TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2082 Shrawan

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

Subject: - Computational Techniques in Civil Engineering *(CE 751)*

- ✓ *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**.*
- ✓ ***Candidate should use separate answer book for each group (Water and Structure).***
- ✓ *Assume suitable data if necessary.*

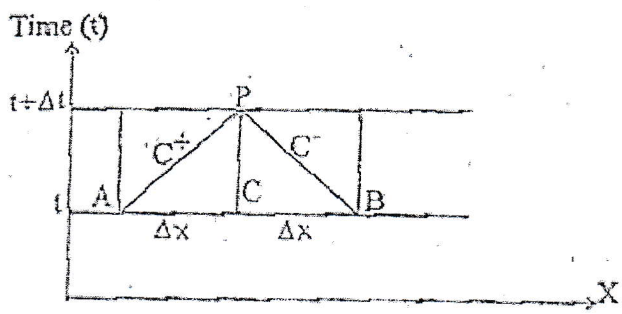
Group A (Water Part)

1. A flood of 275 m^3/s peak discharges passed a gauging station at 7:00 AM on a river. There is a community adjacent to the river 4.38 km downstream. What will be the value of peak discharge at that community at 7:00 AM of the velocity of flow is 1.75 m/s and peak discharge at that community at 6:00 AM is 72 m^3/s. Assume the river width is incised and apply the first-order accurate numerical scheme of kinematic wave equation. [5]

2. Explain implicit four-point scheme with discretization of derivative and non-derivative terms. Develop finite difference equations for dynamic wave model using the same scheme. [2+5]

3. a) How would you define boundary conditions in the context of an unsteady pipe flow problem? Provide an explanation. [2]

   b) Following data are given at two points A and B along a pipe of diameter 30 cm carrying water $Q_A = 0.35\ m^3/s$, $Q_B = 0.36\ m^3/s$, $H_A = 10$ m, $H_B = 12$ m, $\Delta x = 100$ m, $\Delta t = 10$ sec, $f = 0.02$, $c = 1200$ m/s $\left(\frac{dx}{dt} = \pm c\right)$, elevation difference between A and P = 1.2 m. By use of finite difference form of characteristic equation, calculate discharge and head at point P. [6]



4. Derive an expression to simulate 2D steady-state groundwater flow beneath a dam using a finite difference grid. Write the iterative procedure for computing potential at each grid and seepage rate. [5+3]

Group B (Structural Part)

5. List out different Computational Techniques used in Civil Engineering. [2]

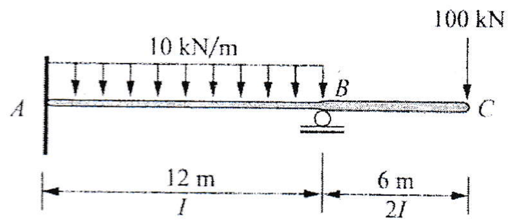
6. Explain the use of typical finite elements for different structural systems. [6]

7. Write down an algorithm for solving a system of linear equations using conjugate gradient method. [4]

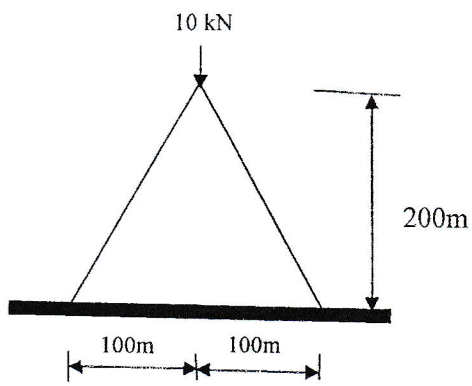
8. Describe the application of one dimensional, two dimensional and three dimensional elements in structural systems with suitable examples. [2+4+2]

9. Derive strain-displacement relation for a quadratic bar element. [8]

10. For the following structural system, find the displacement at nodes B and C. Also, determine the deflection and rotation at the mid-span of AB. Where, E = 200 GPa, $I = 700 \times 10^6$ mm^4. [8+4]



11. A plate of thickness 10 mm is subjected to the load of 10 kN as shown in the following figure. Determine the stresses at the centroid of the element. Take E = 200 GPa, μ=0.3. Neglect the self-weight of the plate. [12]



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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2081 Chaitra

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

Subject: - Computational Techniques in Civil Engineering *(CE 751)*

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
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- ✓ ***Candidate should use separate answer book for each group (Water and Structure).***
- ✓ *Assume suitable data if necessary.*

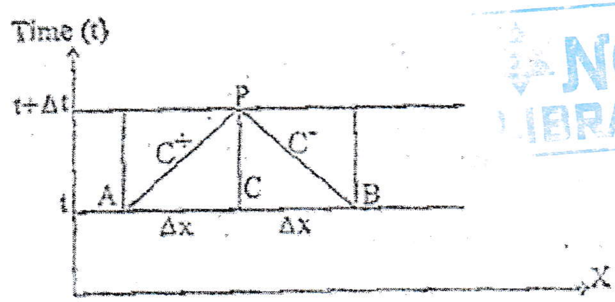
Group A (Water Part)

1. a) Derive numerical solution for the non-linear kinematic wave model for the movement of fluid using central difference scheme. [4]

   b) Describe numerical diffusion and dispersion. [2]

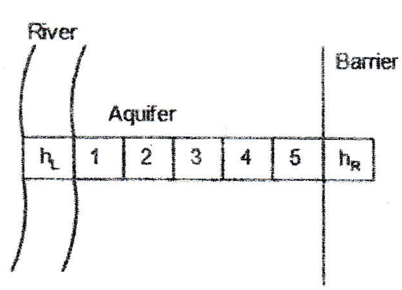
2. A channel with a width of 40m, bed slope 2% and manning's n = 0.03 carries a discharge of 100 m^3/s through a section. If Δx is taken as 500 m, recommend the maximum time step for stable solution kinematic wave routing in this condition. Assume hydraulic radius equal to flow depth. [6]

3. What do you mean by method of characteristics and characteristic curve? Following data are given at two points A and B along a pipe of diameter 30 cm carrying as shown in figure below. $V_A = 4$ m/s, $V_B = 4.5$ m/s, $P_A = 265$ kN/m^2, $P_B = 275$ kN/m^2, $\Delta x = 500$ m, $\Delta t = 5$s, f = 0.02, c = 1200 m/s, elevation difference between A and P = 1.5 m. Using finite difference form of characteristics equations, compute pressure and velocity at point P. [2+6]



4. a) Explain the continuity equation used in 2D ground water flow analysis. [2]

   b) A schematic for simulating river-stage water table fluctuation is shown in figure below. Calculate coefficients of the 1D implicit finite difference model and display the matrix. The following data are given for the simulation: homogeneous and isotropic aquifer, river stage (h_L) = 205 m, length of aquifer 600 m, Δx = 120 m, Δt = 1 day, transmissivity of aquifer = 0.03 m^2/s, storage coefficient = 0.01. The initial value of water table at 5 grid is given as 200.1, 200.11, 200.2, 200.3, 200.4 m, respectively. [6]



Group B (Structural Part)

5. Describe the applications of computational techniques in civil engineering. [4]

6. Explain the basic steps in Finite Element Method for a structural system. [4]

7. Using Conjugate Gradient Method, solve the following system of linear equation. [4]

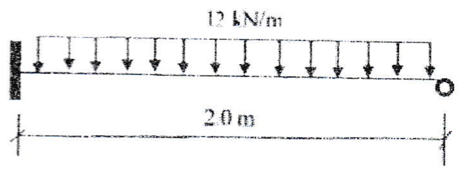
   $2X_1 - X_2 = 1$

   $-X_1 + 2X_2 = 0$

8. Derive strain displacement relation for an isotropic three dimensional solid. [6]

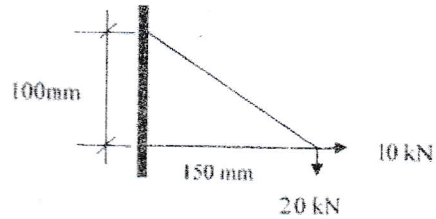
9. Formulate stiffness matrix for a linear bar element. [8]

10. Determine deflection and rotation at the mid-span of the following beam. Take $E = 200$ GPa and $I = 4 \times 10^6$ mm^4. [7+3]



11. Derive shape functions for a 4 noded rectangular element. [4]

12. Determine element stiffness matrix, nodal displacements and stresses at the centroid of the element for a steel plate of 10 mm thickness subjected to the loading as shown in figure. Take E= 200 GPa. μ=0.3. Neglect the self-load of the plate. [8+2+2]



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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.

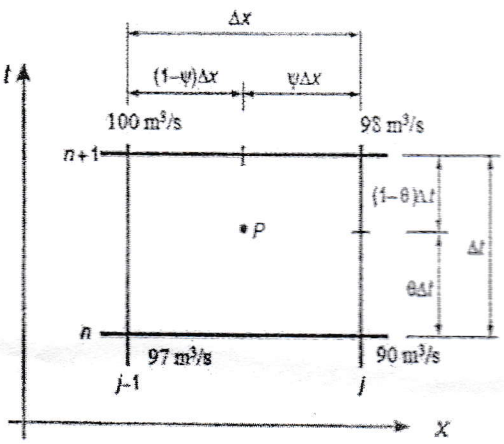
Subject: - Computational Techniques in Civil Engineering *(CE 751)*

- ✓ 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**.*
- ✓ ***Candidate should use separate answer book for each group (Water and Structure).***
- ✓ *Assume suitable data if necessary.*

Group A (Water Part)

1. Derive the expression for first-order accurate implicit finite difference equation for the kinematic wave model in the linear form. Also, derive the expression for parameters of the momentum equation of the kinematic wave model. [6+2]

2. Determine the values of first order partial derivative of discharge with respect to time and space using four-point implicit method. The discharges at four points in the space-time grid are shown in figure below. Take $\Delta t = 1\ hour$, $\Delta x = 500\ m$, $\theta = 0.55$, $\Psi = 0.45$. [2+2]



3. Define Method of Characteristics (*MOC*). Derive the expressions for the application of *MOC* to unsteady pipe flow problems. [1+7]

4. a) Draw a neat sketch presenting the finite difference grid, showing possible boundary conditions, for 2D steady state seepage analysis under a dam. [2]

   b) Table below shows the *2D* grid with values of a potential head in *m* for simulating groundwater seepage. Determine the vertical and horizontal seepage into and out of the highlighted grid. Transmissivity in the *x*-direction and *y*-direction are $2700\ m^2/day$ and $3200\ m^2/day$, respectively, for all grids. Use $\Delta x = 85\ m$ and $\Delta y = 75\ m$. [6]

0	0	0	0
2.99	2.92	2.81	2.08
2.97	2.83	2.66	2.51
2.92	2.74	2.53	2.27
0	0	0	0

Group B (Structure Part)

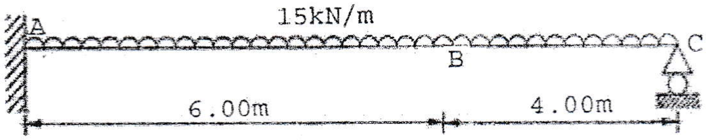
5. Define Computational Techniques. Why do we need Computational Techniques in Civil Engineering? [2+4]

6. Write down the algorithm for Conjugate Gradient Method. Solve the following set of linear equations using Conjugate Gradient Method. [Three Iterations] [3+5]

$$\begin{bmatrix} 3 & 0 & 1 \\ 0 & -1 & 3 \\ 1 & 3 & 0 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} = \begin{Bmatrix} 1 \\ -12 \\ 2 \end{Bmatrix}$$

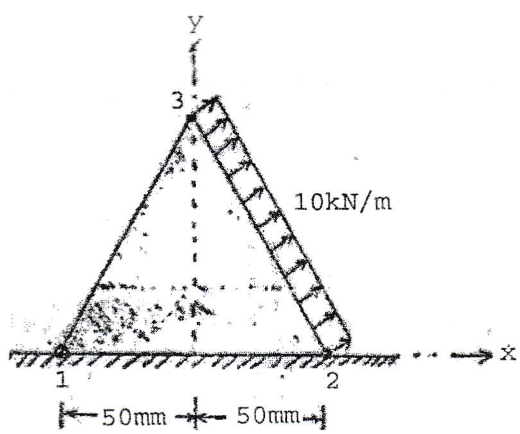
7. Derive Strain-Displacement relationship for 3-D solid element. Explain the necessity of Lame's constants. [6+2]

8. A propped cantilever beam is loaded as shown in figure. Discretize the beam into two elements and find deflection at point B and rotations at point B & C. Also check the result using single element model. Use $E = 20 \times 10^5$ MPa, $I = 5 \times 10^6$ mm^4. [10]



9. Define shape function in finite analysis and write down the properties of shape function. Derive the expressions for Hermite shape function used for the interpolation in beam elements. [3+7]

