TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2079 Jestha

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

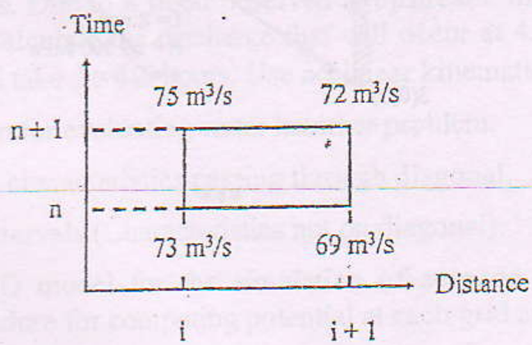
Subject: - Computational Techniques in Civil Engineering (*CE 751*)

- ✓ 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.*
- ✓ *Assume suitable data if necessary.*

Group A (Water Part)

1. Using appropriate equation and graphs, describe first-order and second-order schemes for the finite differences of partial differential equations. [4]

2. Describe numerical dispersion, diffusion, and stability of finite differences Schemes. The value of flow rate Q at four points in the space-time grid is shown in the below. Determine the value of first-order derivations $\partial Q/\partial t$ and $\partial Q/\partial x$ by using the four -point implicit method. Given: $\Delta t = 1$ hour, $\Delta x = 500$ m and θ m= 0.55. [4+4]



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

4. If the MOC is applied for $t_1 = 1$ s and $t_2 = 2$ s, time levels for a pipe with diameter 25 cm carrying water. If $Q_A = 0.6$ m³/s, $Q_B = 0.65$ m³/s, $Q_C = 0.64$ m³/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 $t_1 = 1$ s that will be required for finding Q and H at P when characteristics do not lie on diagonal. Here, $\Delta x = 1000$ m, $\Delta t = 1$ s, $f = 0.02$ and $c = 850$ m/s. [4]

5. Develop a tridiagonal coefficient matrix to assess river stage and water table interactions for a groundwater aquifer along a river. [6]

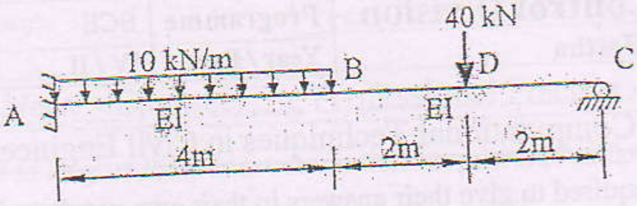
Group B (Structure Part)

6. List the different technique of solving civil engineering problem. Explain how finite element method and finite difference method works to solve the problem. [2+6]

7. Explain the solution methods of solving system of linear equations with examples. [8]

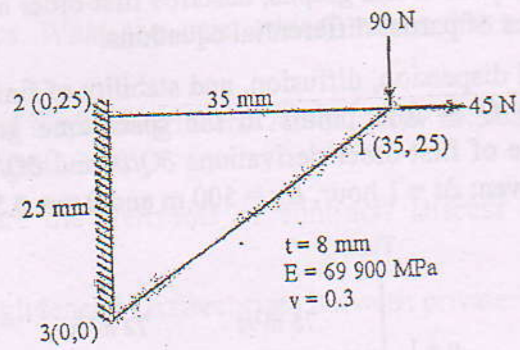
8. Describe plane stress and plain strain problems with examples. [4+4]

9. For the given beam determine deflection at point B and stresses at the same point. [8]



10. Define iso-parametric, super parametric and sub parametric elements. Derive the expression for hermite shape function used for the interpolation in beam elements. [3+7]

11. A plate of thickness 8 mm is being loaded as shown in the figure. Determine the deflection at the point of load application. Also calculate the stresses at the centroid of the plate. Take E = 69900 MPa and v = 0.3. [1



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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2079 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.**
- *Assume suitable data if necessary.*

Group A (Water Part)

1. a) Derive the space-time discretization of second order accurate no-linear kinematic wave model. Write the principle of finite difference method. [5+1]

   b) A river which can be generalized as a trapezoidal channel is 350 m wide with side slope 6:1 has a bed slope 1.5% and Manning's = 0.0359. The initial discharge through the river is 420 cumecs. Due to a flood observed at upstream, the value of discharge rises to 580 cumecs. Calculate the discharge that will occur at 4.65 km downstream. Take $\Delta x = 4650$ m and take Δt=1.5 hours. Use no-linear kinematic wave solution. [6]

2. Derive a numerical solution for evaluating water hammer problem. [4+4]

   a) Using rectangular grid, characteristics passing through diagonal.

   b) Using specified time intervals (Characteristics not on diagonal).

