JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT
TEST - 3 EXAMINATION (December 2025)
B.Tech. - III Semester (Civil Engg)

COURSE CODE (CREDITS): 18B11MA311 (3) MAX. MARKS: 35
COURSE NAME: NUMERICAL METHODS
COURSE INSTRUCTORS: RKB* MAX. TIME: 2 Hours.

Note: All questions are compulsory. Use of scientific calculator is allowed. The candidate is allowed to make suitable numeric assumptions wherever required for solving problems.

<table>
<tr><th>Q.No</th><th>Question</th><th>CO</th><th>Marks</th></tr>
<tr><td>Q1</td><td>A small nonlinear support (e.g., a soil spring with cubic stiffening) at a structural node lead, after nondimensionalization, to the equilibrium equation for the normalized displacement x. The equation reduces to a polynomial like $x^3 + 5x - 4 = 0$. Solve the polynomial using Newton-Raphson method correct to 3 decimal places.</td><td>CO-1</td><td>5</td></tr>
<tr><td>Q2</td><td>The rainfall intensity (in mm/hr) on a construction site varies over time and is modeled by the function: $R(t) = 0.5 + 0.8t + 0.2t^2, 0 \le t \le 6$. Using Simpson's 3/8 rule with $n = 6$ equal intervals, estimate the total rainfall $\int_0^6 R(t)dt$ (in mm) over the period of 6 hrs.</td><td>CO-3</td><td>5</td></tr>
<tr><td>Q3</td><td>In a certain characterization, both the value of a function (delay) and its slope (sensitivity to input slew) are often required. Suppose the measured propagation delay $f(x)$ of a logic gate (in ns) at different input transition times (slew, in ns) and its slopes are given as:
<table>
<tr><th>x</th><th>$f(x)$</th><th>$f'(x)$</th></tr>
<tr><td>1</td><td>0.13</td><td>0.11</td></tr>
<tr><td>1.5</td><td>0.25</td><td>0.17</td></tr>
</table>
Use Hermite interpolation to estimate the propagation delay at an input slew of $x = 1.2$.</td><td>CO-3</td><td>5</td></tr>
<tr><td>Q4</td><td>Solve for x, y and z using LU decomposition.
$2x + y + z = 7$
$x + 2y + z = 8$
$x + y + 2z = 9$</td><td>CO-3</td><td>5</td></tr>
<tr><td>Q5</td><td>A 3-node structural system (e.g., a simplified analysis of axial forces in connected truss joints or equilibrium at nodes of a grillage structure) leads to the following system of linear equilibrium equations for joint displacements:
$15x_1 - 3x_2 - x_3 = 10$
$-3x_1 + 10x_2 - 2x_3 = 5$
$-x_1 - 2x_2 + 8x_3 = 7.$
Using Gauss Seidel iterative method, solve this system.</td><td>CO-3</td><td>5</td></tr>
<tr><td>Q6</td><td>Using Runge-Kutta method of order 4, solve the initial value problem $\frac{dy}{dx} = x^2(1 + y); y(0) = 1$ finding y for $x = 0.1, 0.2$ and 0.3.</td><td>CO-4</td><td>6</td></tr>
<tr><td>Q7</td><td>Use Milne Predictor and corrector formula to estimate the value of y for $x = 0.4$, based on the values of $y(0.1), y(0.2), y(0.3)$ obtained in question no 6.</td><td>CO-4</td><td>4</td></tr>
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