10. Considering plane stress conditions, find out the nodal displacements and stresses of the given CST element. Take $E = 210 \times 10^3$ MPa, $\nu = 0.3$, $t = 1$ cm, $\gamma = 78.5$ kN/m^3, length of each side = 100 mm. [10]



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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2079 Chaitra

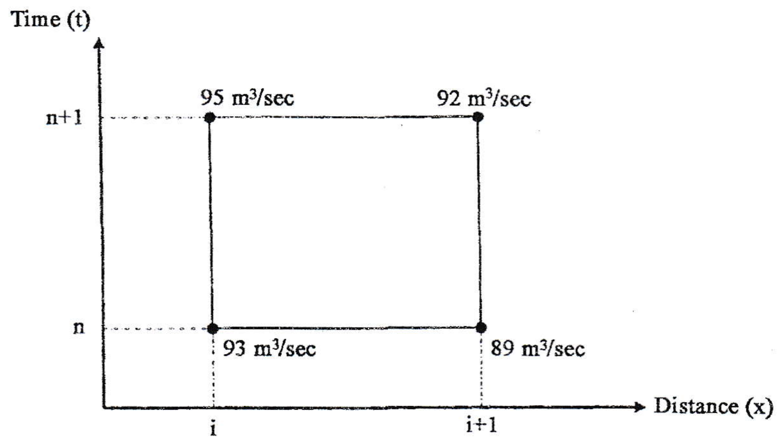
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Computational Techniques in Civil Engineering *(CE 751)*

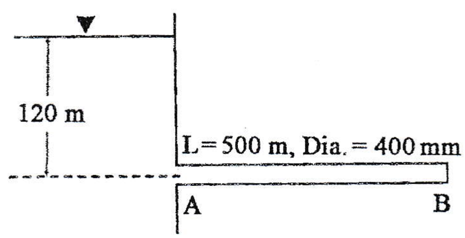
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Candidate should use separate answer book for each group (Water and Structure).***
- ✓ *Assume suitable data if necessary.*

Group A (Water Part)

1. Derive the expression for Leap frog explicit finite equation for dynamic wave modal. [6]
2. The value of flow rate Q at four points in the space time grid are shown in the figure below. Determine the value of first-order derivates $\frac{\partial Q}{\partial t}$ and $\frac{\partial Q}{\partial x}$ by using four-point implicit method. Given: dt = 1 hr, dx = 500 m and θ = 0.47. [6]



3. A pipe conveys water from a reservoir as shown in the figure below. Take f = 0.02, C = 1200 m/s. The HGL at the reservoir is given as H_{PA} = 120 + 3 Sin(πt). The discharge at the downstream end is zero at all times. By using only one reach, compute discharge from A and elevation of hydraulic grad line at B at 3 sec using a discretized equation of the method of characteristics in the form of HGL and discharge. [8]



4. Derive finite difference equation to evaluate river stage-water table interaction for one dimensional flow along a river and express in terms of tridiagonal coefficient matrix. [8]

Group B (Structure Part)

5. a) Describe briefly the basic steps in Finite Element Method (FEM). [5]

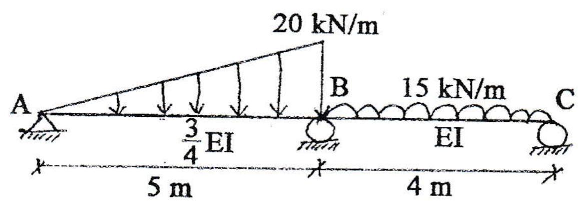
   b) Write the advantages of Finite element method over other methods. [3]

6. a) Write down the algorithm of conjugate gradient method for solving system of linear equations. [4]

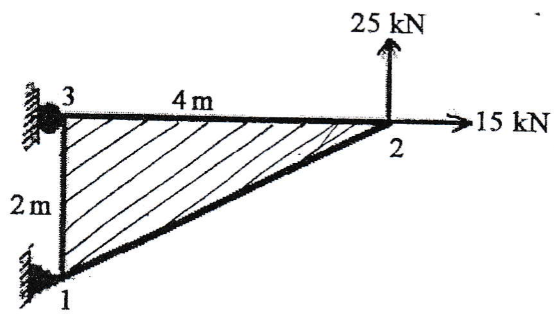
   b) Explain with suitable example how banded matrix and skyline storage scheme helps in memory optimization. [4]

7. Derive the constitutive relationship for three dimensional solid. Also, deduce the expression for plane stress and plane strain problem. [5+3]

8. Using direct stiffness matrix method, analyze the given beam. Calculate the deflection and rotation at mid span of the beam. Flexural rigidity of span AB is three fourth to that of BC. [12]



9. A plate of thickness 15 mm is being loaded as shown in figure. Considering the plane stress condition, determine the stresses and strains at the centroid of CST element. Take $E = 2\times10^5$ N/mm^2, $v = 0.25$ and unit weight of 80 kN/m^3. [10]



10. What is Jacobian matrix? Obtain the shape function for eight noded rectangular element in natural coordinate system. [2+4]

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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2078 Chaitra

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

Subject: - Computational Techniques in Civil Engineering *(CE 751)*

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

Group A (Water Part)

1. Write down the governing equations used for analyzing the moment of fluid. Discuss forward, backward and central differencing with expressions. [2+3]

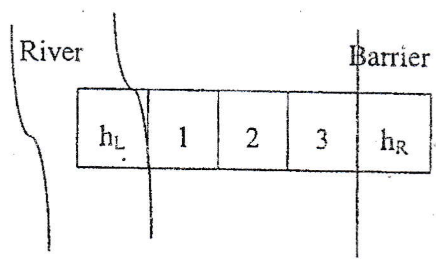
2. Following are data pertaining to a rectangular channel:

   Width of channel = 200 ft
   Length of Channel = 15000 ft
   Bed Slope, S_0 = 1%
   Manning's n = 0.035

   At the t = 0, there is a uniform flow of 2000 cfs along the channel. The discharge value at the upstream boundary from inflow hydrograph at time t = 3 min is obtained as 2250 cfs. Determine the discharge at a distance of 3000 ft downstream along the channel. Use the linear kinematics wave modal. Take Δx = 3000ft and Δt = 3 min. There is no lateral inflow (q = 0). [6]

3. What do you understand by Method of characteristics? Derive the finite difference form of characteristic equations for unsteady pipe flow in terms of head and discharge. [2+6]

4. a) A schematic for simulating river stage water table fluctuation is shown in figure.



   The following data are given for the simulation of homogenous and isotropic aquifer, river stage (h_L) = 365m, length of aquifer = 1200 m, Δt = 1 day, Δx = 400 m, transmissivity of aquifer = 600 m^2/day, storage coefficient = 0.15. The initial value of water table at 3 grids as 349.13, 347.97, 339.36 respectively. Calculate water table elevation in each grid. [5]

   b) Explain the concept of finite difference method. What are explicit and implicit schemes in finite difference method? [2+1+1]

Group B (Structure Part)

1. Explain about the necessity of computational technique in civil engineering. Also discuss about the algorithm followed while solving problems using Finite Element Method. Write down the advantages of Finite Element Method. [2+4+2]

2. a) Briefly explain about the different iterative methods used for the solution for given set of equations. [3]

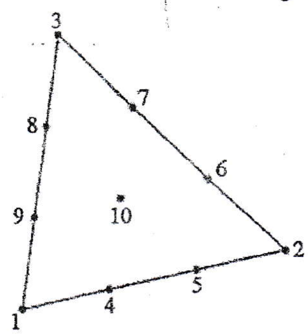
   b) Solve the given system of equations using conjugate gradient method. [5]

$$2x_1 - x_2 = 4$$
$$-x_1 + 2x_2 - x_3 = 0$$
$$-x_2 + 2x_3 = 0$$

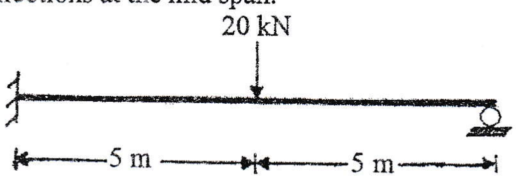
3. a) Derive constitutive relations for 3D-state of a solid. [5]

   b) Differentiate plane stress and plane strain problems with examples. [5]

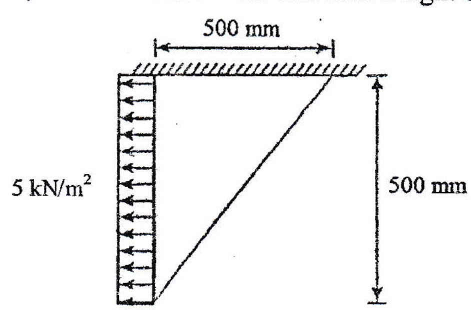
4. Derive the shape function for the element as shown in figure below. [6]



5. Draw Bending Moment and Shear force diagrams of the concrete beam shown in the following figure using finite element method. Take the beam section 500 mm × 1000 mm. Also determine the deflections at the mid span. [10]



6. A steel plate of uniform thickness 10 mm is being loaded as shown in figure below. Considering the plane stress condition, determine the stiffness matrix, load vector and nodal displacements of the given CST element. Take, modulus of elasticity = 200 × 10^3 MPa, Poisson's ratio = 0.3 and unit weight of steel = 78.5 kN/m^3. [4+2+4]



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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2077 Chaitra

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

Subject: - Computational Techniques in Civil Engineering *(CE 751)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
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- ✓ ***Candidate should use separate answer book for each group (Water and Structure).***
- ✓ *Assume suitable data if necessary.*

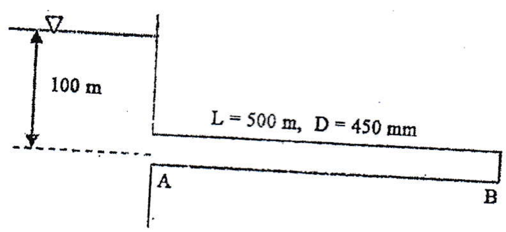
Group A (Water Part)

1. What is finite difference method? Explain explicit and implicit finite difference schemes with examples. [2+3]

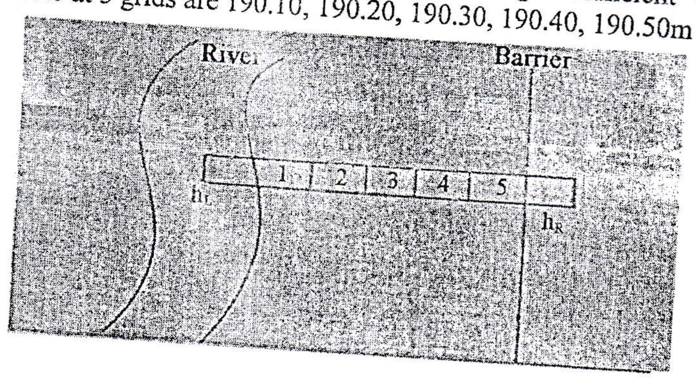
2. For a 30 m wide and 0.015 bed slope rectangular channel following flow rates are given: $Q_i^{\ n} = 20\ m^3/s$, $Q_i^{\ n+1} = 28\ m^3/s$ and $Q_{i+1}^{\ n} = 18\ m^3/s$. Taking Manning's n = 0.025, $\Delta x = 1200$ m and $\Delta t = 10$ min, determine $Q_{i+1}^{\ n+1}$ using finite difference scheme for linear kinematic wave model. Assume lateral inflow to be zero. Take wetted perimeter is approximately equal to the width of the channel. [6]

3. a) What is method of characteristics? Define diffusion, dispersion and stability. [4]

   b) The figure below shows a pipe conveying water from a reservoir. The HGL at the reservoir is given as $H_{PA} = 100 + 2\sin(\pi t)$. The discharge at the downstream end is zero at all times. By using only one reach, compute discharge from A and elevation of HGL at B at 2 seconds using the discretized equation of the MOC in the form of head and discharge. Take f = 0.02 and c = 1250 m/s. [6]

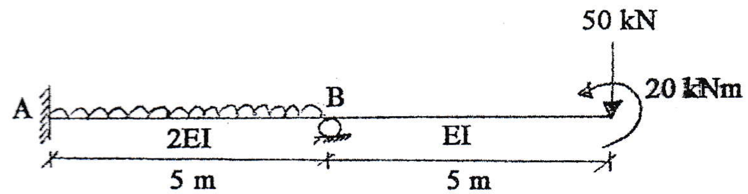


4. Define courant condition. Compute coefficients of 1-D implicit finite difference model and display the matrix for the schematic diagram for simulating river stage water table fluctuation which is as shown in figure below .Consider the data for the simulation as: Homogeneous and isotropic acquifer, river stage $h_L = 195$m, aquifer length = 500 m, Δx = 100m
Δt = 1 day, transmissivity of acquifer = 0.024 m/s, storage coefficient = 0.015, and initial value of water table at 5 grids are 190.10, 190.20, 190.30, 190.40, 190.50m respectively. [1+6]