3. 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. [8]

Group B (Structure Part)

4. a) Explain different methods of numerical computations in solving equations. [4]

   b) Explain different types of elements to model structural solids. [4]

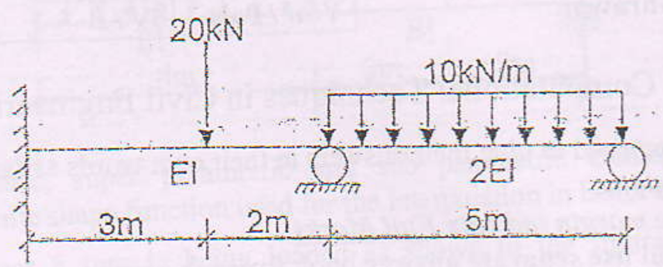
5. a) What do you mean by sparse matrix, banded matrix and memory optimization? [3]

   b) Explain conjugate gradient method and its algorithm for solving system of linear equations. [5]

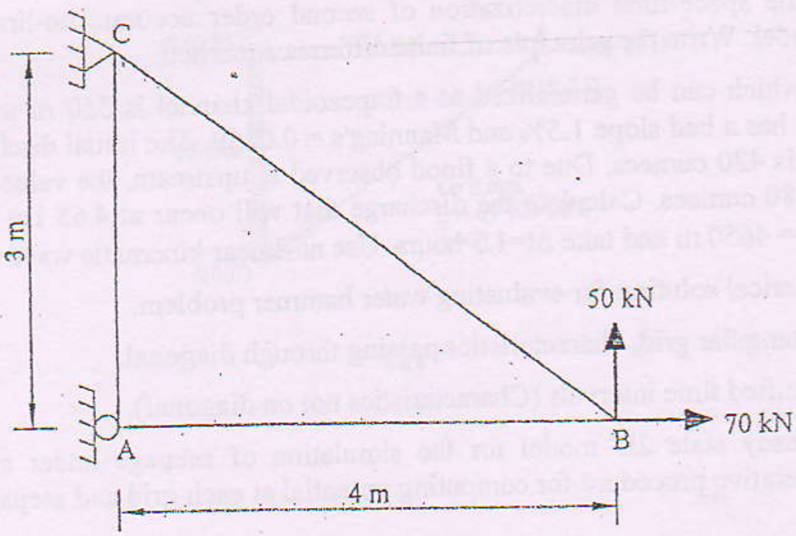
6. Explain plane strain and axisymmetric problems with examples. Derive constitutive law for a plane stress problem. [5+5]

7. Derive shape functions for a quadrilateral element. [6]

8. Determine the deflection and slope under the point load of the given beam using FEM. Also draw BMD. Take E = 210 GPa and $I - 6\times10^6$ mm^4



9. A plate of thickness 20 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 $= 2.1 \times 10^5$ N/mm^2, $\nu = 0.3$. Ignore weight of the plate.



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

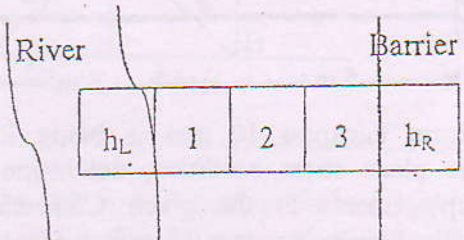
2. Following are data pertaining to a rectangular channel:

   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]

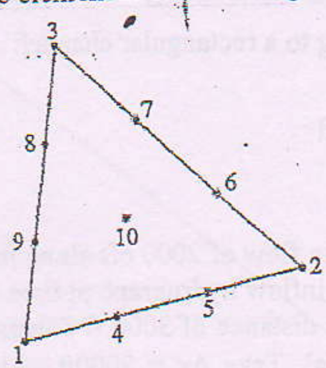
   b) Solve the given system of equations using conjugate gradient method. [5]

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

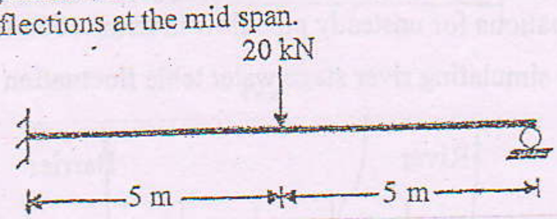
3. a) Derive constitutive relations for 3D-state of a solid. [5]

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

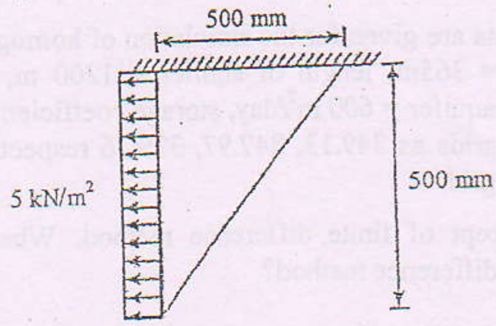
4. Derive the shape function for the element as shown in figure below. [6]



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

2078 Kartik

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.*
- ✓ *Assume suitable data if necessary.*

Group A (Water Part)

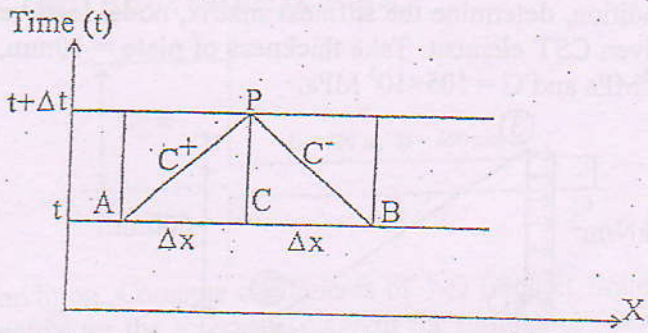
1. Write down the governing equations used for analyzing the movement of fluid. What are the Kinematic wave approximation of these governing equations? Also define courant number. [2+2+1]

