizontal Acceleration (PHA).

$$\ln PHA(gals) = 6.74 + 0.859M - 1.80 \ln(R + 25)$$

15. Describe the followings in brief: (ANY THREE)

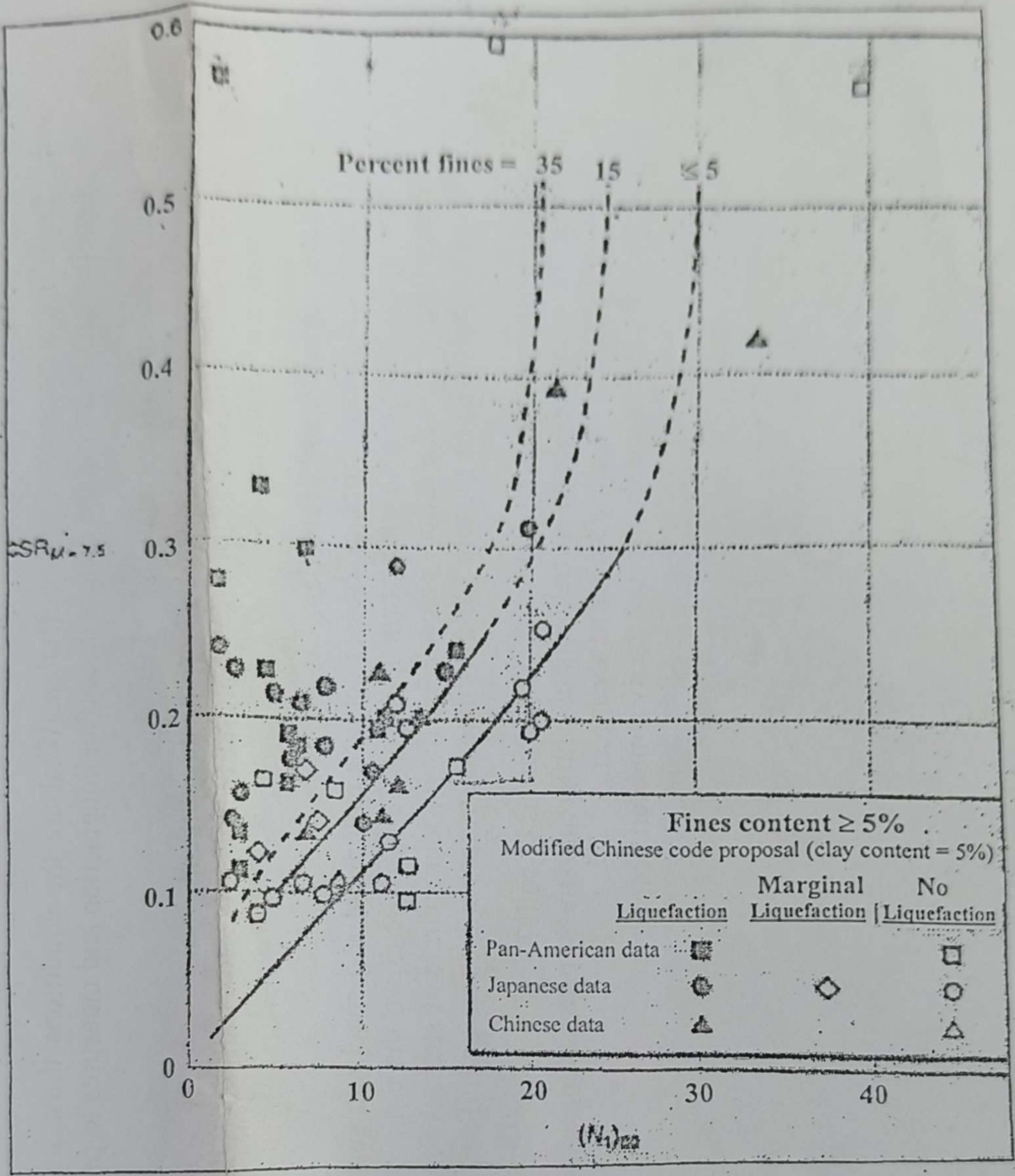
(a) Moho's discontinuity and Guntenberg discontinuity

(b) Asperity and Barrier Models

(c) Seismic gap and Isoseismal maps

(d) Flow liquefaction and cyclic mobility

(e) Influence of earth's structure on the distribution of seismic wave



Percent fines = 35 15 ≤5
CSR M=7.5
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
(N1)60
Fines content ≥ 5%
Modified Chinese code proposal (clay content = 5%)
Liquefaction
Marginal Liquefaction
No Liquefaction
Pan-American data
Japanese data
Chinese data