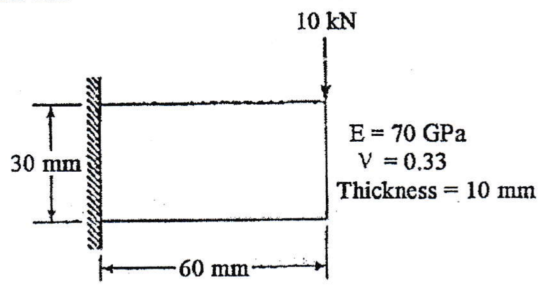


Group B (Structure Part)

1. a) Describe basic steps in Finite Element Analysis. [4]
   b) Explain different types of problems that can be solved with finite element analysis. [4]
2. a) Explain with relevant examples how banded matrix and skyline storage scheme optimizes the memory. [3]
   b) Write down the algorithm for solving the set of linear equations by conjugate gradient method and its limitations. [3+2]
3. a) Derive the expression for Lame's constant. [5]
   b) Explain about axisymmetric problems with examples. Write down the constitutive relations and strain displacement relation for axisymmetric problems. [5]
4. Derive shape functions for a beam element. [8]
5. Determine rotation and deflection at free end of the given beam and hence draw BMD. Take EI to be constant. [10]



6. Find the stiffness matrix using two elements for the following plate, loaded as shown in figure. Take $\Upsilon = 78.5\ KN/m^3$ [8]



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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Bhadra

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

Subject: - Computational Techniques in Civil Engineering *(CE 751)*

- ✓ 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**.*
- ✓ ***Candidate should use seperate answer book for each group.***
- ✓ *Assume suitable data if necessary.*

Group A (Water Part)

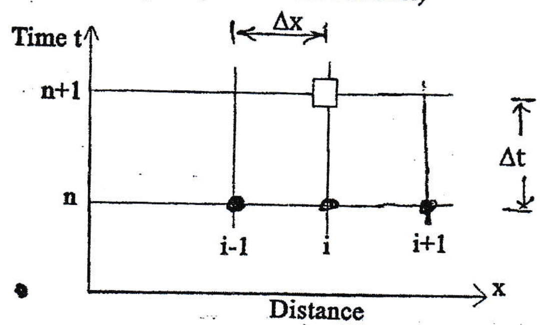
1. a) Write the concept of finite difference method. Explain forward, backward and central difference approximation of finite difference equation. What are the differences between explicit and implicit schemes of finite difference approaches. [5]

   b) Water flows in a rectangular channel of width 25m having bed slope 0.015. Assume no lateral inflow. Consider wetted perimeter is equal to width of the channel. Taking ΔX=1500m, Δt=10min & take manning's n=0.035. Given that

   $Q_{i-1}^{n} = 30m^3/s, Q_i^n = 22m^3/s, Q_{i+1}^{n} = 20m^3/s$

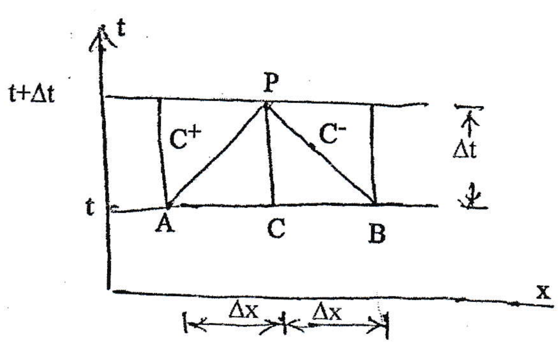
   $y_{i-1}^{n} = 1.25m, y_i^n = 1.45m, y_{i+1}^{n} = 1.65m$

   Using an explicit method, determine the depth and discharge at the grid point (i,n+1) for full Saint-Venant equation (ie. Dynamic wave model) [7]



2. a) Define charcteristics curve and method of characteristics (MOC). Also write the advantages of MOC. [3]

   b) Following data are given at two points "A" and "B" along a pipe of diameter 40cm carrying water. Q_A=0.5 m^3/sec, Q_B=0.55 m^3/sec, H_A=25m, H_B=26m, Δx=600m, Δt=0.50sec, f=0.02, a=1200 m/sec elevatin difference between A and P=1m; using the finite difference form of characteristic equations, Compute discharge and head at point P. [5]



3. Derive expression for finite difference scheme for 2D ground water simulation in steady state for homogeneous and isotropic aquifer. [8]

Group B (Structure Part)

4. List and explain the different solution techniques in Civil Engineering. Also explain the advantages of Finite Element Analysis over other method of analysis of structure. [4+4]

5. a) What do you understand by banded matrix and memory optimization technique? [4]

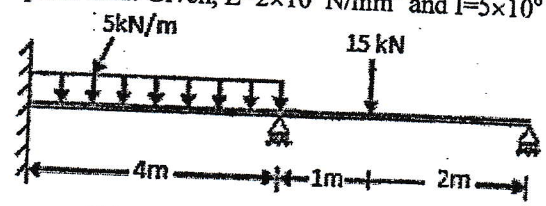
   b) Solve the following system of equations using Gauss-Siedal iteration method. [4]

   $2x-y=2$
   $x+6y-2z=-4$
   $4x-3y+8z=5$

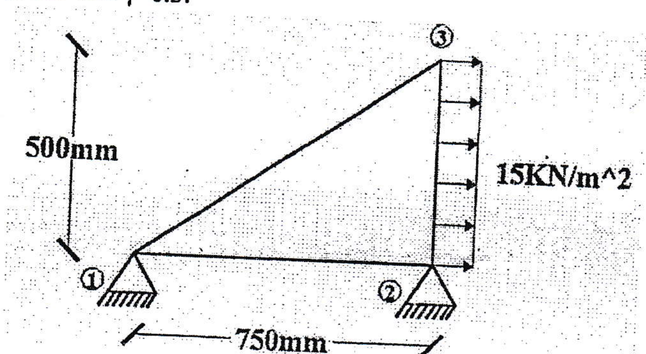
6. a) Explain how strain can be expressed in terms of stresses for a 3-D object. [5]

   b) What do you understand by anisymmetric problem? Write the constitutive relations and strain displacement relation for anisymmetric condition. [5]

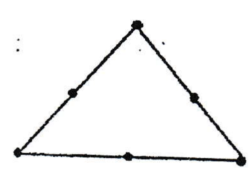
7. Analyze the beam shown in figure by finite element method. Also determine the deflections under point load. Given, $E=2\times10^5\ N/mm^2$ and $I=5\times10^6\ mm^4$. [10]



8. Using plane stress condition, calculate the displacement and stress in CST elements shown in figure below. Take E=210GPa, thickness= 15 mm, unit weight of material=$80KN/m^3$ and $\gamma=0.3$. [8]



9. Explain Iso-parametric formulation, Obtain the shape function for the element shown in figure. [2+6]



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01 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.

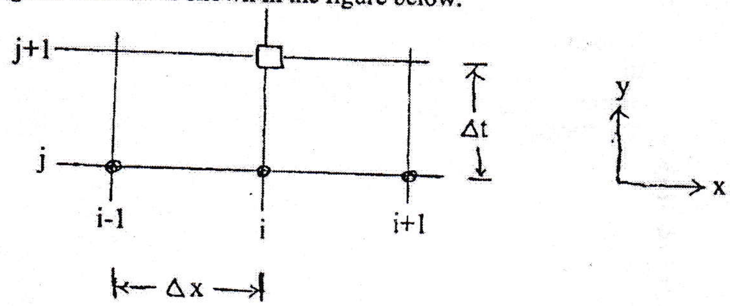
Subject: - Computational Techniques in Civil Engineering *(CE751)*

- ✓ 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.***
- ✓ ***Candidate should use separate answer book for each group (Water and Structure).***
- ✓ *Assume suitable data if necessary.*

Group A (Water Part)

1. Describe basic steps in finite difference method. Explain explicit and implicit schemes in finite difference method using suitable examples and expressions. [2+2+2]

2. A finite difference grid of points constructed to solve for the unsteady flow problems in a wide rectangular channel is shown in the figure below.



Using an appropriate finite difference scheme for two governing equations of fluid flow (continuity and momentum), compute the velocity and flow depth at grid pint (i, j+1) for the following given data:

Velocity: $y_{i-1}^{j} = 2.2\text{m/sec}$, $V_{i}^{j} = 1.8\text{m/sec}$, $V_{i+1}^{j} = 1.5\text{m/sec}$

Flow depth: $y_{i-1}^{j} = 1.6\text{m/sec}$, $y_{i}^{j} = 2.0\text{m/sec}$, $y_{i+1}^{j} = 2.4\text{m/sec}$

Bed slope = 1%, Manning's n = 0.032, Δx = 1000 m, Δt = 4 minutes, No lateral in flow. [6]

3. What is meant by method of characteristics and why it is necessary? Derive finite difference equations of the characteristic form of unsteady flow equations in a pipe to obtain solution in terms of head and discharge. [2+6]

4. Derive a suitable finite difference expression for two dimensional (2D) groundwater simulation in steady state condition for homogeneous and isotropic aquifer. also describe the iterative procedure for computing potential at each grid and seepage rate under a dam. [5+3]

Group B (Structure Part)

5. a) Discuss about the software used to evaluate the problems in FEM and FDM. [4]

   b) What is meant by discretization, describe with example? [4]

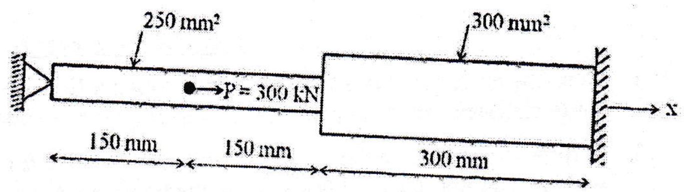
6. Explain different solution techniques of linear equations. For the given linear system

$$\begin{bmatrix} 12 & -6 & 0 \\ -6 & 12 & -6 \\ 0 & -6 & 6 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} = \begin{Bmatrix} 24 \\ 24 \\ 0 \end{Bmatrix}$$

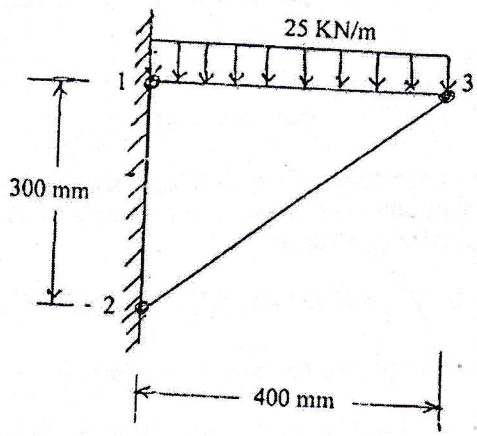
Using the starting vector $x^{(0)} = (4, 4, 0)^T$, carry out two iterations of conjugate gradient method and show the result. [3+5]

7. Derive constitutive relation for plane stress problems. Explain axi-symmetric problems with examples. [5+3]

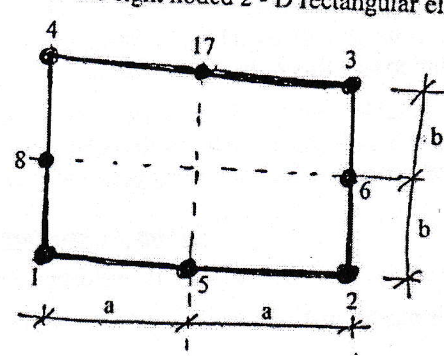
8. Determine the nodal displacements, element stresses and support reactions for the bar as shown in figure below. Take E = 200 GPa. [10]



9. A steel plate of uniform thickness 10 mm is being loaded as shown in the figure below. Considering the plane stress condition for this CST element, determine (a) element stiffness matrix, (b) nodal displacements, and (c) strains and stresses at the centroid of the element. Take E = 210 × 10^3 MPa, and G = 105 × 10^3 MPa. The unit weight of steel is 78.5 KN/m³. [10]



10. Derive the shape functions for the eight noded 2 - D rectangular element given in figure. [8]



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01 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.