2. Using any explicit finite differences scheme for full saint venant equations, compute discharge and flow depth at grid (i, n+1) for the following data:

   Rectangular channel width = 50m, Bèd slope = 0.0002. Manning's n= 0.035; No lateral inflow, Δx = 1.0km and Δt = 10min Discharge: $Q^n_{i-1} = 38m^3/sec$, $Q^n_i = 36m^3/sec$, $Q^n_{i+1} = 35m^3/sec$. Flow depth: y^n_{i-1}=1.87m, y^n_i=1.82m, y^n_{i+1} = 1.97m. [6]

3. a) Define characteristics curve and method of characteristics (MOC). Develop the characteristic equations from the partial differential form of the unsteady pipeflow. [1+1+3]

   b) Following data are given at two points A and B along a pipe of diameter 30cm carrying as shown in figure below. Q_A =0.4m³/sec, Q_B=0.45m³/sec, H_A=26.5m, H_B=27.5m, Δx=500m, Δt=0.4sec, f= 0.02, a(or c) = 1200m/sec, elevation difference between A and P = 1 m. Using the finite difference form of characteristics equations, compute discharge and head at point P. [6]



4. The final values of hydraulic head at four grid point are: $h_{i+1}^{\ j}$ = 50m, $h_i^{\ j-1}$ = 10m, $h_i^{\ j+1}$ = 95m and $h_{i-1}^{\ j}$ = 75m. The hydraulic conductivities are: $k_{xx} = 0.95\times10^{-5}$m/s and $k_{yy}=0.99\times10^{-5}$m/s. Assuming steady flow with no withdrawal, determine the hydraulic head at h_i^j and discharges in it from other four grids. Take Δx = 100m and Δy = 80m. [5+1]

Group B (Structure Part)

a) Give a brief history about evolution of computational techniques in civil engineering problem. [2]

b) Write in brief: [3×2]

(i) Boundary element method
(ii) Discrete element method
(iii)Smoothed Particle Hydrodynamics

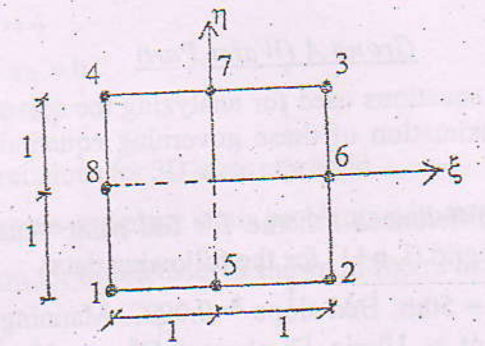
2. What are the direct methods and iterative methods of solving linear equations? Solve the following set of linear equations by Gauss Siedal method starting with initial guess of [1, 2, 3]. [2+6]

$12x + 3y - 5z = 1$
$x + 5y + 3z = 28$
$3x + 7y + 13z = 76$

3. a) Derive constitutive relation for a two dimensional problem of isotropic material. [6]

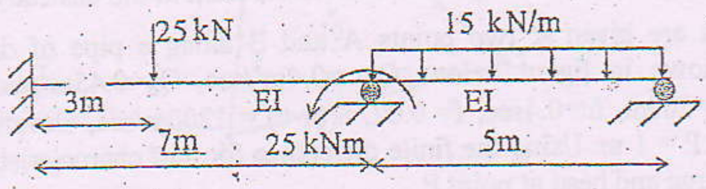
   b) Differentiate between plain stress problem and plain strain problem with suitable examples and necessary figures. [4]

4. Derive the shape functions for the given eight-noded rectangular element. [6]

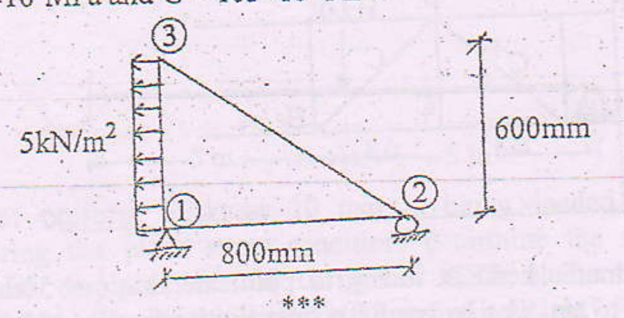


5. Determine support reactions and deflections at mid span for the given structure. [10]

$E = 2\times10^5$MPa
$I = 5 \times 10^6 mm^4$



6. Using plane stress condition, determine the stiffness matrix, nodel load vector and nodal displacement of the given CST element. Take thickness of plate = 10mm, unit weight = 78.5 kN/m^3, E = 2×10^5MPa and G = 105×10^3 MPa. [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.*
- ✓ *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.*

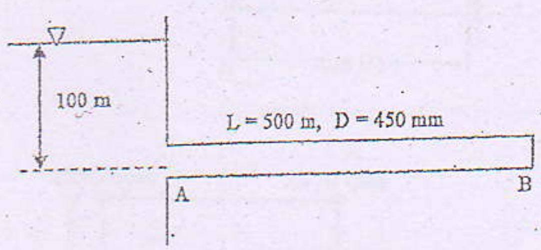
Group A (Water Part)