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INSTITUTE OF ENGINEERING

Examination Control Division

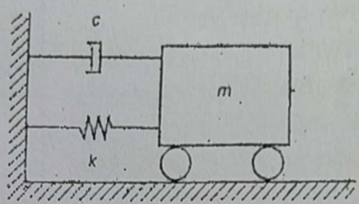
2072 Chaitra

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	Earthquake Engineering	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Theory of Vibration

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

1. (a) The SDOF oscillator shown in the figure below is set in motion by an initial displacement, $v(0) = 1$. The ratio of the initial displacement to the succeeding displacement is 1.18. The oscillator has the following properties: $m = W/g = 10$ lb/386.4 in/sec and $k = 20$ lb/in. Determine the following: (5)



(i) The natural circular frequency, ω; the natural cyclic frequency, f; and the fundamental period, T.

(ii) The logarithmic decrement.

(iii) The damping ratio.

(iv) The damping coefficient.

(v) The damped natural frequency.

(b) For a system with damping ratio ξ, determine the number of free vibration cycles required to reduce the displacement amplitude to 10% of the initial amplitude; the initial velocity is zero. (3)

(c) An SDOF system is excited by a sinusoidal force. At resonance the amplitude of displacement was measured to be 2 in. At an exciting frequency of one-tenth the natural frequency of the system, the displacement amplitude was measured to be 0.2 in. Estimate the damping ratio of the system. (4)

2. (a) Show that the steady-state response of an SDOF system to a cosine force, $p(t) = p_0 \cos \varpi t$, is given by

$$v(t) = \frac{p_0}{k} \frac{\left[1-(\varpi/\omega)^2\right]\cos \varpi t + \left[2\xi(\varpi/\omega)\right]\sin \varpi t}{\left[1-(\varpi/\omega)^2\right]^2 + \left[2\xi(\varpi/\omega)\right]^2}$$ (9)

(b) Show that the maximum deformation due to cosine force is the same as that due to sinusoidal force. (3)

3. (a) A machine part having a mass of 2.5kg vibrates in a viscous medium. A harmonic exciting force of 30N acts on the part and causes resonant amplitude of 14 mm with a period of 0.22s. Find the damping coefficient. If the frequency of the exciting force is changed to 4Hz, also determine the increase in the amplitude of the forced vibration upon the removal of the damper. (8)

(b) Write down the expressions for the Fourier Series in terms of trigonometrical functions as well as in terms of complex exponential functions. Define the coefficients of the terms also. (4)

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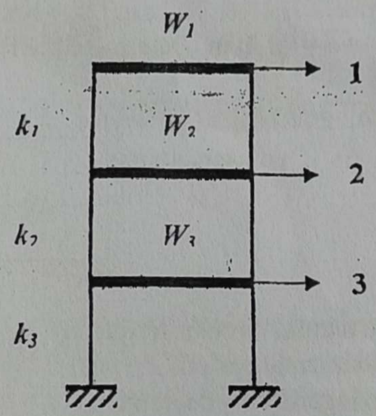

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5. Write in brief the principles and concepts of (any three only) (3 x 4

~~(a) Base Isolation and Transmissibility Ratio~~
(b) Duhamel Integral for damped SDOF system
(c) Resonant response amplitude of an undamped SDOF system
(d) Critically damped system
(e) Partial differential equations for transverse vibration of a string, transverse vibration of a beam, and axial vibration of a rod with associated boundary conditions

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64 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Chaitra

Exam.		Regular	
Level	M.Sc.	Full Marks	60
Programme	Earthquake Engineering	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Seismology

- ✓ 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.*

[50 × 10 = 50]

1. (a) Define magnitude of an earthquake. Compare magnitude and intensity of an earthquake.
(b) Calculate the amount of energy released during Gorkha earthquake. Also compare its energy with the amount of energy released during Nepal-Bihar earthquake.

2. (a) Explain briefly the reflection, refraction and dispersion of seismic waves.
(b) What is attenuation of seismic waves? What are different attenuation laws?

3. (a) Explain the computational procedure of Fourier amplitude spectrum of the strong motion record.
(b) Differentiate between amplitude parameters and frequency content parameters.

4. (a) What are earthquake recording instruments? With the help of a neat diagram, explain the working principle of an Accelerograph.