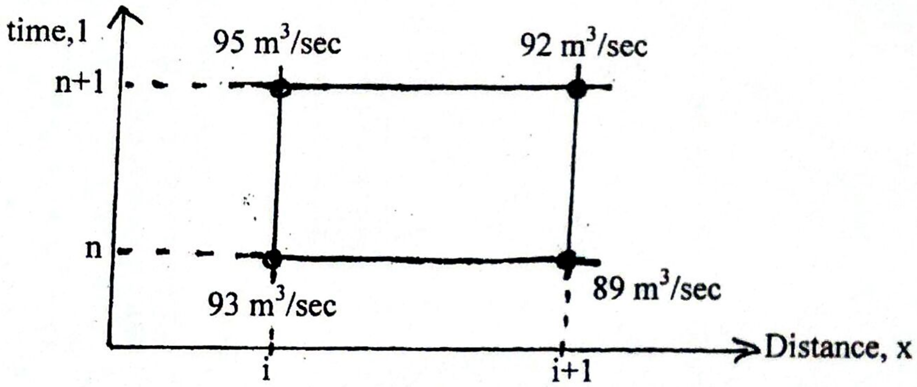
Subject: - Computational Techniques in Civil Engineering *(CE751)*

- ✓ 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.*

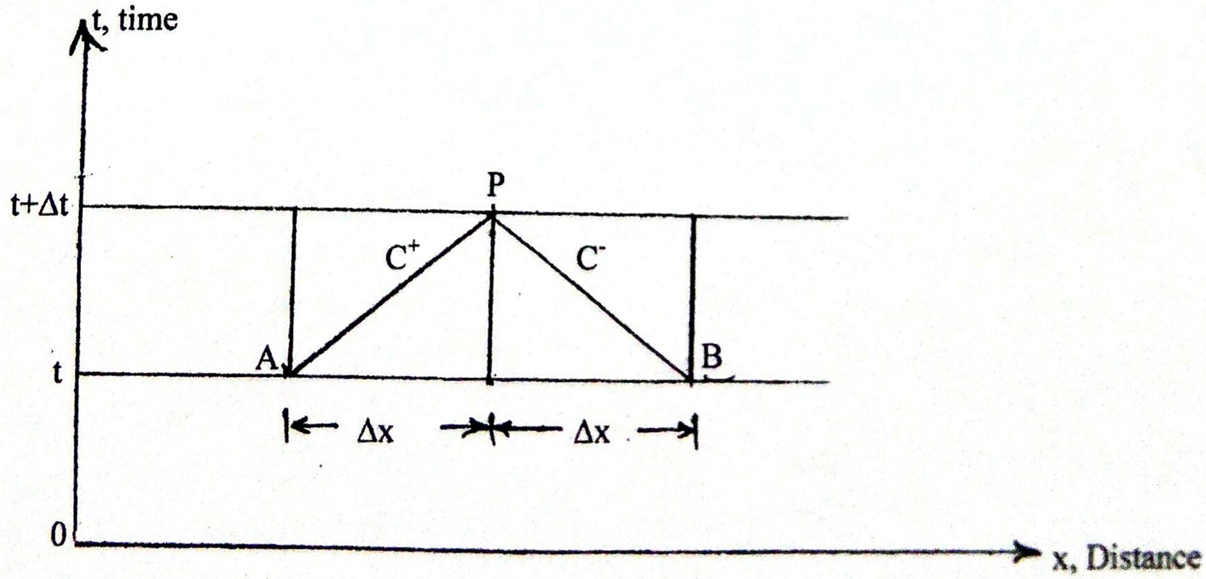
Group A (Water)

1. Derive the finite difference equations for full Saint-Venant equations representing the fluid flow using second order accurate explicit scheme. [6]

2. Describe numerical dispersion, diffusion and stability of Finite Difference Schemes. The value of flow rate Q at four points in the space time grid are shown in the figure below. Determine the value of first-order derivations $\partial Q/\partial t$ and $\partial Q/\partial x$ by using four-point implicit method. Given: $\Delta t = 1$ hour, $\Delta x = 600$ m and $\theta = 0.55$ [4+4]



3. What do you understand by characteristic curve? Explain, A pipe of diameter 35 cm carrying water has the following data at two points A and B: $V_A = 6$ m/sec, $V_B = 6.25$ m/sec, $p_A = 102$ KN/m^2, $p_B = 124$ KN/m^2, $\Delta x = 500$ m, $\Delta t = 0.5$ sec, $f = 0.02$, $a = 1000$ m/sec $\left(\frac{dx}{dt} = \pm a\right)$, elevation difference between A to P = 2.50 m. By the use of finite difference form of characteristics equation, compute the velocity and pressure at point P. [2+6]



4. Develop a steady state 2D model for the simulation of seepage under a dam. Also describe the iterative procedure for computing potential at each grid and seepage rate. [6]

Group B (Structure)

5. Describe the concepts and applications of finite element and finite difference method with their advantages and disadvantages with other methods of numerical computations used in solving civil engineering problems. [3+3+2]

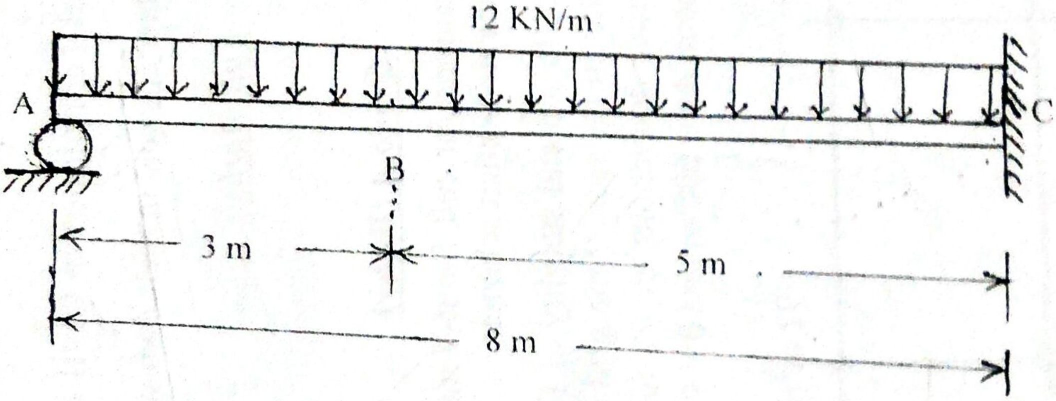
6. Describe briefly about the Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT). Carry out the three iterations of conjugate gradient method for the following system of linear equations: [4+4]

$$\begin{bmatrix} 10 & -6 & 0 \\ -6 & 8 & -2 \\ 0 & -2 & 5 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} = \begin{Bmatrix} 12 \\ 0 \\ 0 \end{Bmatrix}$$

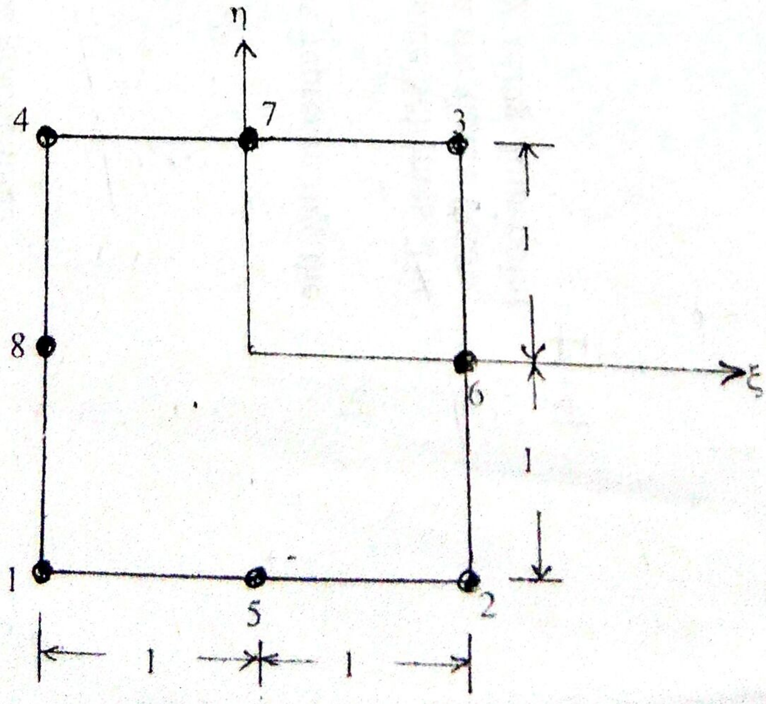
7. a) Describe about the plane stress, plane strain and axisymmetric problems with their examples and constitutive relations to be used for stress analysis problems. [2+2+2]

   b) Differentiate between isotropic and anisotropic material body. Derive the expressions for Lame's constants for linearly elastic isotropic material body. [2+2]

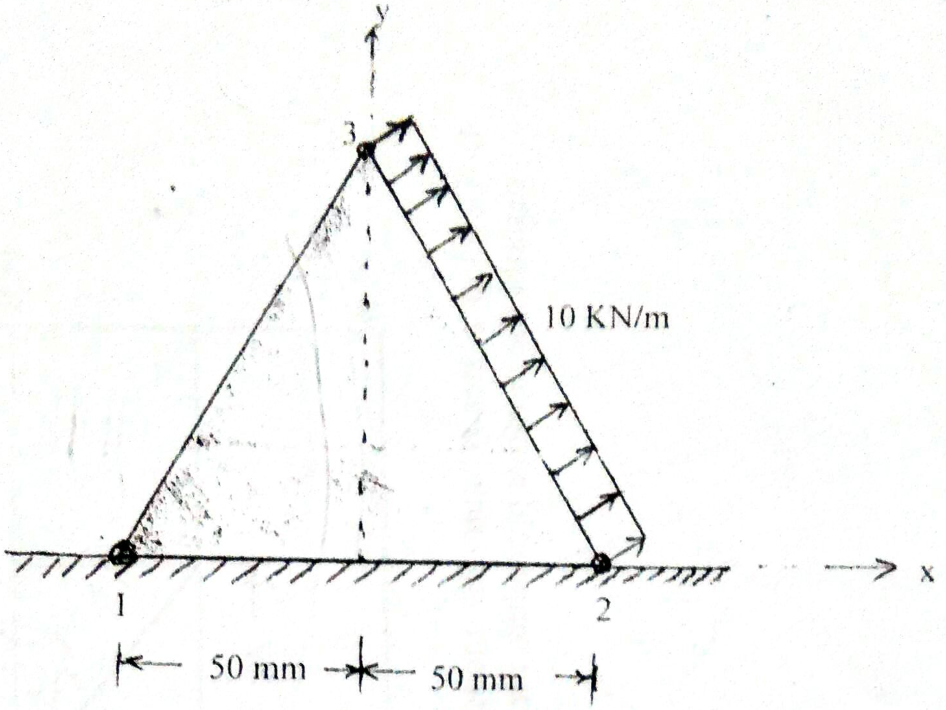
8. A propped cantilever beam is loaded as shown in figure below. Discretize the beam into two elements and fine deflection at point B and rotations at point B and C. Also check the result using single element model. Take EI as constant throughout the beam. [6+4]



9. What is isoprametric formulation? Obtain shape functions N_i for the eigth-noded rectangular element as shown in figure below. [1+5]



10. A steel plate of thickness 10 mm is being loaded as shown in figure below. Considering the plane stress condition, determine the stresses and strains at the centroid of the CST element. Take $E = 210 \times 10^3$ MPa, $V = 0.30$ and unit weight of steel is 78.50 KN/m^3, length of each side = 100 mm. [10]



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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Magh

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

Subject: - Computational Techniques in Civil Engineering *(CE751)*

- ✓ 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.*
- ✓ *Candidate should use separate answer book for each group (Water and Structure)*

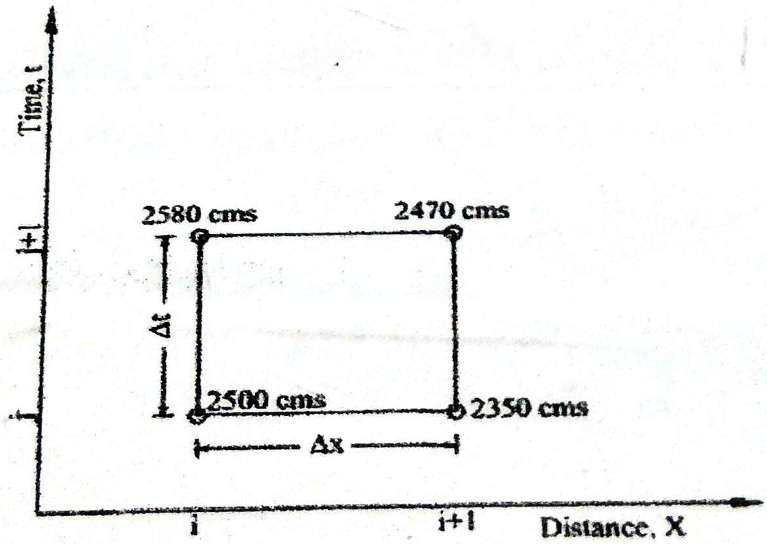
Group A
(Water Part)

1. a) Write down the governing equations used for analyzing the movement of fluid. [2]

   b) What are the kinematic wave approximations of these governing equations? [2]

   c) A channel having a width of 30m carries a discharge of 110 m^3/s through a section. The bed slope and the Manning's "n" value are 3% and 0.035 respectively and the hydraulic radius is equal to flow depth. Recommend the maximum time step required for stable solution of kinematic wave routing in this condition, if the value of Δx is considered as 1400 meters. [5]

