Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - III EXAMINATION - WINTER 2025

Subject Code: BE03000191 **Date: 22-12-2025**

Subject Name: Numerical Methods for Electrical Engineering

Time: 10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions

1. Attempt all questions.

2. Make suitable assumptions wherever necessary.

3. Figures to the right indicate full marks.

4. Simple and non-programmable scientific calculators are allowed.

			Marks
Q.1	**(a)**	Define initial value problem. Give an example.	**03**
	(b)	Solve the following system of linear equations using Gauss-Jacobi Method $10x + 2y + z = 9$ $2x + 20y - 2z = -44$ $-2x + 3y + 10z = 22$	**04**
	(c)	Apply Secant method to find the root of the equation $x^3 + x^2 - 3x - 3 = 0$ correct up to five decimal places.	**07**
Q.2	**(a)**	State the primary criterion for selecting the next interval in the False position Method and write down the iteration formula for the Newton-Raphson Method.	**03**
	(b)	Find the root of the equation $x^3 - 4x - 1 = 0$ using the Bisection Method correct up to two decimal place.	**04**
	(c)	Consider a 3-mesh ladder equations (A.I=V) using mesh current I_1, I_2, I_3 : $(Z_1 + Z_{12}) I_1 - Z_{12} I_2 = V_1$ $-Z_{12} I_1 + (Z_2 + Z_{12} + Z_{23}) I_2 - Z_{23} I_3 = V_2$ $-Z_{23} I_2 + (Z_3 + Z_{23}) I_3 = V_3$ Where impedance(Ω) $Z_1 = 10, Z_2 = 8, Z_3 = 6, Z_{12} = 4, Z_{23} = 5$, phasor voltages (volts) $V_1 = 10, V_2 = 5, V_3 = 8$. Apply L-U decomposition method to solve the above system of linear equations.	**07**
		OR	
	(c)	Apply Gauss-Siedel method, to solve the following system of linear equations: $5x + y - z = 10$ $2x + 4y + z = 14$ $x + y + 8z = 20$	**07**
Q.3	**(a)**	Write the predictor and corrector formula for the Modified Euler Method.	**03**

(b) Solve ordinary differential equation $\frac{dy}{dx} = x + y$ with initial value $y(0) = 1$ using Modified Euler Method with step size $h = 0.1$ and compute y for $x = 0.2$. **04**

(c) Apply RK 4 method, to find approximate value of y when $x = 0.2$, for the ODE $10\frac{dy}{dx} = x^2 + y^2, y(0) = 1$ Use step size of $h = 0.1$. **07**

OR

(a) Write the formula for Trapezoidal rule to solve initial Value problem. **03**

(b) Solve the initial value problem $\frac{dy}{dx} = x + 3y, y(0) = 1$, for $x = 0.1$ using Trapezoidal rule with step size $h = 0.05$. **04**

(c) Apply Heun Method, to find approximate value of y when $x = 1.2$ given that $\frac{dy}{dx} = 3x + y, y(1) = 1.3$. Use step size of $h = 0.1$. **07**

Q.4 **(a)** Define Finite Element Method. **03**

(b) For one dimensional two-node linear finite element of length L, derive the shape function $N_1(x)$ and $N_2(x)$. **04**

(c) Apply Finite Element Method (FEM), to solve the boundary value problem $y'' = -2$ with boundary conditions $y(0) = 0$ and $y'(1) = 0$. (Use a single, two-node linear element) **07**

OR

(a) Explain Finite Element Discretization. **03**

(b) Apply three nodal constraints at nodes $\zeta = -1, 0, 1$ to derive the expression of quadratic shape function $N_2(\zeta) = a\zeta^2 + b\zeta + c$. **04**

(c) Consider a simple series RL circuit with a constant DC voltage source V_s.The governing ODE for the current $i(t)$ is given by Kirchhoff's Voltage Law: **07**

$$L\frac{di}{dt} + Ri = V_s$$

where $L = 1H$ is the induction, $R = 1\Omega$ is the resistance and $V_s = 1V$ with initial condition $i(0) = 0$. Apply Finite Element Method to find the current $i(t), t \in [0, 1]$. (Use 3 modes and 2 linear elements)

Q.5 **(a)** Explain continuous and discrete optimization. **03**

(b) Find the local minimum of the continuous, unconstrained function $f(x) = x^3 - 6x^2 + 5$ using using optimality criterion. **04**

(c) Apply Fibonacci search method to minimize the function $f(x) = x^2 + 4x$ on $[1, 5]$ with $n = 6$. **07**

OR

(a) Explain local and global optimization. **03**

(b) Minimize $f(x) = x^2 - x + 1$, on $[0, 1]$ by using Interval-Halving method up to first three iteration. **04**

(c) Apply Exhaustive search method to minimize the function $f(x) = x^2 - 4x + 5$ on $[0, 5]$ with $n = 10$. (Final answer to 3 decimal places) **07**

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