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

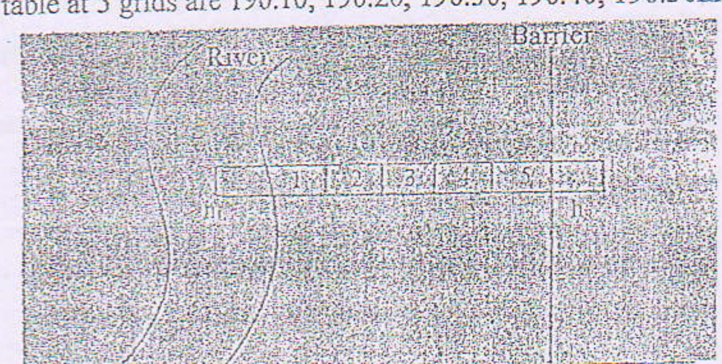
2. For a 30 m wide and 0.015 bed slope rectangular channel following flow rates are given: $Q_i^{\,n} = 20\ m^3/s$, $Q_i^{\,n+1} = 28\ m^3/s$ and $Q_{i+1}^{\,n} = 18\ m^3/s$. Taking Manning's n = 0.025, $\Delta x = 1200$ m and $\Delta t = 10$ min, determine $Q_{i+1}^{\,n+1}$ using finite difference scheme 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 = 195m, aquifer length = 500 m, Δx = 100m and Δt = 1 day, transmissivity of acquifer = 0.024 m/s, storage coefficient = 0.015, 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]

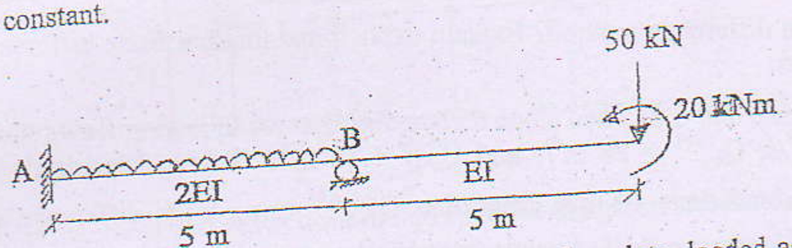
   b) Write down the algorithm for solving the set of linear equations by conjugate gradient method and its limitations. [3+2]

3. a) Derive the expression for Lame's constant. [5]

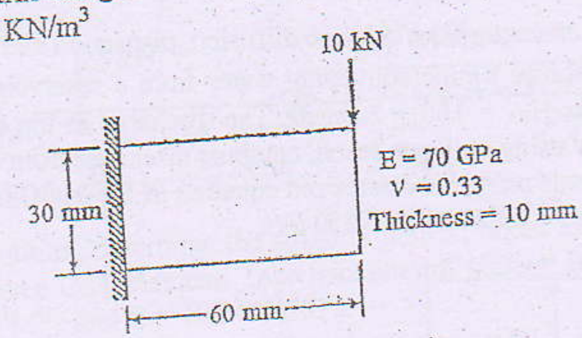
   b) Explain about axisymmetric problems with examples. Write down the constitutive relations and strain displacement relation for axisymmetric problems. [5]

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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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.

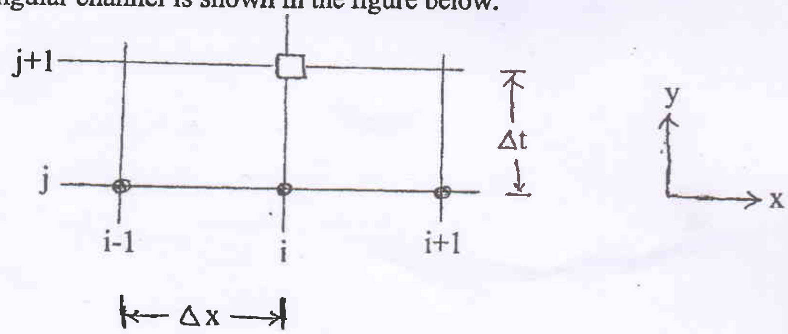
Subject: - Computational Techniques in Civil Engineering *(CE751)*

- ✓ 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]

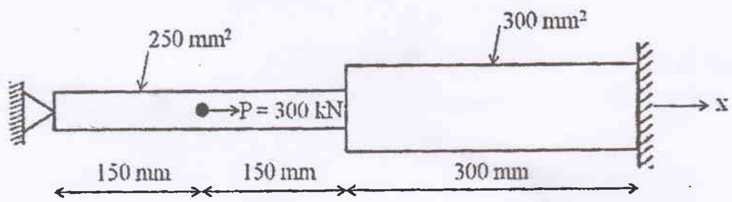
6. Explain different solution techniques of linear equations. For the given linear system

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

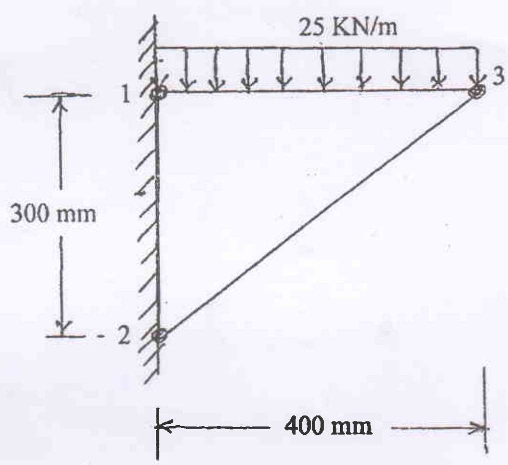
Using the starting vector $x^{(0)} = (4, 4, 0)^T$, carry out two iterations of conjugate gradient method and show the result. [3+5]