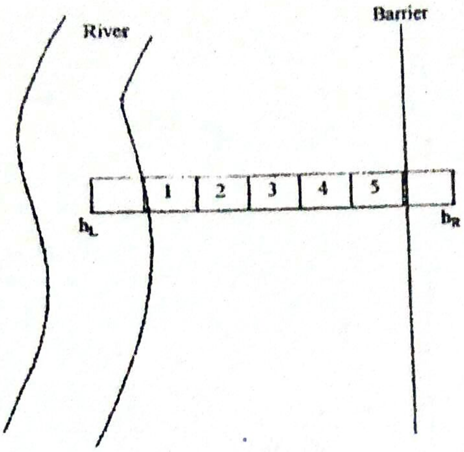
   d) In the space-time grid as shown in figure below Q represents the value of flow rate at the four points. Determine the values of $\delta Q/\delta t$ and $\delta Q/\delta x$ by four point implicit method, considering $\Delta t = 1.5$ h, $\Delta x = 800$m, $\theta = 0.58$. Here θ is weighting factor. [4]



2. a) Define Characteristic Curve and Method of Characteristics (MOC). [2]

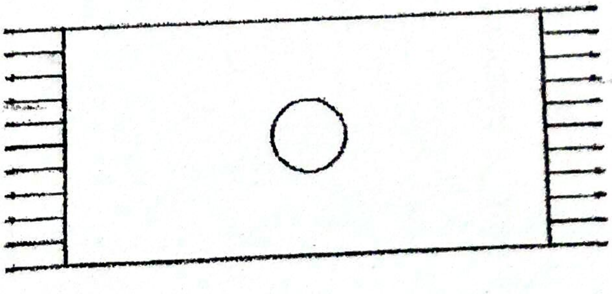
   b) Derive the characteristic equations from the partial differential form of the unsteady pipe flow equations. [6]

3. Compute coefficients of the 1-D implicit finite difference model and display the matrix for the schematic diagram for simulating river stage water table fluctuation which is as shown in figure below Consider the data for the simulation as:
Homogeneous and isotropic aquifer, river stage, $h_L = 196$ m; Aquifer length = 400 m; Δx = 80 m; Δt = 1 day; transmissivity of aquifer = 0.025 m/s; storage coefficient = 0.015; initial value of water table at 5 grids are 190.08, 190.15, 190.21, 190.3, 190.4 m respectively. [7]

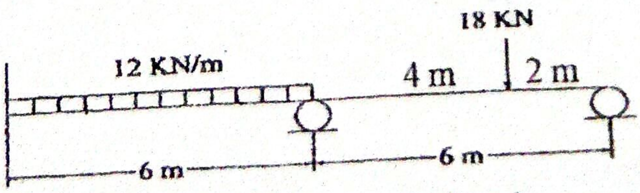


Group B
(Structure Part)

4. a) Briefly discuss the different types of numerical computations in civil engineering. [6]
   b) How do you discretize the element shown in figure below and why? [3]



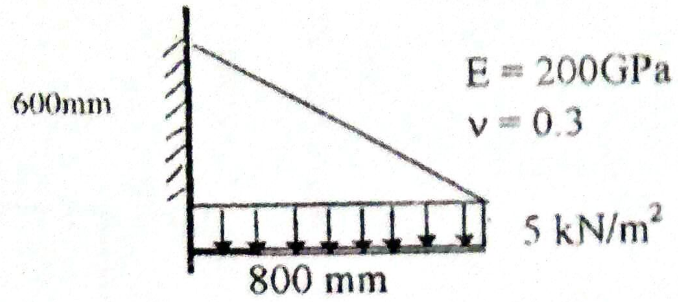
5. a) What do you mean by Banded Matrix and how do you optimize the memory? [5]
   b) Explain the different solution techniques of linear equations. [6]
6. Derive strain-stress relation for two dimensional isotropic materials. Explain the terms plain stress and plain strain problems with examples. [4+4]
7. Determine the deflections at the middle of both the spans of the beam as shown in figure below. Determine the support reactions and draw "BM diagram" also. [12]



E = 200 GPa ; I = 5×10^6 mm^4

8. Derive shape functions of a three nodded iso-parameter triangullar element. A steel plate of thickness 10 mm is being loaded in the structural system as shown in figure below. Calculate stresses at centroid of the element using constant strain triangle. [2+10]

Take $E = 200\times10^3$ MPa, $\nu = 0.3$ and unit weight of steel is 78.5 KN/m^3



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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Bhadra

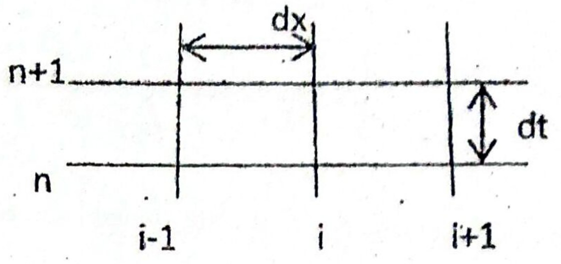
Exam.		Regular	
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Computational Techniques in Civil Engineering *(CE751)*

- ✓ 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__.*
- ✓ ***Candidate should use separate answer book for each group (Water and Structure).***
- ✓ *Assume suitable data if necessary.*

Group A
(Water)

1. Explain the concept of finite difference method. What do you mean explicit and implicit scheme in finite difference method? For the grids given below discretize using explicit and implicit scheme using forward, backward and central difference approach for space and time derivatives. [2+2+2]



2. A river which is generalized as trapezoidal channel is 300m wide with side slope 5:1, has bed slope 1% and Manning's n 0.04. Initially discharge through the river is 100 m^3/s. Due to a flood the discharge observed at the upstream section of the river is $300m^3/s$, compute discharge at 2650m downstream from upstream section. Take $\Delta x = 2650m$ and $\Delta t = 1$ hr. Use linear kinematic wave solution. [6]

3. The following is the characteristic form of equation for one dimensional unsteady pipe flow:

$$\frac{dV}{dt} \pm \frac{1}{\rho c}\frac{dP}{dt} + g\text{Sin}\theta + \frac{fV|V|}{2D} = 0$$ where V = Average velocity over a section, ρ = density of fluid, P = pressure at a point, c = celerity of wave, g = acceleration due to gravity, Sinθ = slope of pipe, f = friction factor, D = diameter of pipe. Develop finite difference equations for above equations using the concept of method of characteristics (MOC). Also, explain the criteria for the stability of the MOC solution. [6+2]

4. The figure shows a 2 dimensional grid with the values of potential function (ϕ) for simulating seepage. Calculate vertical and horizontal seepage into and out of grid A i.e. Q_A, Q_B, Q_C and Q_D. Transmissivity in x-direction and y-direction are 2200 m^2/day and 2400 m^2/day respectively, for all grids; $\Delta X = 80m$ and $\Delta Y = 90m$. [8]

0	0	0	0
2.3	2.2	2.1	2.08
2.27	2.23	2.06 Grid A	2.01
2.22	2.12	2.03	2
0	0	0	0

Group B

(Structure)

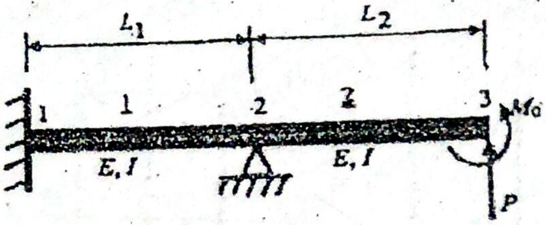
5. Describe briefly the different solution techniques used for numerical computations of civil engineering problems. Also mention their merits and demerits. [8]

6. What do you mean by Banded Matrix and how do you optimize the memory? Write the algorithm for Conjugate Gradient Method. [4+4]

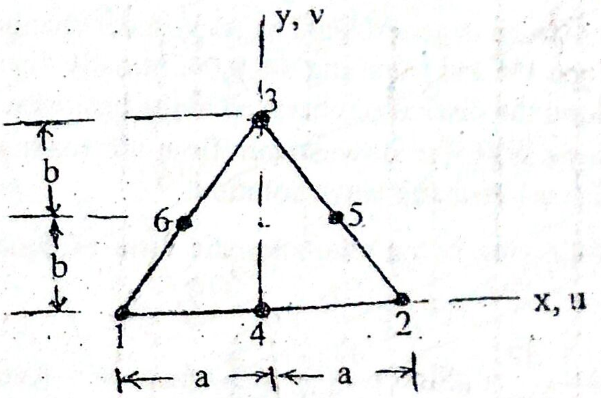
7. a) Differentiate the plain stress and plain strain problem with suitable example. [4]

   b) Derive the equilibrium equations for solid element and also define the axisymmetric problems. [6]

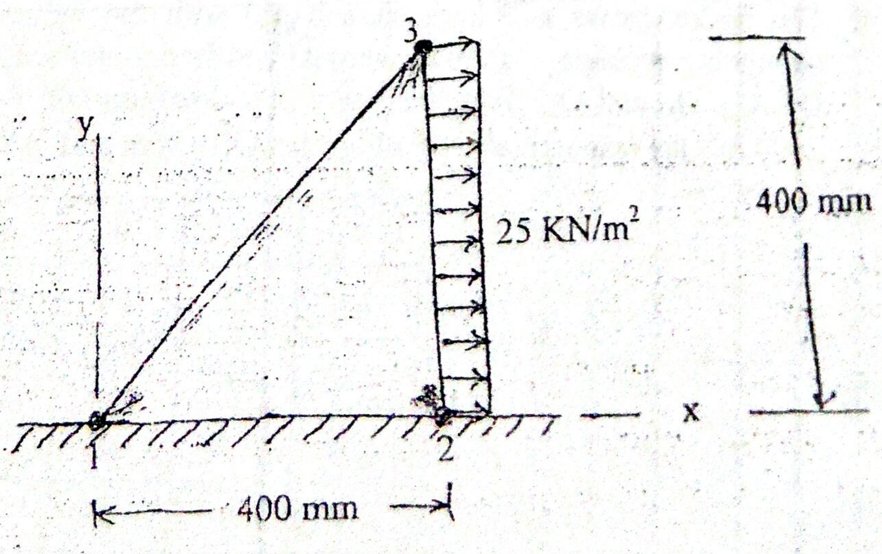
8. Determine the nodal displacements and reaction forces of the beam loaded as shown in figure below. Give that, L1 = L2 = 3 m, P = 15 KN, MO = 40 KN-m, E1 = E2 = 2×10^5 MPa, $I_1 = I_2 = 5\times10^6$ mm^4. [10]



9. Derive the shape functions Ni for the six-noded triangular 2D element shown in the figure below. [6]



10. A steel plate of thickness 8 mm is being loaded as shown in the figure below. Considering the plane stress condition, determine the nodal displacements and stresses of the CST element. Take E = 210 × 10^3 MPa, G = 105 × 10^3 MPa, and unit weight of the steel is 78.5 KN/m^3. [10]



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01 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: - Computational Techniques in Civil Engineering *(CE751)*

- ✓ 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__.*
- ✓ ***Candidate should use separate answer book for each group (Water and Structure).***
- ✓ *Assume suitable data if necessary.*

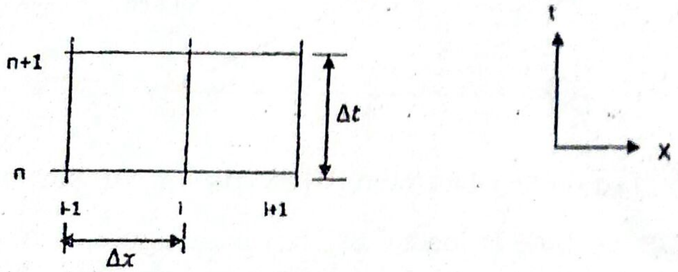
Group A
(Water)

1. a) With appropriate expressions and graphs, explain first and second order accurate schemes of finite differences of partial differential equations. [4]

   b) Using any explicit finite difference scheme for full Saint Venant equations, compute discharge and flow depth at grid (i, n+1) for the following data: [6]
   Rectangular channel, width = 10m, Bed slope = 0.0002, Manning's n = 0.04, No lateral flow, $\Delta x = 1\text{km}$ and $\Delta t = 5\text{min}$

   Discharge: $Q_{i-1}^{n} = 40\text{m}^3/\text{s}$ and $Q_i^n = 38\text{m}^3/\text{s}$, $Q_{i+1}^{n} = 37.5\ \text{m}^3/\text{s}$