(b) Assuming P and S wave traveled through the crust at 5 km/s and 3 km/s respectively, locate the epicenter of the earthquake whose characteristics are given below:

S. No.	Seismograph location		P-wave arrival time	S-wave arrival time
	Latitude $\times 10^3$ (m)	Longitude $\times 10^3$ (m)		
1	4156	13552	05:15:18.52	05:15:26.50
2	4198	13603	05:15:34.82	05:15:38.68
3	4212	13535	05:15:46.22	05:15:52.50

5. (a) What are the major points to be considered during the earthquake resistance design of a building? Describe.
(b) Is it possible to predict the occurrence of an earthquake? Explain.

6. Write short notes on (any **TWO**) [20 × 5 = 10]

(a) History of seismology
(b) Response spectra
(c) IAEA safety standards

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INSTITUTE OF ENGINEERING

Examination Control Division

2072 Chaitra

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	Earthquake Engineering	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Seismology

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2072 Chaitra

Exam.	Regular		
Level	M.Sc.	Full Marks	60
Programme	Earthquake Engineering	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Geotechnical Earthquake Engineering

- ✓ 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. Differentiate the mechanism of shallow and deep earthquakes Consider an earthquake fault is to be a simple system with elastic constant 'K' and damping constant 'C' for the fault material. Write down a modeling domain and displacement time history of the point in the fault after on earthquake happens, also discuss the consequences. [4+2]
2. What would be the basis of working earthquake early warning system? How do you find the epicenter of an earthquake using the difference in time between 'P' and the 'S' curve? [3+3]
3. What are the basis of using different scale of measurement in earthquake? Why earthquake engineers are interested in how structures respond to the ground motion? What are the major factors controlling the level of shaking? [2+2+2]
4. Write down the soil-dynamic and Geo-physical parameters. Write down the representative plots of stress and strain in case of effect of confining pressure and pore water pressure? How do you estimate Young's modulus and Poisson's ratio? [2+2+2]
5. How should a ground motion be applied is designing? When are 1D, 2D and 3D analyses appropriate? How much difference does it make in equivalent linear Vs. non-linear analysis? [1+2+3]
6. How do you perform dynamic analysis of low strength masonry house based on site specific earthquake ground motion? Differentiate static, pseudo-static and dynamic analysis. [4+2]
7. What are the governing parameters controlling the seismic liquefaction? How do you perform parametric analysis to explore the governing phenomena? Differentiate liquefaction and seismic liquefaction. What are the major effects of seismic liquefaction? Relate your answer with respect to Gorkha earthquake 2015. [1+2+1+2]
8. Write down the interface formulation of seismic soil structure interaction and what would be the near and far field boundary conditions in case of seismic soil structure interaction? In which form are you getting soil structure interaction effects? How is it different than the ordinary method of analysis? [4+1+1]
9. Differentiate continuum and dis-continuum modeling methods. Flow do you explore numerical and computational accuracy impact factors? Do you know factored shear strength parameters and strength reduction factor (SRF)? How do you satisfy 'phi-nu' inequality test during strength reduction process? [1+2+2+1]
10. a) Explain the different modes of Tsunami. How long does Tsunami wave take to get Srilanka from Sumatra island Indonesia? Earthquake Epicenter is in Sumatra Indonesia. Consider, shortest distance 1600 km, water depth 4000 m. [1+3]

    b) Write down the importance of characteristic curve in tunnel support system designing. What would be the possible support system in tunneling? [1+1

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2072 Chaitra

Exam.		Regular	
Level	M.Sc.	Full Marks	60
Programme	Earthquake Engineering	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

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Examination Control Division

2072 Chaitra

Exam.		Regular	
Level	M.Sc.	Full Marks	60
Programme	Earthquake Engineering	Pass Marks	30
Year / Part	I / I	Time	3 hrs.

Subject: - Theory of Vibration

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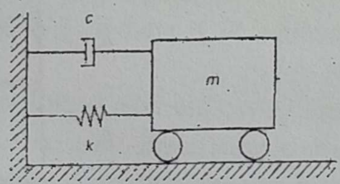

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(iv) The damping coefficient.

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(b) For a system with damping ratio ξ, determine the number of free vibration cycles required to reduce the displacement amplitude to 10% of the initial amplitude; the initial velocity is zero. (3)

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(b) Show that the maximum deformation due to cosine force is the same as that due to sinusoidal force. (3)