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

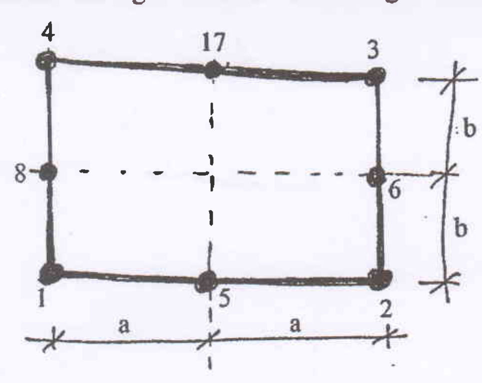
8. Determine the nodal displacements, element stresses and support reactions for the bar as shown in figure below. Take E = 200 GPa. [10]



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 $E = 210 \times 10^3$ MPa, and $G = 105 \times 10^3$ MPa. The unit weight of steel is 78.5 KN/m^3. [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.

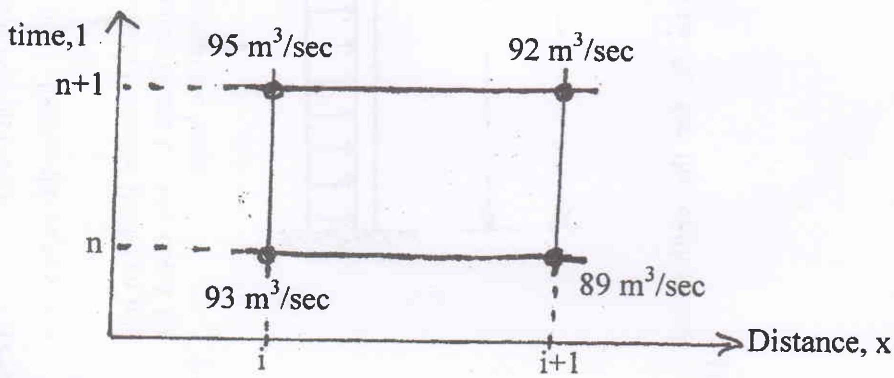
Subject: - Computational Techniques in Civil Engineering *(CE751)*

✓ 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.*

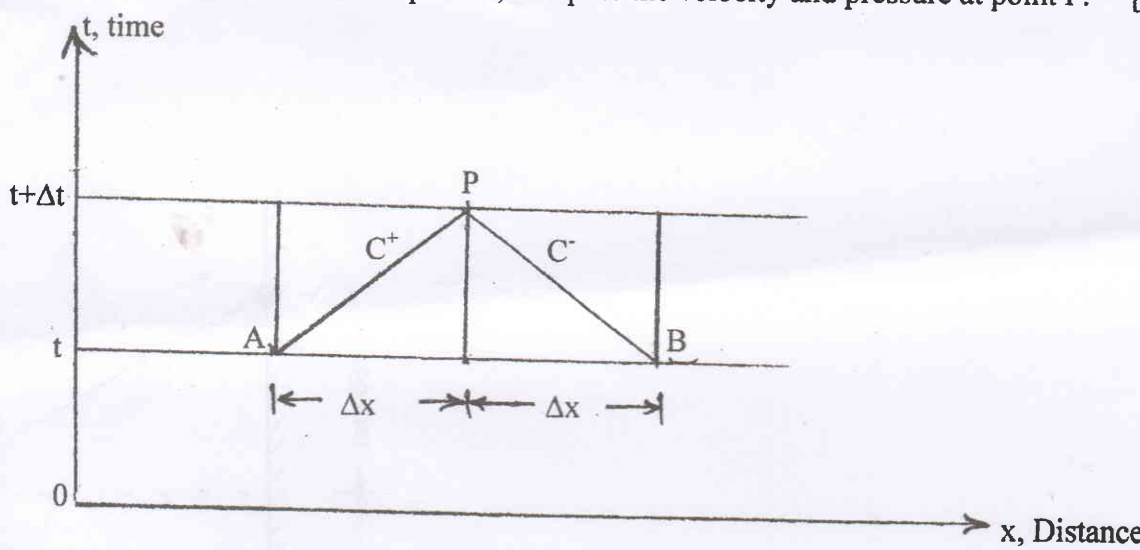
Group A (Water)

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]

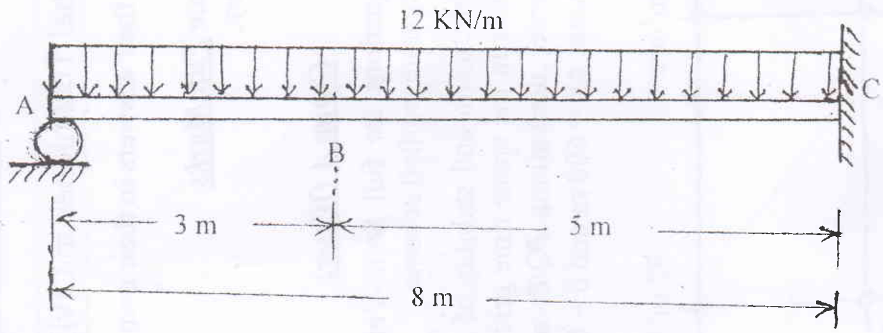
6. Describe briefly about the Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT). Carry out the three iterations of conjugate gradient method for the following system of linear equations: [4+4]

