GUJARAT TECHNOLOGICAL UNIVERSITY

BE 7 SEMESTER – OLD PAPER – S22 TO S26 – QUESTION BANK

Subject Name & Code: Computational Geotechnics - 3170620

Chapter 1: Solution of Linear & Non-linear Equations

Repeated Questions:

1. Newton-Raphson Method (Theory):

- **Q.** Explain Newton-Raphson method with suitable example / Explain Newton's Raphson method… / Explain N-R method… / Enlist various linear and non-linear methods. Explain Newton-Raphson method with suitable example. **(SUMMER 2022, 3 Marks; SUMMER 2022, 4 Marks; WINTER 2022, 4 Marks; SUMMER 2023, 3 Marks; WINTER 2023, 3 Marks; SUMMER 2024, 4 Marks; WINTER 2024; SUMMER 2025, 4 Marks)**

2. Bisection and False Position Methods (Theory):

- **Q.** Explain Bisection method with suitable example. **(SUMMER 2024, 3 Marks; WINTER 2024; SUMMER 2025, 3 Marks; WINTER 2025, 4 Marks; SUMMER 2026, 3 Marks)**
- **Q.** Explain False Position method with suitable example. **(SUMMER 2022, 3 Marks; SUMMER 2023, 4 Marks; SUMMER 2024, 3 Marks; SUMMER 2025, 3 Marks)**

3. Bisection Method (Numerical):

- **Q.** Find a root of the equation $x^3 - 4x = 9$ using the Bisection method in four stages. **(SUMMER 2022; SUMMER 2024, 4 Marks; SUMMER 2025, 4 Marks)**

4. Gauss Jacobi Method (Numerical):

- **Q.** Solve the following system by Gauss Jacobi method: $20x + y - 2z = 17$, $3x + 20y - z = -18$, $2x - 3y + 20z = 25$. **(SUMMER 2024, 7 Marks; SUMMER 2025, 7 Marks; SUMMER 2026, 7 Marks)**

5. Linear and Non-linear Analysis Methods:

- **Q.** Briefly explain different linear and nonlinear analysis methods. **(WINTER 2022, 3 Marks; WINTER 2024; SUMMER 2026, 3 Marks)**

Other Important Questions:

1. Bisection and False Position Methods (Numerical):

- **Q.** Find negative roots of $x^3 - 7x + 3 = 0$ by Bisection method up to 3 step. **(SUMMER 2023, 3 Marks)**
- **Q.** Find a real root of $\cos x - 3x + 5 = 0$, correct to four decimal places using the false position method. **(WINTER 2024)**

2. Gauss-Seidel Method (Numerical):

- **Q.** Solve the following system by Gauss Seidel method correct up to 3 decimal places. (Use $X_0 = 3$, $Y_0 = 3$, $Z_0 = 2$) $2x + y + 54z = 110$; $27x + 6y - z = 85$ [Data truncated in source – refer to the original question paper] **(SUMMER 2023, 7 Marks)**
- **Q.** Solve the following system by Gauss Seidel method: $10x + y + z = 12$; $2x + 10y + z = 13$; $2x + 2y + 10z = 14$. **(WINTER 2022, 7 Marks)**
- **Q.** Solve the following system by Gauss Seidel method: $10X_1 + X_2 + X_3 = 6$; $X_1 + 10X_2 + X_3 = 6$; $X_1 + X_2 + 10X_3 = 6$. **(WINTER 2023, 7 Marks)**
- **Q.** Using Gauss-Seidel method, perform three iterations to solve: $8x - y + 2z = 20$; $2x + 6y - z = -12$; $x - y + 7z = 15$. Start with initial guess (0, 0, 0). **(WINTER 2025)**

3. Gauss Jacobi Method:

- **Q.** Solve the following system by Gauss Jacobi method: $6x + y + z = 105$; $4x + 8y + 3z = 155$; $5x + 4y - 10z = 65$. **(SUMMER 2022, 7 Marks)**
- **Q.** Explain Jacobi's method with suitable example. **(WINTER 2024)**