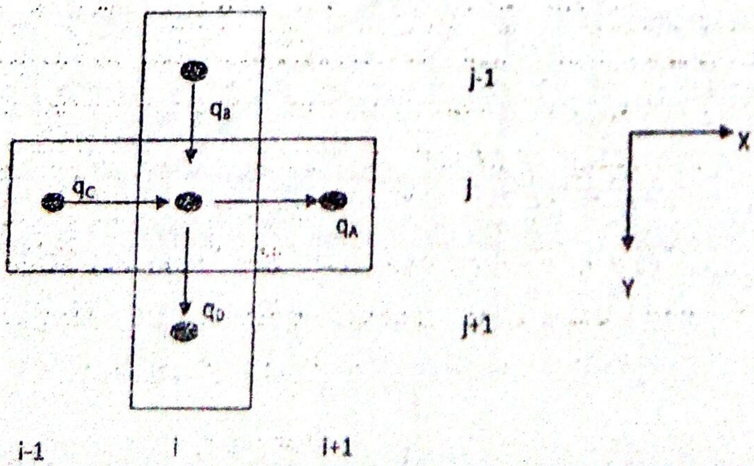
   Flow depth $y_{i-1}^{n} = 1.9\text{m}$, $y_i^n = 1.85\text{m}$, $y_{i+1}^{n} = 2.0\text{m}$



2. The figure below shows a central grid surrounded by four grids for simulating two dimensional groundwater flow under steady state condition. Values of potential function (ϕ) are given below:

   $\phi_{i-1,j} = 12$, $\phi_{i+1,j} = 14$, $\phi_{i,j} = 13$, $\phi_{i,j-1} = 13.5$, $\phi_{i,j+1} = 11$

   Transmissivity in X-direction = $0.013\text{m}^2/\text{S}$ for all grids, Transmissivity in Y-direction = $0.015\text{m}^2/\text{S}$ for all grids. Taking $\Delta X = 20\text{m}$ and $\Delta Y = 25\text{m}$, compute Darcy fluxs q_A, q_B, q_C and q_D from the finite difference equation in terms of ϕ. [6]



3. Develop a finite difference solution of the characteristics form of unsteady flow equations to obtain solution in terms of velocity and pressure. [6]

4. Develop tridiagonal coefficient matrix to evaluate river stage-water table interactions for an aquifer along a river. [6]

Group B
(Structure)

5. Describe the different solution techniques in civil Engineering and list their suitability. [4+4]

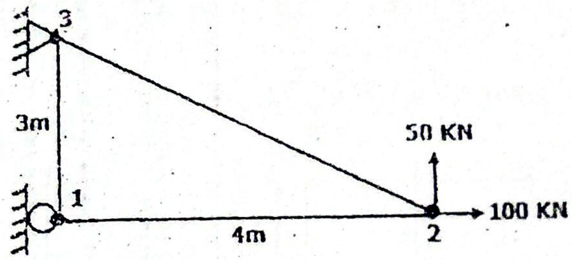
6. Write down the algorithm for conjugate gradient method. Consider the system

$$\begin{bmatrix} 2 & -1 & 0 \\ 1 & 6 & -2 \\ 4 & -3 & 8 \end{bmatrix}\begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} = \begin{Bmatrix} 2 \\ -4 \\ 5 \end{Bmatrix}$$

Solve the above system by using Gauss-Seidel iteration starting with $x^{(0)} = (0,0,0)^T$. [4+4]

7. Define plane stress and plane strain problems. Derive the differential equation of equilibrium for three dimensional problems. [3+7]

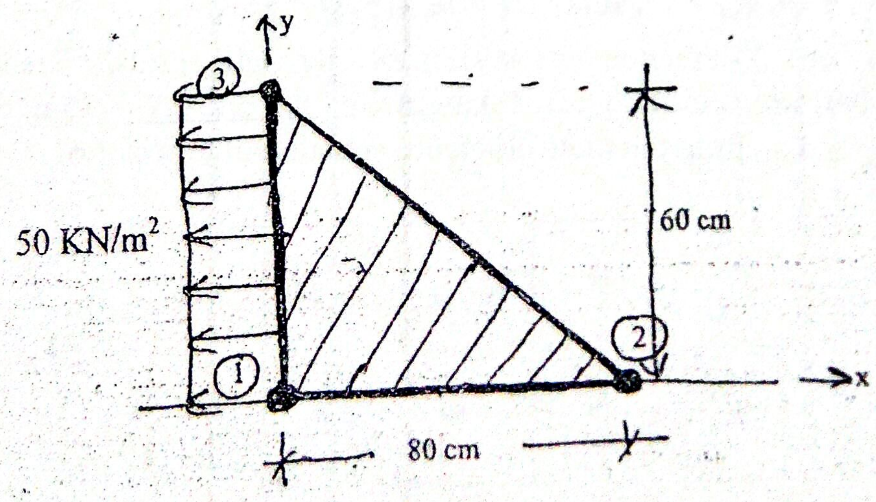
8. Determine the nodal displacements, reaction forces, and member forces of the given truss structure, loaded as shown in figure. Given that for each member, sectional area, A = 2×10^{-3} m^2 and modulus of elasticity, E = 2×10^5 MPa. [10]



9. Derive the relation of strain-Displacement [B] matrix for constant strain triangle. [6]

10. A steel plate of 10mm thick is loaded as shown in figure below. For the plane stress problem, obtain the nodal deformations and the stresses in the CST element.

Take E = 2×10^5 MPa,
G = 105×10^3 MPa and
unit weight of steel is 78.5 KN/m^3. [10]



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01 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2072 Ashwin

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

Subject: - Computational Techniques in Civil Engineering *(CE751)*

- ✓ 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**.*
- ✓ *Candidates should use separate answer book for each group.*
- ✓ *Assume suitable data if necessary.*

Group A

(Water Part)

1. a) Derive the expression for second order accurate explicit finite equation for dynamic wave model. [6]

   b) A channel with a width of 40 m, bed slope 2% and Mannings n=0.03 carries a discharge of 100 m^3/s through a section. If Δx is taken as 1500 meters, recommened the maximum time step for stable solution of kinematic wave routing in this condition. Assume hydraulic radius equal to flow depth. [6]

2. a) Write an algorithm for simulation of water hammer process using method of characteristics. [4]

   b) If the MOC is applied for $t_1 = 1$ sec and $t_2 = 2$ sec, time levels for a pipe with diameter 30 cm carrying water. If $Q_A = 0.7\ m^3/s$, $Q_B = 0.76\ m^3/s$ and $Q_C = 0.74\ m^3/s$, $H_A = 20$ m, $H_B = 20.6$ m and $H_C = 20.4$ m are the values at grid points. Find the values of Q and H at $t_1 = 1$ sec that will be required for finding Q and H at P when characteristics do not lie on diagonal. Here, $\Delta x = 1000$ m, $\Delta t = 1$ sec, $f = 0.02$ and $c = 800$ m/s [4]

3. Derive expression for finite difference scheme for 2D groundwater simulation in steady state for homogeneous and isotropic aquifer. Describe about the boundary conditions and flow coefficients. [8]

Group B

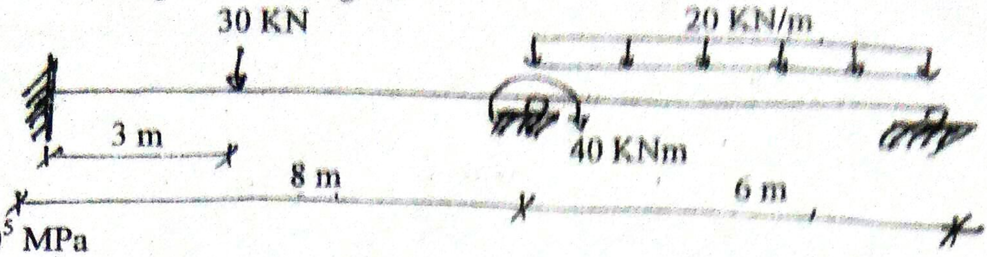
(Structure Part)

4. Describe briefly the various solution techniques used for solving civil engineering problems. Also give their advantages and disadvantages. [8]

5. Explain different solution techniques of linear equations. Write the algorithm for conjugate gradient method. [5+3]

6. Explain the terms axi-symmetric problem with examples. Derive strain-displacement and constitutive relationships that exist in plane stress problem for isotropic material. [4+6]

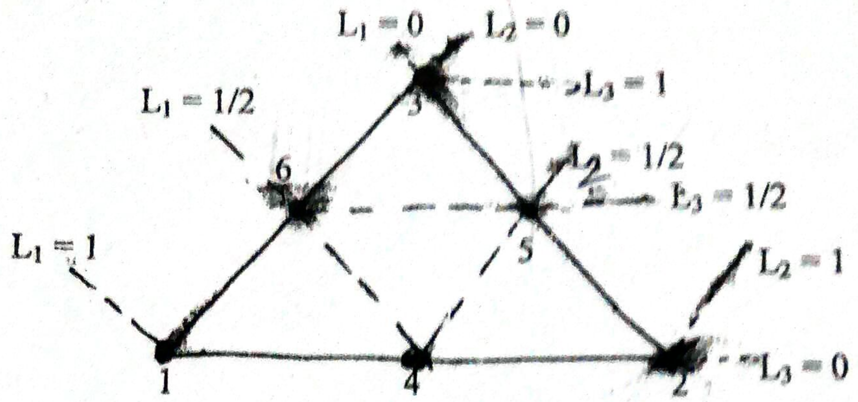
7. a) Determine the support reactions and deflections at mid-span for the given structure. Also draw bending moment diagram. [10]



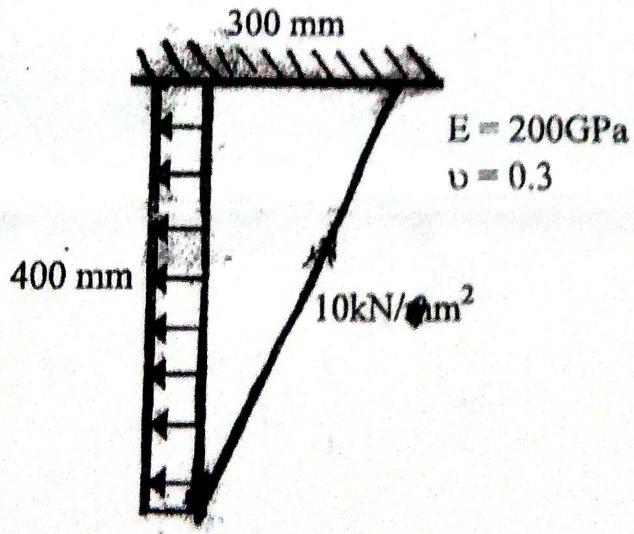
$E = 20\times10^5$ MPa

$I = 5\times10^6$ mm^4

b) Derive shape function for the element as shown in figure below. [6]



8. A steel plate of thickness 10 mm is being loaded in the structural system as shown in figure below. Calculate stresses at the centroid of the plate. [10]



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01 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2072 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: - Computational Techniques in Civil Engineering *(CE751)*

- ✓ 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**.*
- ✓ *Candidates should use separate answer book for each group.*
- ✓ *Assume suitable data if necessary.*

Group A
(Water Part)

1. (a) Using definition sketch, discretize the following form of the Saint Venant equations using implicit four point method. [6]

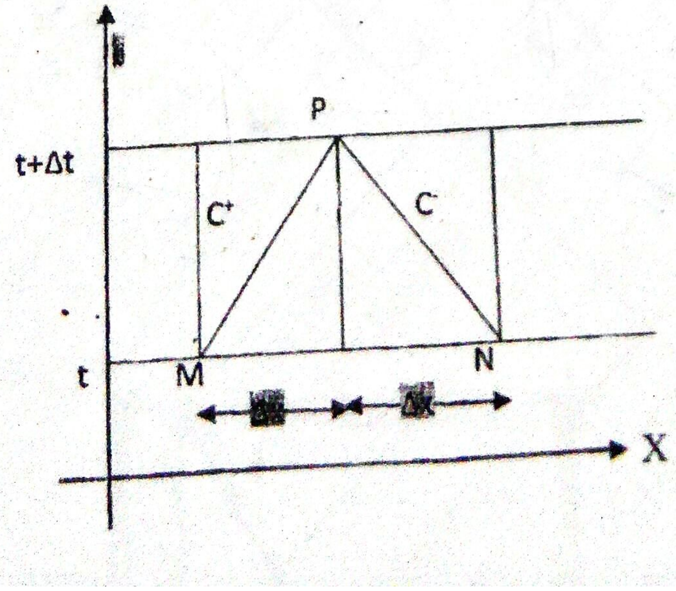
$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = 0$ (Continuity)

$\frac{\partial Q}{\partial t} + \frac{\partial (Q^2/A)}{\partial x} + gA\frac{\partial y}{\partial x} - gA(S_0 - S_f) = 0$ (Momentum)

Where Q = discharge at x, A= Cross-sectional area at x, y = flow depth, g = acceleration due to gravity, S_f = energy slope, S_0 = bed slope.

b) Water flows through a rectangular channel 25m wide, having bed slope 0.015 and Manning's n 0.035. The following flow rates are given: Q_i^{n+1}=30 m³/s, Q_i^n=22 m³/s and Q_{i+1}^n=20 m³/s, where i = index for space and n = index for time. Taking Δx = 1500m and Δt = 10 min, determine Q_{i+1}^{n+1} using first order accurate linear kinematic wave model. Assume lateral flow to be zero and wetted perimeter is equal to width of the channel. [6]