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

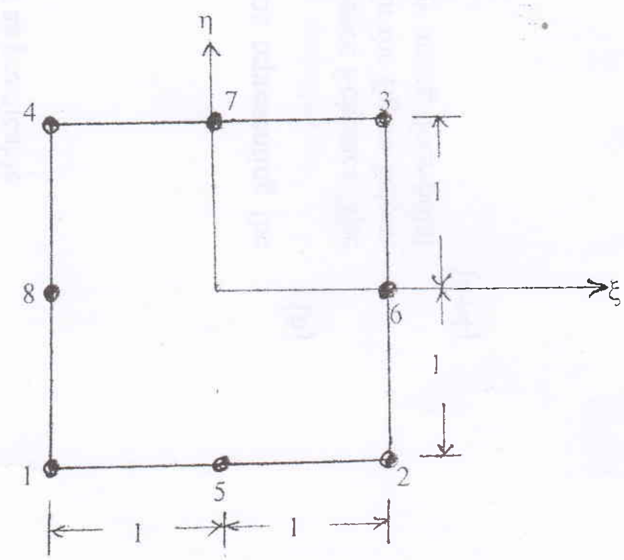
7. a) Describe about the plane stress, plane strain and axisymmetric problems with their examples and constitutive relations to be used for stress analysis problems. [2+2+2]

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

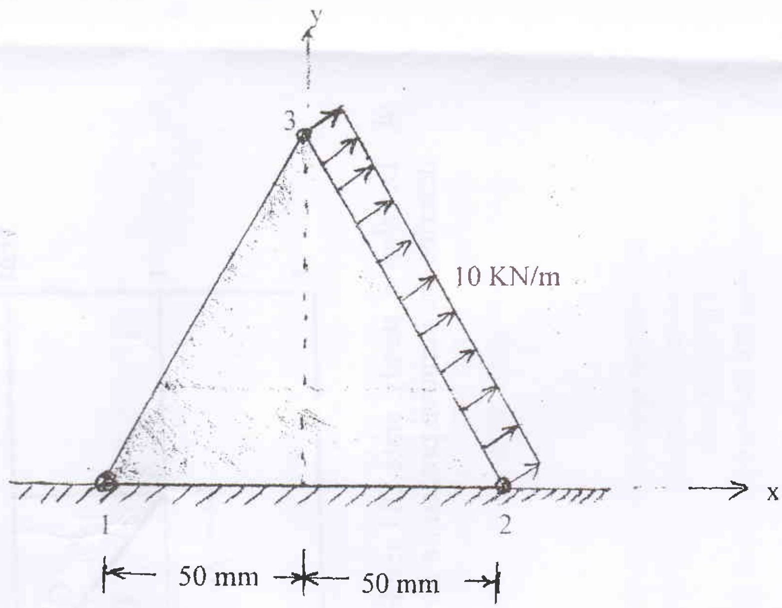
8. A propped cantilever beam is loaded as shown in figure below. Discretize the beam into two elements and fine deflection at point B and rotations at point B and C. Also check the result using single element model. Take EI as constant throughout the beam. [6+4]



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 = 210×10^{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

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

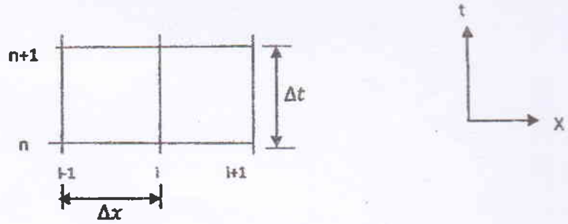
(Water)

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, $\Delta x = 1km$ and $\Delta t = 5min$

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

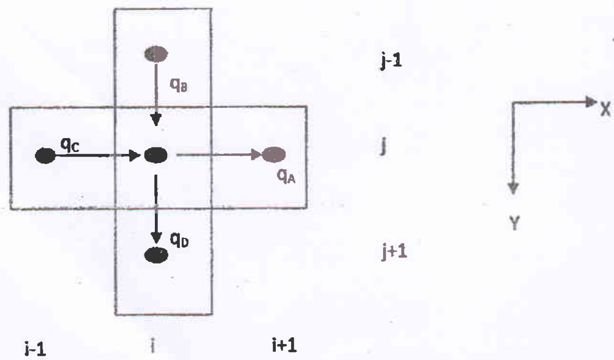
   Flow depth $y_{i-1}^{n} = 1.9m$, $y_{i}^{n} = 1.85m$, $y_{i+1}^{n} = 2.0m$



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 = $0.013m^2/S$ for all grids, Transmissivity in Y-direction = $0.015m^2/S$ for all grids. Taking $\Delta X = 20m$ and $\Delta Y = 25m$, 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]