4. SOR Method and Comparison of Methods (Theory):

- **Q.** Define Successive Over Relaxation (SOR) method and explain the role of relaxation factor. **(WINTER 2025, 3 Marks)**
- **Q.** Compare Bisection method and Successive Approximation method. **(WINTER 2025, 4 Marks)**

Chapter 2: Finite Difference Method / ODE–PDE / Boundary Conditions

Repeated Questions:

1. Taylor's Series and Runge-Kutta Methods (Theory):

- **Q.** Explain Taylor's series method. **(WINTER 2022, 4 Marks; WINTER 2023, 3 Marks; WINTER 2024; SUMMER 2026, 3 Marks)**
- **Q.** Explain Runge-Kutta Second and Fourth order methods of differential equations / Write down steps of fourth order Runge-Kutta method with suitable example / Explain Second order Runge-Kutta method with suitable example. **(WINTER 2023, 7 Marks OR; WINTER 2025, 7 Marks; WINTER 2025, 7 Marks OR; SUMMER 2026, 7 Marks)**

2. Runge-Kutta Methods (Numerical):

- **Q.** Use fourth order Runge-Kutta method to find y(1.1) with h = 0.05, given that $dy/dx = x - y$, $y(1) = 1$. **(WINTER 2022, 7 Marks; SUMMER 2023, 7 Marks OR; SUMMER 2024, 7 Marks OR; SUMMER 2025, 7 Marks OR)**
- **Q.** Use second order Runge-Kutta method to solve initial value problem $y' = -y$, where $y(0) = 1$, for $x_1 = 0.2$ and $x_2 = 0.4$. **(SUMMER 2024, 7 Marks; SUMMER 2025, 7 Marks)**

3. Boundary Conditions and Differential Equations (Theory):

- **Q.** What are Dirichlet and Neumann conditions? / Explain Dirichlet conditions / Enlist types of boundary conditions. Explain Dirichlet conditions. **(SUMMER 2023, 3 Marks OR; WINTER 2023, 3 Marks OR; WINTER 2024, OR; SUMMER 2026, 4 Marks; SUMMER 2026, 3 Marks)**
- **Q.** Explain ordinary and partial differential equations with suitable example / What are ODE and PDE? Give one geotechnical example for each. **(WINTER 2024; WINTER 2025, 3 Marks OR; SUMMER 2026, 3 Marks)**

Other Important Questions:

1. ODE, PDE, IVP and BVP (Theory):

- **Q.** Enlist different ODE and PDE method. **(WINTER 2022, 3 Marks)**
- **Q.** Explain the difference between initial value problems (IVP) and boundary value problems (BVP) with appropriate applications in geotechnical engineering. **(WINTER 2025, 3 Marks)**

2. Second Order Runge-Kutta Method (Numerical):

- **Q.** Use second order Runge-Kutta method to find y(0.2) with h = 0.1, given that $dy/dx = x - y^2$, $y(0) = 1$. **(WINTER 2022, 7 Marks)**
- **Q.** Use second order Runge-Kutta method to find y(0.2), given that $dy/dx = 2x + y$, $y(0) = 1$; use h = 0.1. **(SUMMER 2022, 7 Marks OR)**
- **Q.** Use the Runge-Kutta method of order two to integrate $dy/dx = \sin y$ with $y(0) = 1$ from x = 0 to 0.5 in steps of h = 0.1. Keep four decimal places in the calculations. **(WINTER 2024)**

3. Fourth Order Runge-Kutta Method (Numerical):

- **Q.** Use fourth order Runge-Kutta method to find y(0.2) with h = 0.1, given that $dy/dx = X + Y$, $y(0) = 1$. **(WINTER 2023, 7 Marks)**
- **Q.** Use the Runge-Kutta method of fourth order to solve $dy/dx = 1 + y^2$ subject to $y(0) = 0$, find y(0.2) and y(0.4). **(SUMMER 2022, 7 Marks)**
- **Q.** Using the Runge-Kutta method of order four and with h = 0.2, obtain an approximate solution of $dy/dt = -2ty^2$, $y(0) = 1$, in the initial $0 \le t \le 1$ with h = 0.2. The exact value of y is given by $y = 1/(1 + t^2)$. Compute the relative error and the percentage relative error. **(WINTER 2024, OR)**

