

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 3 – EXAMINATION – SUMMER 2026
Subject Code: BE03000191 **Date: 02/07/2026**
Subject Name: NUMERICAL METHODS FOR ELECTRICAL ENGINEERING
Time: 02:30 PM TO 05:00 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.

- Q.1** (a) Minimize $f(x) = x + 1$ on $[0,1]$ by using interval-halving method up to two iteration. **03**
- (b) In an electrical network, the mesh current equations are given as: **04**

$$2x + 3y = 8, 4x + 9y = 20$$

where x and y represent mesh currents in amperes. Using the LU decomposition method, solve for the mesh currents x and y .

- (c) Use fourth order Runge-Kutta method to calculate $y(1.1)$ with $h = 0.05$ given that $y' = x - y$, $y(1) = 1$. **07**

- Q.2** (a) Explain finite element discretization. **03**
- (b) Find a root of the equation **04**

$$x^3 - 2x - 5 = 0$$

which lies in the interval (1.75, 2.5) using false-position method correct up to 3 significant digits.

- (c) Find root of an equation $xe^x - 1 = 0$ using secant method correct to 4 significant digits. **07**

OR

- Q.2** (c) Find the positive root of equation $x = \cos x$ correct up to 3 decimal places by bisection method. **07**

- Q.3** (a) Find a real root of the equation $x^3 + x - 1 = 0$ using Newton-Raphson method correct up to 4 decimal places. **03**

- (b) Solve the following system by Gauss-Jordan method. **04**

$$x + 2y + z = 8, 2x + 3y + 4z = 20, 4x + 3y + 2z = 16.$$

- (c) Solve the following equations by Gauss-Seidel method: **07**

$$4x + y + 3z = 17, \quad x + 5y + z = 14, \quad 2x - y + 8z = 12.$$

OR

- Q.3 (a)** Find a root of the equation $2^x - x - 3 = 0$ which lies in the interval $(-3, -2)$ using fixed point method correct up to 3 decimal places. **03**
- (b)** Using Gauss-Jordan method, find inverse of the matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 5 & 3 \\ 1 & 0 & 8 \end{bmatrix}$. **04**
- (c)** Solve the following equations by Gauss-Jacobi method: $10x + y + z = 6$, $x + 10y + z = 6$, $x + y + 10z = 6$. **07**
- Q.4 (a)** Find the absolute error, relative error, and percentage error in the approximation of π when the approximate value is 3.14. **03**
- (b)** Use Euler's method to obtain an approximate value of $y(1)$ for the equation $\frac{dy}{dx} = x^2 + y^2$, $y(0) = 1$, using $h = 0.2$. **04**
- (c)** Consider the initial value problem: $\frac{dy}{dx} = x + y^2$, $y(0) = 1$. Use Heun's method with step size $h = 0.1$ to approximate $y(0.2)$. **07**
- OR
- Q.4 (a)** Define: Absolute error, Relative error, Percentage error. **03**
- (b)** Consider the initial value problem: $y'(x) = x + 1$, $y(0) = 2$. Find an approximate value of $y(1)$ using the trapezoidal rule with step size $h = 0.5$. **04**
- (c)** Using modified Euler's method, find an approximate value of y corresponding to 0.2 given that $\frac{dy}{dx} = 1 - y$, $y(0) = 0$. Use step size $h = 0.1$. **07**
- Q.5 (a)** Explain constrained and unconstrained optimization. **03**
- (b)** Apply Fibonacci search method to maximize the function $f(x) = x^2 + 4x + 5$ on $[1, 4]$ with $n = 5$. **04**
- (c)** A simple series RL circuit is excited by a constant DC voltage source V . The governing differential equation for the current $i(t)$ is given by Kirchhoff's voltage law as: $L \frac{di}{dt} + Ri = V$ where $L = 1 \text{ H}$ (induction), $R = 1 \Omega$ (resistance) and $V = 1 \text{ V}$ (constant source) with initial condition $i(0) = 0$. Using the finite element method, determine the current $i(t)$ over the interval $t \in [0, 1]$. Use 2 linear elements and appropriate shape functions (3 nodes approximation). **07**
- OR
- Q.5 (a)** Apply exhaustive search method to maximize the function $f(x) = x^2 + 3x$ on $[0, 5]$ with $n = 6$. **03**
- (b)** Find the local minimum and maximum of the continuous, unconstrained function $f(x) = x^3 - 12x + 5$ using optimality criterion. **04**
- (c)** Apply finite element method to solve the boundary value problem: $y'' + y = 0$, $y(0) = 0$ and $y(1) = 1$. (Use a single, two-node linear element) **07**