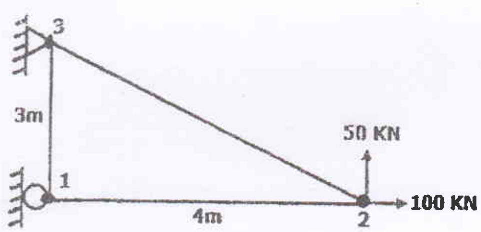
6. Write down the algorithm for conjugate gradient method. Consider the system

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

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]

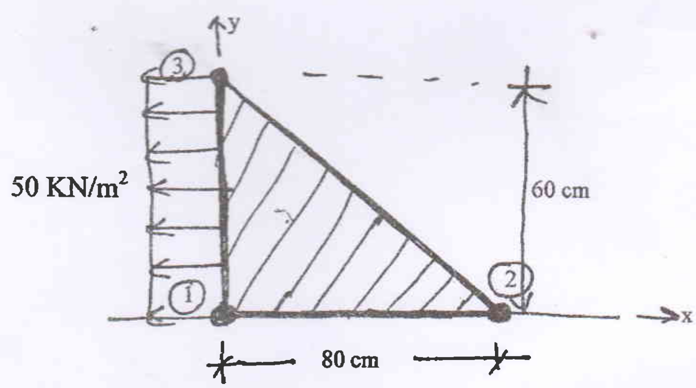
8. Determine the nodal displacements, reaction forces, and member forces of the given truss structure, loaded as shown in figure. Given that for each member, sectional area, A = 2×10^{-3} m^2 and modulus of elasticity, E = 2×10^5 MPa. [10]



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]

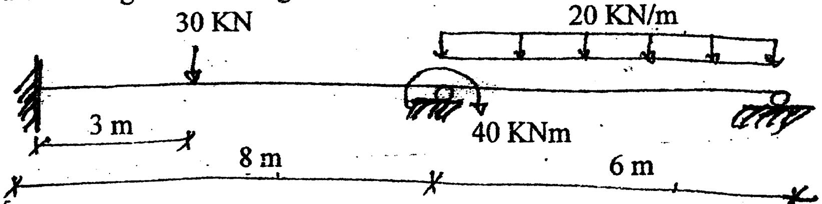
Group B
(Structure Part)

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]

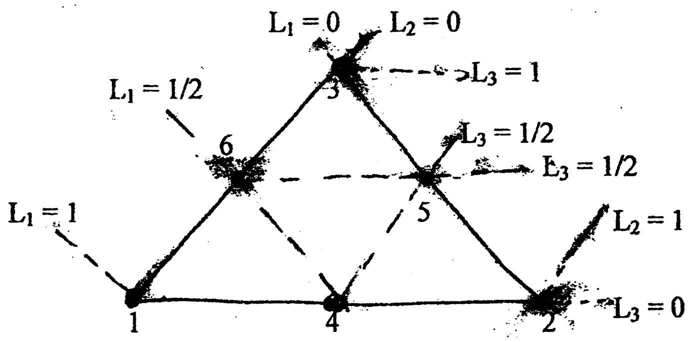
6. Explain the terms axi-symmetric problem with examples. Derive strain-displacement and constitutive relationships that exist in plane stress problem for isotropic material. [4+6]

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

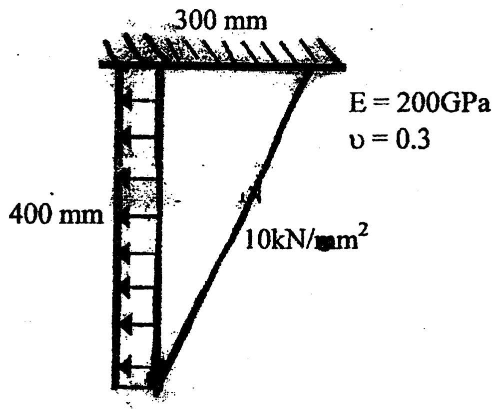


$E = 20\times10^5$ MPa
$I = 5\times10^6$ mm^4

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
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]

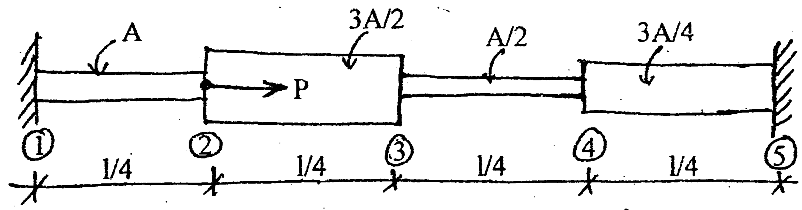
   b) Solve the given system of equations using conjugate gradient method. [5]

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

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

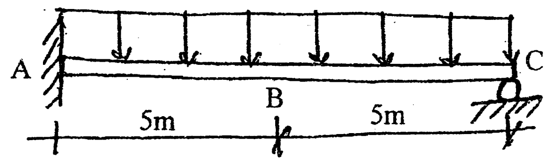
   b) What are the conditions at which axisymmetric stress exists? Write the stress-strain relations for axisymmetric condition. [4]

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

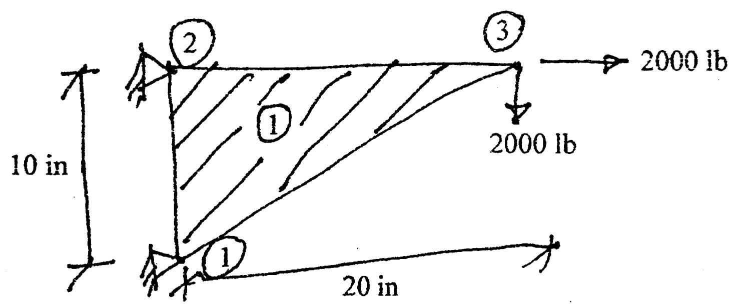


Take E = constant and cross-sectional areas as indicated in the figure.