Chapter 3: Discrete Modeling / DEM

Repeated Questions:

1. Discrete Element Method (DEM):

- **Q.** Briefly explain discrete element method (DEM). **(WINTER 2022, 3 Marks; WINTER 2023, 4 Marks; SUMMER 2026, 4 Marks)**

2. Discrete and Continuum Modeling:

- **Q.** Explain basic concept of discrete modelling. **(SUMMER 2022, 3 Marks; SUMMER 2023, 3 Marks OR; SUMMER 2024, 7 Marks; SUMMER 2025, 7 Marks)**
- **Q.** Give difference between discrete modeling versus continuum modeling. **(SUMMER 2022, 3 Marks OR; WINTER 2022, 3 Marks; SUMMER 2023, 3 Marks; SUMMER 2024, 3 Marks OR; WINTER 2024; SUMMER 2025, 3 Marks OR)**
- **Q.** Briefly explain continuum modeling. **(SUMMER 2024, 3 Marks; SUMMER 2025, 3 Marks; SUMMER 2026, 3 Marks)**

Other Important Questions:

1. Discrete Element Method (DEM):

- **Q.** Give detail note on DEM for understanding of soil behavior. **(SUMMER 2023, 3 Marks)**
- **Q.** Define discrete element method. How it is useful to the geotechnical engineering? **(SUMMER 2022, 3 Marks)**
- **Q.** Explain the role of integration algorithm for solution of DEM problems. **(WINTER 2023, 3 Marks)**
- **Q.** Define “contact forces” in Discrete Element Modelling (DEM). Mention their significance in simulating granular materials. **(WINTER 2025, 3 Marks)**

2. DEM versus FEM:

- **Q.** Give difference between discrete element method and Finite Element Method. **(SUMMER 2023, 4 Marks OR)**

Chapter 4: Classical Plasticity and Soil Behavior / Constitutive Models / FEM

Repeated Questions:

1. Finite Element Method (FEM):

- **Q.** Explain concept of Finite Element Method. Give its applications in geotechnical engineering. / Explain the concept of Finite Element Method? Give its applications in Geotechnical engineering / Write a detail note on FEM method. Explain the applications of FEM method in geotechnical engineering. **(SUMMER 2022, 4 Marks; WINTER 2022, 4 Marks; SUMMER 2023, 4 Marks; SUMMER 2023, 4 Marks OR; WINTER 2023, 7 Marks; SUMMER 2024, 4 Marks; WINTER 2024; SUMMER 2025, 4 Marks; SUMMER 2026, 3 Marks)**

2. Elasticity, Plasticity and Soil Constitutive Behavior (Theory):

- **Q.** Differentiate between elastic model and plastic model. **(WINTER 2022, 4 Marks; WINTER 2023, 3 Marks; SUMMER 2024, 4 Marks; WINTER 2024; SUMMER 2025, 4 Marks; SUMMER 2026, 4 Marks)**
- **Q.** What is classical plasticity? Explain general framework of classical plasticity. **(WINTER 2022, 7 Marks; SUMMER 2023, 7 Marks; SUMMER 2024; WINTER 2024, OR; WINTER 2025, OR)**
- **Q.** Explain One-dimensional (1D) plasticity theory for understanding the behavior of soil. **(SUMMER 2022, 7 Marks OR; WINTER 2022, 7 Marks; SUMMER 2024, 7 Marks OR; WINTER 2024, 7 Marks OR; SUMMER 2025, 7 Marks OR; SUMMER 2026, 7 Marks)**
- **Q.** Explain concept of Cam clay / Write a short note on Cam clay / List major assumptions used in Cam Clay constitutive modelling. **(WINTER 2022, 4 Marks; SUMMER 2023, 4 Marks OR; WINTER 2023, 3 Marks OR; WINTER 2024, OR; WINTER 2025, 3 Marks OR; SUMMER 2026, 4 Marks)**