2. Following are the data given at two points M and N along a pipe of diameter 15cm carrying water. The discharges are 0.25m³/s and 0.28m³/s respectively at M and N, the heads are 18.5m and 18m at M and N respectively. Compute the discharge and head at point P using finite difference form of characteristics equations if Δx=100m, Δt=10 sec, f=0.02, c=1200m/s elevation difference for 100m distance =1.5m. [8]



3. The figure below shows the 2 dimensional grid for simulating seepage under a dam. The values of potential function (ϕ) are shown in the grid. Compute vertical and horizontal seepage to grid A. Take Transmissivity in X-direction = 2900m²/day for all grids, Transmissivity in Y-direction = 2400m²/day for all grids, ΔX = 100m and ΔY =75m. [8]

0	0	0	0
0	2	2	0
0	2.1	2.1	0
0	2.12	2.09 Grid A	0
0	2.12	2.12	0
0	0	0	0

Group B
(Structure Part)

1. Explain importance of numerical computations of civil engineering problems. How Finite Element Method works in a structural analysis. [4+4]

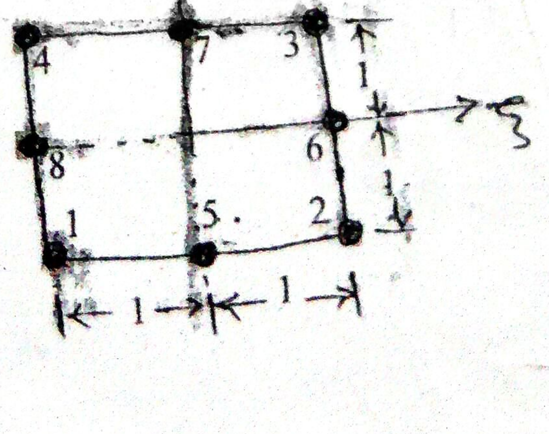
2. a) Explain the concept of Bonded Matrices. Also explain data storage and memory optimization techniques using bonded matrix. [3]

   b) Solve the following set of linear equations using Gauss siedel interation or conjugate gradient method. [5]

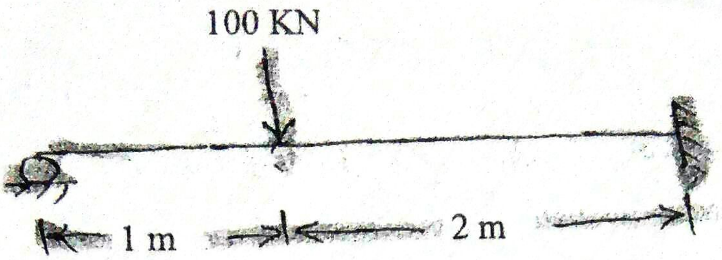
$$6x+3.8y+9z=12$$
$$1.2x+2y-3.8z=16$$
$$-4x+5y+6z=-15$$

3. Explain constitutive relations for a two dimensional problems of isotropic materials. Explain plain stress, plain strain and axi-symmetric problems with examples. [4+6]

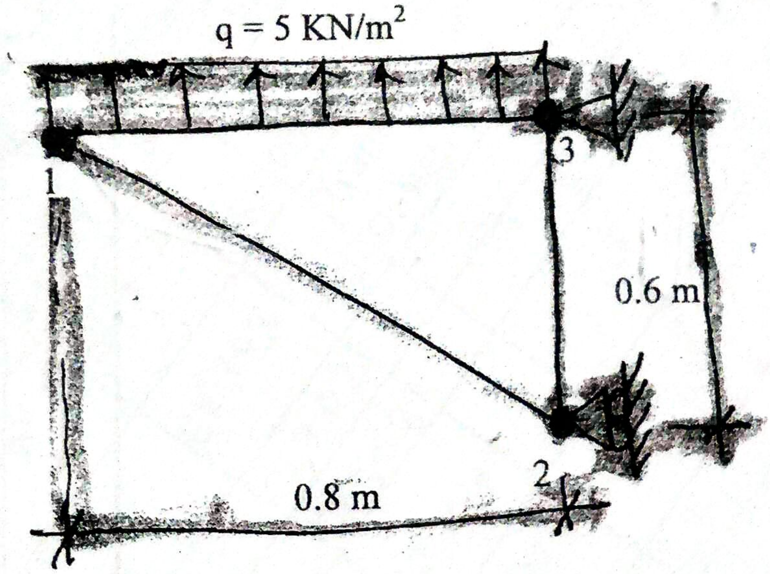
4. a) Derive shape functions for the element as shown in figure below. [6]



b) For the beam shown in figure below, Calculate displacement and slope 1 m from the simply supported end. Neglect the self wt. of the beam. [8]



5. What is isoparametric element? Using plane stress condition, calculate displacements and stresses of the CST element as shown in figure below. Given E = 200 GPa, t = 10 mm, γ = 78.5 KN/m^3, ν = 0.3, q = 5 KN/m^2. [2+10]



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01 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2072 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: - Computational Techniques in Civil Engineering *(CE751)*

- ✓ 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**.*
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Group A
(Water Part)

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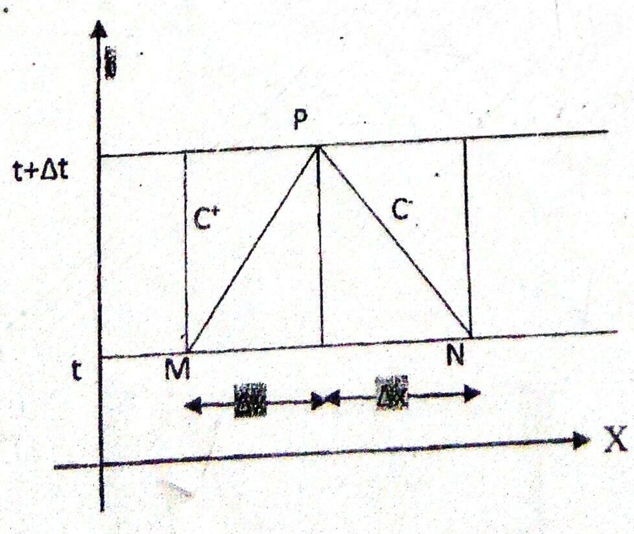
Where Q = discharge at x, A= Cross-sectional area at x, y = flow depth, g = acceleration due to gravity, S_f = energy slope, S_0 = bed slope.

b) Water flows through a rectangular channel 25m wide, having bed slope 0.015 and Manning's n 0.035. The following flow rates are given: Q_i^{n+1}=30 m³/s, Q_i^n=22 m³/s and Q_{i+1}^n=20 m³/s, where i = index for space and n = index for time. Taking Δx = 1500m and Δt = 10 min, determine Q_{i+1}^{n+1} using first order accurate linear kinematic wave model. Assume lateral flow to be zero and wetted perimeter is equal to width of the channel. [6]

2. Following are the data given at two points M and N along a pipe of diameter 15cm carrying water. The discharges are 0.25m³/s and 0.28m³/s respectively at M and N, the heads are 18.5m and 18m at M and N respectively. Compute the discharge and head at point P using finite difference form of characteristics equations if Δx=100m, Δt=10 sec, f=0.02, c=1200m/s elevation difference for 100m distance =1.5m. [8]



3. The figure below shows the 2 dimensional grid for simulating seepage under a dam. The values of potential function (ϕ) are shown in the grid. Compute vertical and horizontal seepage to grid A. Take Transmissivity in X-direction = 2900m^2/day for all grids, Transmissivity in Y-direction = 2400m^2/day for all grids, ΔX = 100m and ΔY =75m. [8]

0	0	0	0
0	2	2	0
0	2.1	2.1	0
0	2.12	2.09 Grid A	0
0	2.12	2.12	0
0	0	0	0

Group B
(Structure Part)

1. Explain importance of numerical computations of civil engineering problems. How Finite Element Method works in a structural analysis. [4+4]

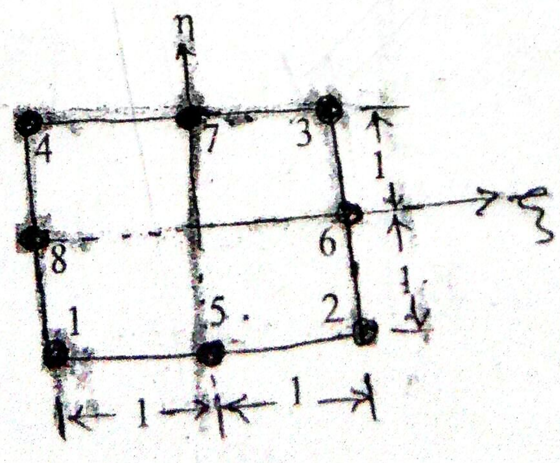
2. a) Explain the concept of Bonded Matrices. Also explain data storage and memory optimization techniques using bonded matrix. [3]

   b) Solve the following set of linear equations using Gauss siedel interation or conjugate gradient method. [5]

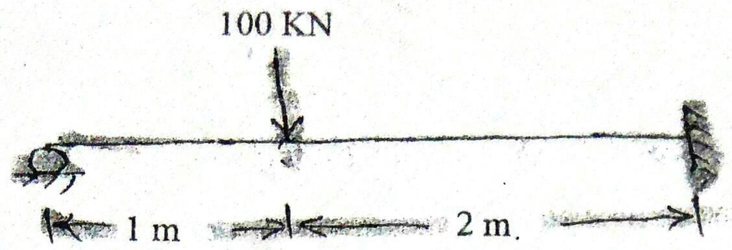
$$6x + 3.8y + 9z = 12$$
$$1.2x + 2y - 3.8z = 16$$
$$-4x + 5y + 6z = -15$$

3. Explain constitutive relations for a two dimensional problems of isotropic materials. Explain plain stress, plain strain and axi-symmetric problems with examples. [4+6]

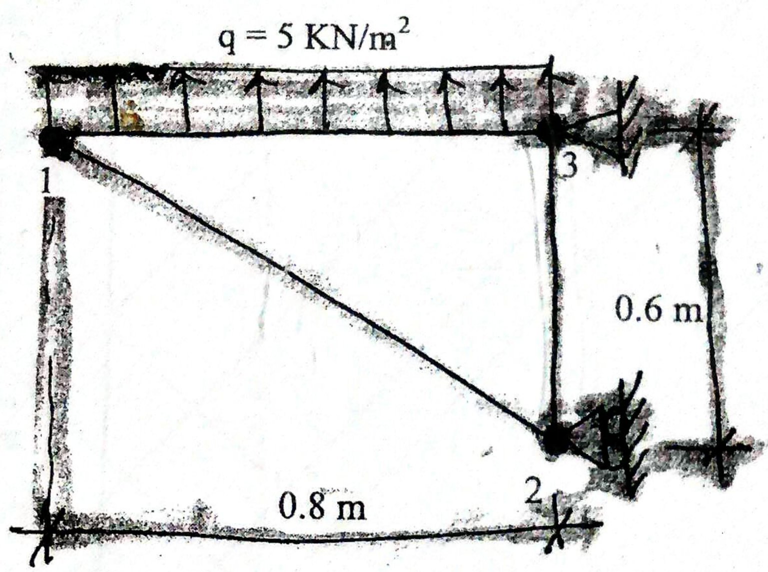
4. a) Derive shape functions for the element as shown in figure below. [6]



b) For the beam shown in figure below, Calculate displacement and slope 1 m from the simply supported end. Neglect the self wt. of the beam. [8]



5. What is isoparametric element? Using plane stress condition, calculate displacements and stresses of the CST element as shown in figure below. Given E = 200 GPa, t = 10 mm, $\gamma = 78.5$ KN/m^3, $\nu = 0.3$, q = 5 KN/m^2 [2+10]



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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Bhadra

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

Subject: - Computational Techniques in Civil Engineering *(CE751)*

- ✓ 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**.*
- ✓ ***Candidate should use separate answer book for each group (Water and Structure).***
- ✓ *Assume suitable data if necessary.*

Group A
(Water)

1. a) Derive the first order accurate implicit Finite Difference equation for kinematic wave model in the non-linear form. [6]

   b) Using the Finite Difference equation developed in question (a), compute the discharge at 1 km d/s of location X at time 14:00 hrs, for the following data: [6]

   Rectangular channel, width = 20 m, Bed slope = 0.001, Manning's n = 0.03
   Discharge at location X at time 14:00 hrs = 14 m^3/s
   Discharge at location X at time 13:45 hrs = 12 m^3/s
   Discharge at 1 km d/s of location X at time 13:45 hrs = 11 m^3/s
   No lateral flow, wetted perimeter approximately equal to width of channel.