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)*

- ✓ 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.*
- ✓ ***Candidates use separate answer book for each group.***

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]

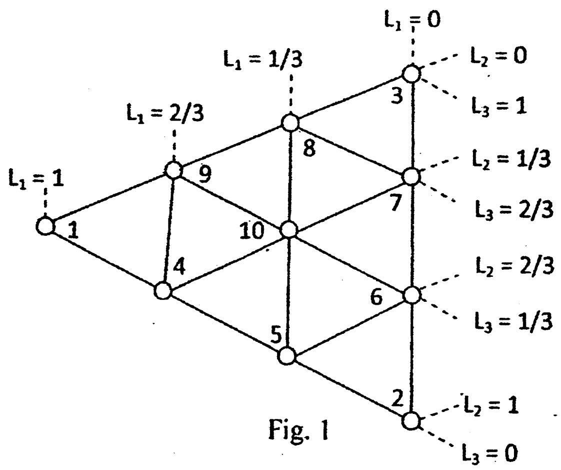

Fig. 1

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

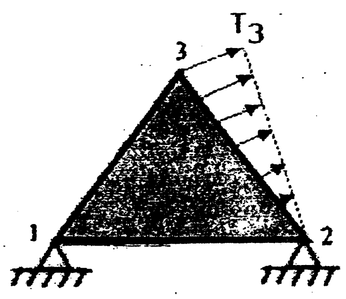

Fig. 2

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.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ ***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]

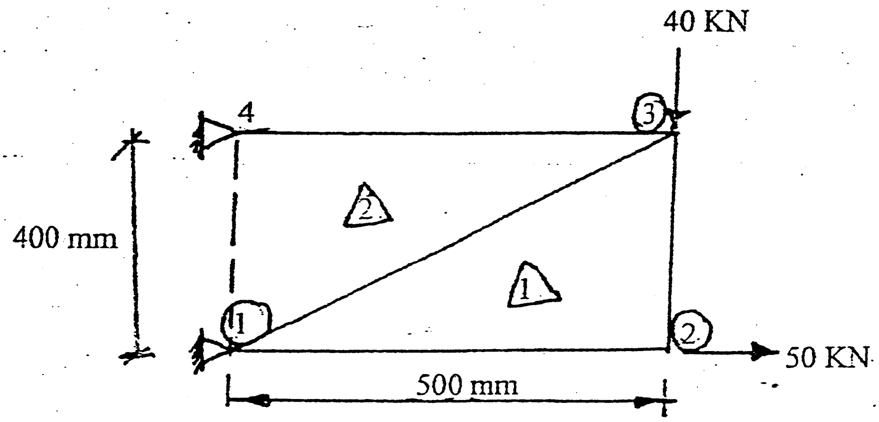
2. Write an algorithm and a program (C or Fortran or Matlab) for fast Fourier transform. With a suitable example explain what parameters can be identified with the help of time domain and frequency domain. [12]

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]

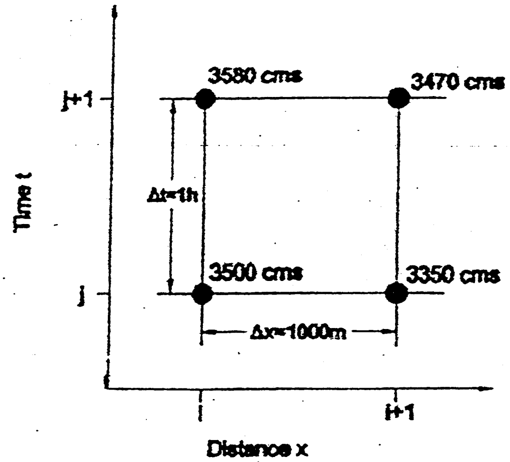
4. (a) Formulate stiffness matrix for a bar element. Rotate the same bar element and formulate stiffness matrix for 2D truss element. [10]

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



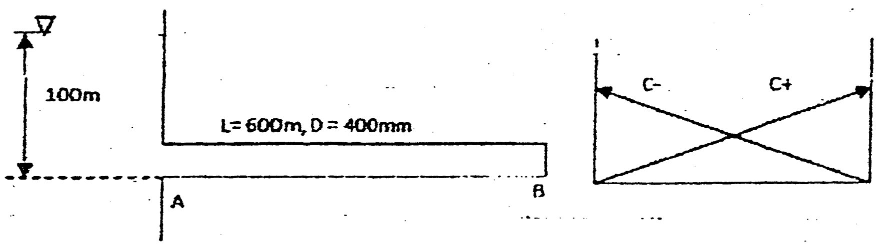
Group B

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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