3. Failure Criteria and Shear Strength of Soil (Theory):

- **Q.** Explain Mohr-Coulomb theory / Explain Mohr Coulomb theory of shear strength. **(SUMMER 2022, 7 Marks; WINTER 2022, 7 Marks; WINTER 2022, 3 Marks; SUMMER 2023, 7 Marks OR; WINTER 2023, 4 Marks; SUMMER 2024, 7 Marks; SUMMER 2025, 7 Marks; SUMMER 2026, 7 Marks)**
- **Q.** Explain Modified Mohr Coulomb failure theory for shear strength of soil. Draw/sketch typical strength envelope for different type of soil. [Diagram required – refer to the original question paper] **(SUMMER 2022; SUMMER 2023, 7 Marks OR; WINTER 2023, 7 Marks OR; SUMMER 2024, 4 Marks OR; SUMMER 2025, 4 Marks OR; WINTER 2025, 4 Marks; SUMMER 2026, 7 Marks)**
- **Q.** Briefly explain Drucker-Prager theory. **(SUMMER 2022, 4 Marks OR; WINTER 2022, 4 Marks; WINTER 2023, 4 Marks; SUMMER 2024, 4 Marks; SUMMER 2025, 4 Marks; SUMMER 2026, 4 Marks)**
- **Q.** Explain theory of Lade-Duncan criterion for earth pressure coefficient / Explain earth pressure coefficients based upon Lade-Duncan criterion / Explain coefficient of earth pressure with help of Lade-Duncan criterion. **(SUMMER 2022, 7 Marks; WINTER 2022, 7 Marks; SUMMER 2023, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 7 Marks; WINTER 2024; SUMMER 2025, 7 Marks; WINTER 2025, 4 Marks; SUMMER 2026, 7 Marks)**

4. Boundary Value Problems in Geotechnical Engineering:

- **Q.** Explain the importance of initial boundary value problem / boundary value problems in geotechnical engineering. / Explain role of initial boundary value problems (IBVP) in modelling consolidation and slope stability. **(WINTER 2022, 3 Marks; WINTER 2023, 4 Marks OR; SUMMER 2024, 3 Marks; SUMMER 2025, 3 Marks; WINTER 2025, 7 Marks OR)**

Other Important Questions:

1. Finite Element Method (FEM):

- **Q.** Differentiate between FEM and FDM. **(WINTER 2023, 4 Marks)**

2. Soil Constitutive Models and Plasticity (Theory):

- **Q.** Briefly explain soil constitutive model. **(WINTER 2024)**
- **Q.** Explain the need for constitutive modelling in soil mechanics. **(WINTER 2025, 3 Marks OR)**
- **Q.** Write a detailed note on Frictional 1-D plasticity models and explain how they help in understanding the stress-strain behaviour of soils. **(WINTER 2025, 7 Marks)**
- **Q.** Discuss the engineering relevance of yield surfaces in geotechnical constitutive models. **(WINTER 2025, 3 Marks)**

3. Failure Criteria (Theory):

- **Q.** Explain the Huber-von Mises failure criterion and state its limitations for geomaterials. **(WINTER 2025, 7 Marks)**
- **Q.** Differentiate between Tresca failure theory and Von Mises failure theory for soil. **(WINTER 2024)**

4. Shear Strength Terms:

- **Q.** Explain the following terms: 1. Angle of internal friction 2. Cohesion of soil particle 3. Shear strength of soil 4. Pore water pressure. **(SUMMER 2023, 4 Marks)**
- **Q.** Explain the following terms: 1. Angle of Repose 2. Shear strength of Soil. **(WINTER 2023, 4 Marks)**

Chapter 5: Numerical Solutions / Consolidation / Tri-axial Test / Flow Through Porous Media

Repeated Questions:

1. Consolidation – Basic Concepts:

- **Q.** Explain concept of consolidation. **(WINTER 2022, 3 Marks; SUMMER 2024, 3 Marks; SUMMER 2025, 3 Marks)**
- **Q.** Differentiate between consolidation and compaction / Distinguish between Compaction and consolidation. **(SUMMER 2022, 4 Marks; SUMMER 2023, 4 Marks; SUMMER 2026, 4 Marks OR)**
- **Q.** Define following terms: 1. Immediate Settlement 2. Primary Consolidation 3. Secondary Consolidation. **(SUMMER 2023, 3 Marks OR; WINTER 2023, 3 Marks OR; SUMMER 2024, 3 Marks; SUMMER 2025, 3 Marks)**
- **Q.** Explain compression index (C_c) and Swelling index (C_s). **(WINTER 2022, 4 Marks; WINTER 2023, 3 Marks; SUMMER 2024, 4 Marks OR; WINTER 2024; WINTER 2025, 4 Marks; SUMMER 2026, 4 Marks)**

2. Theory of Consolidation:

- **Q.** Explain consolidation mechanism through spring analogy theory / Explain spring analogy theory for primary consolidation / Briefly explain spring analogy theory. **(SUMMER 2022, 7 Marks; SUMMER 2023, 7 Marks; WINTER 2023, 4 Marks OR; SUMMER 2024; WINTER 2024; SUMMER 2025; WINTER 2025, 7 Marks; SUMMER 2026, 7 Marks)**
- **Q.** List the assumptions made in the theory of 1-D consolidation. **(WINTER 2022, 3 Marks; SUMMER 2024, 3 Marks OR; WINTER 2024, OR; SUMMER 2025, 3 Marks OR; WINTER 2025, 4 Marks OR; SUMMER 2026, 3 Marks OR)**
- **Q.** Explain Terzaghi's theory of 1-dimensional consolidation with assumptions. **(SUMMER 2022, 7 Marks OR; WINTER 2022, 7 Marks; WINTER 2023, 7 Marks)**

3. Tri-axial Test:

- **Q.** Explain Tri-axial test with neat sketch. Also enlist its limitation / merits and de-merits. [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks; WINTER 2022, 7 Marks; SUMMER 2023, 7 Marks OR; WINTER 2023, 7 Marks; SUMMER 2024, 7 Marks OR; WINTER 2024; SUMMER 2025, 7 Marks OR; WINTER 2025, 7 Marks OR; SUMMER 2026, 7 Marks OR)**

4. Flow Through Porous Media and Numerical Solutions:

- **Q.** Explain flow through porous media / Write a note on flow through porous media / Write comprehensive note on flow through porous media, covering governing equations, assumptions, and numerical modelling approaches. **(SUMMER 2022, 3 Marks OR; WINTER 2022, 4 Marks; WINTER 2023, 4 Marks; WINTER 2024, OR; WINTER 2025, 7 Marks OR; SUMMER 2026, 4 Marks)**
- **Q.** Explain the applications of numerical solution. **(WINTER 2023, 7 Marks; WINTER 2024)**

Other Important Questions:

1. Consolidation (Theory):

- **Q.** Give detail note on one dimensional consolidation. **(SUMMER 2023, 3 Marks)**
- **Q.** Briefly explain 1-Dimensional consolidation. **(SUMMER 2022, 4 Marks)**
- **Q.** Give detail explanation on various types of consolidation. **(SUMMER 2022, 3 Marks)**
- **Q.** Explain consolidation in detail. **(SUMMER 2022)**
- **Q.** Discuss the physical meaning and laboratory determination of coefficient of consolidation (C_v). **(WINTER 2025, 4 Marks)**
- **Q.** Explain the numerical modelling steps for 1-D consolidation using FDM. **(WINTER 2025, 4 Marks OR)**

2. Consolidation (Numerical):

- **Q.** A saturated clay layer of 4 m thickness takes 2 years for 50% primary consolidation when drained on both sides. Its coefficient of volume change $m_v = 1.5\times10^{-3}$ m²/kN. Determine the coefficient of consolidation and coefficient of permeability. Assume $\gamma_w = 10$ kN/m³. **(SUMMER 2022)**

3. Flow Through Porous Media:

- **Q.** Define seepage velocity and hydraulic gradient. Explain their role in modelling flow through porous media. **(WINTER 2025, 3 Marks)**

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