2. Define characteristic curve and method of characteristics (MOC). Develop the characteristic equations from the partial differential form of the unsteady pipe flow equations. [2+6]

3. Explain the continuity equation used in groundwater flow analysis. Write down the algorithm for simulation of seepage under a dam. [3+5]

Group B
(Structure)

1. List the computational techniques used in Civil Engineering. Why FEM is predominating others? Explain briefly the steps involved in FEM. [2+2+4]

2. a) Write the algorithm for conjugate gradient method. [3]

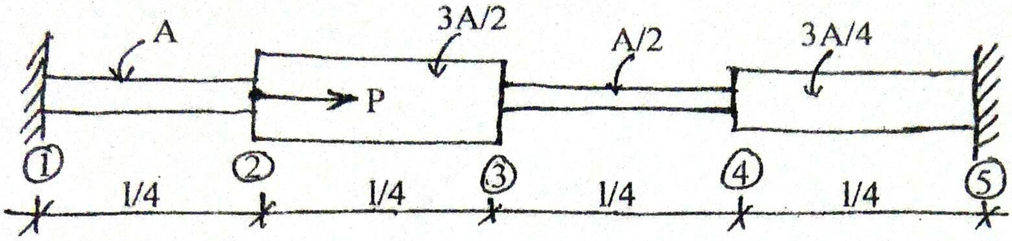
   b) Solve the given system of equations using conjugate gradient method. [5]

$$\begin{bmatrix} 3 & 0 & 2 \\ 0 & 1 & 1 \\ 2 & 1 & 3 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} = \begin{Bmatrix} 1 \\ 0 \\ -1 \end{Bmatrix}$$

3. a) Derive the constitutive relation ($\{\sigma\} = [D]\{E\}$) for an elastic isotropic material. [6]

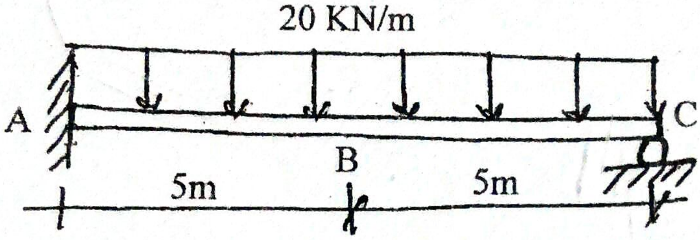
   b) What are the conditions at which axisymmetric stress exists? Write the stress-strain relations for axisymmetric condition. [4]

4. a) For the given stepped bar obtain nodal displacements at nodes 2, 3 and 4. Also obtain forces developed at the supports. [8]

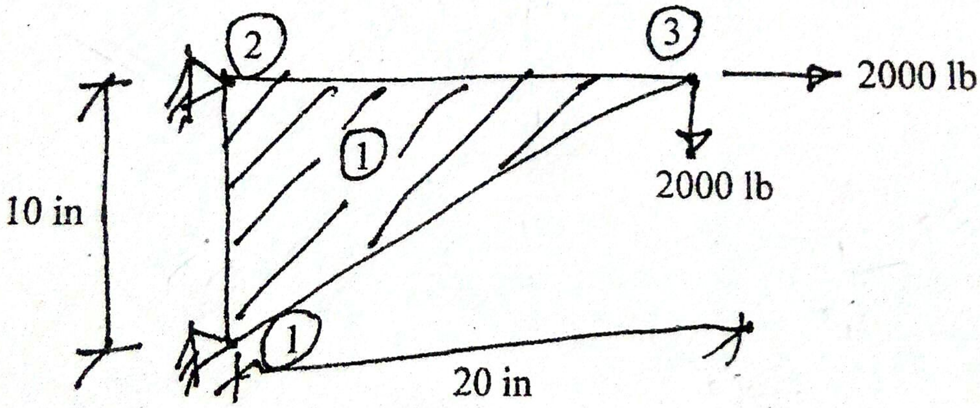


Take E = constant and cross-sectional areas as indicated in the figure.

b) For the given beam find deflection at point B and rotations at points B and C. Take EI as constant throughout the beam. Discretise the beam into two elements. [10]



c) A thin plate is subjected to the loads as shown in figure below. The plate thickness is 0.3 in and the other dimensions are shown in figure. Given that the Poisson's ratio = 0.3 and the modulus of elasticity E = 30×10^6 psi. Determine nodal load displacements and the elemental stresses. [8]



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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Bhadra

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

Subject: - Computational Techniques in Civil Engineering ***(CE751)***

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Group A

1. With the help of mechanics, explain various numerical methods for solving civil engineering problems. Given their advantages and disadvantages. [8]

2. a) Derive the expression for Lame constants. [5]

   b) Define plane stress and plane strain problems with necessary conditions and suitable examples. [5]

3. a) Derive the shape function for the element as shown in the Fig. 1. [8]

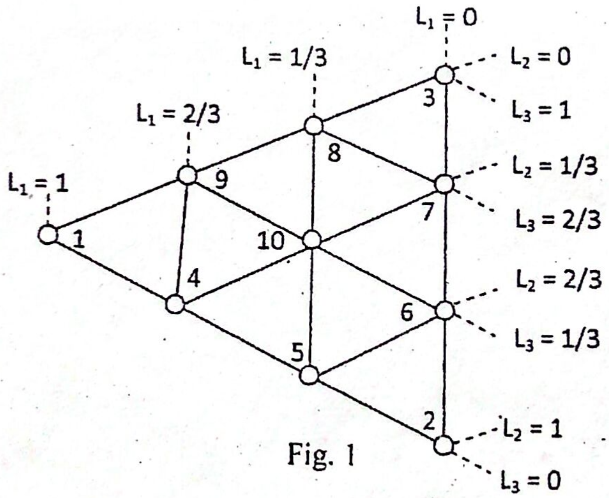

Fig. 1

   b) Considering plane stress condition, find out the nodal displacements and stresses of the CST element as shown in Fig. 2. $E = 30 \times 10^6$ psi, $t = 0.3$ in, $\gamma = 460$ lb/in^3, $\upsilon = 0.3$, $T_3 = 360$ psi with usual notations. [12]

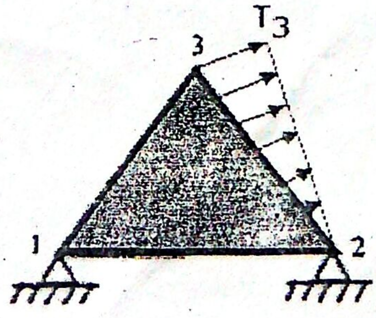

Fig. 2

Group B

4. a) Why conjugate gradient method is used in computation over Gaussian methods? [4]

   b) Solve the following equation by using conjugate gradient method (max. 5 iterations) [8]

$$\begin{bmatrix} 3 & 0 & 1 \\ 0 & -1 & 3 \\ 1 & 3 & 0 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} = \begin{Bmatrix} 1 \\ -12 \\ 2 \end{Bmatrix}$$

5. a) Write down the complete governing equations describing the movement of fluid. [2]

   b) Derive the kinematic wave approximation for the movement of fluid. [4]

   c) Derive a second order accurate finite difference scheme of linear kinematic wave equation which computes discharge for unknown time and location. [8]

6. Prepare an algorithm to compute discharge and head based on the following form of finite difference equations for unsteady pipe flow problem using rectangular grid. [8]

   $H_{Pi} = H_{i-1} - B(Q_{Pi} - Q_{i-1}) - RQ_{i-1}|Q_{i-1}|$

   $H_{Pi} = H_{i+1} + B(Q_{Pi} - Q_{i+1}) + RQ_{i+1}|Q_{i+1}|$

   Where H = head, Q = discharge, H_{pi} and Q_{pi} = head and discharge at point of intersection of two characteristics, B and R = coefficients.

7. Explain the 1D implicit model to evaluate the river stage water table interaction. [8]

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 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: - Computational Techniques in Civil Engineering *(CE751)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt __All__ questions.*
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- ✓ ***Candidates use separate answer book for each group.***

Group A

1. Explain foundation of finite element method. Why this method is less appropriate for large deformation problem? How do you choose numerical method for different problems? Illustrate with examples. [8]

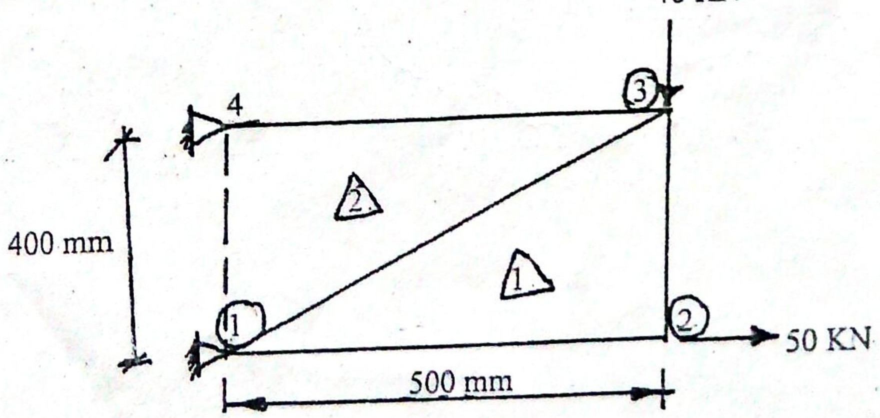
2. Write an algorithm and a program (C or Fortran or Matlab) for fast Fourier transform. With a suitable example explain what parameters can be identified with the help of time domain and frequency domain. [12]

3. (a) Derive equilibrium equations for 3D state of stress in a solid. [5]

   (b) What do you understand by axisymmetric problem? Write the constitutive relations and strain displacement relation for axisymmetric condition. [5]

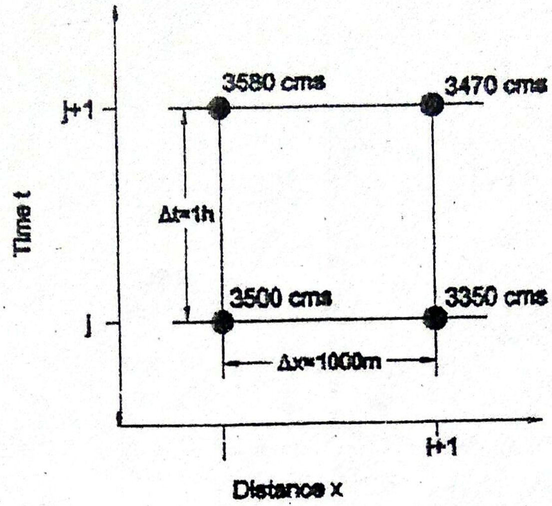
4. (a) Formulate stiffness matrix for a bar element. Rotate the same bar element and formulate stiffness matrix for 2D truss element. [10]

   (b) Determine the stiffness matrices for the element as shown in Fig. 1. A=300 mm^2 and E=2.1X10^5 MPa. [10]



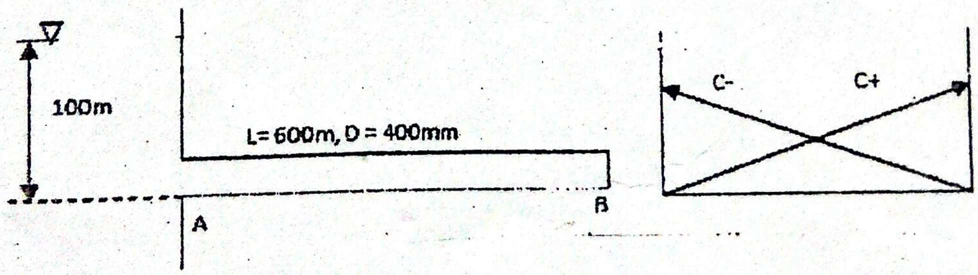
Group B

1. a) The value of flow rate Q at four points in the space-time grid are shown in figure below. Δt=1 h, Δx=1000m and θ=0.55, calculate the values of $\partial Q/\partial t$ and $\partial Q/\partial x$ by four point implicit method. θ = weighting factor. [6]



b) A flood of 150m^3/s peak discharges passed a gaging station at 12:00 noon on a river. There is a community adjacent to the river 7.2 km downstream. What will be the value of peak discharge at that community at 12:00 noon of the velocity of flow is 1.2m/s^2 and peak discharge at that community at 9:00 A.M is 100m^3/s. Assume width of river as inside and use first order accurate numerical scheme of kinematic wave equation, Take Δx= 7.2 km and Δt = 1 hrs. [6]

2. A pipe conveys water from a reservoir as shown in the figure. Take f = 0.02, C = 1200m/s. The hydraulic grad line (HGL) at the reservoir is given as H_{PA} = 100+3sin (πt). The discharge at the downstream end is zero at all times. By using only one reach, compute discharge from A and elevation of hydraulic grad line at B at 3Sec using discretized equation of the method of characteristics in the form of HGL and discharge. [8]



3. Finite difference equation for simulating river stage-water table interactions considering one dimensional flow. [8]

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