SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

S.R.M. Nagar, Kattankulathur - 603203

DEPARTMENT OF MATHEMATICS

QUESTION BANK

IV SEMESTER

B. E- Civil, EEE, EIE

1918401 – NUMERICAL METHODS

Regulation – 2019

Academic Year – 2022 - 2023

Prepared by

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DEPARTMENT OF MATHEMATICS

SUBJECT : 1918401 – NUMERICAL METHODS

SEM / YEAR: IV / II year B.E. (COMMON TO CIVIL, EEE, & EIE)

UNIT I - SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS: Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method , Inverse of a matrix by Jordan Method –Iterative method of Gauss Seidel –Dominant Eigenvalue of a matrix by Power method.

Q.No.	Question	BT Level	Competence
	PART – A		
1.	Give two examples of transcendental and algebraic equations	BTL -1	Remembering
2.	When should we not use Newton Raphson method?	BTL -1	Remembering
3.	Write the iterative formula of Newton's- Raphson Method	BTL -1	Remembering
4.	State the rate of Convergence and the criteria for the convergence of Newton Raphson method.	BTL -2	Understanding
5.	Derive the Newton's iterative formula for P^{th} root of a number N.	BTL -3	Applying
6.	Find where the real root lies in between, for the equation x tanx = -1.	BTL -3	Applying
7.	State the order and condition for Convergence of Iteration method.	BTL -2	Understanding
8	State the principle used in Gauss Jordon method.	BTL -2	Understanding
9.	Find the inverse of A = $\begin{pmatrix} 4 & 1 \\ 1 & 3 \end{pmatrix}$ by Jordon method.	BTL -3	Applying
10	Solve by Gauss Elimination method x + y =2 and 2x + 3y = 5	BTL -2	Understanding
11.	Distinguish the advantages of iterative methods over direct method of solving a system of linear algebraic equations.	BTL -4	Analyzing
12.	Find the inverse of A = $\begin{pmatrix} 1 & 3 \\ 2 & 7 \end{pmatrix}$ by Jordan method.	BTL -3	Applying
13.	Compare Gauss Elimination, Gauss Jordan method.	BTL -4	Analyzing
14.	State the condition for the convergence of Gauss Seidel iteration method for solving a system of linear equation.	BTL -2	Understanding
15.	Compare Gauss seidel method, Gauss Jacobi method.	BTL -4	Analyzing
16.	Which of the iterative methods is used for solving linear system of equations it converges fast? Why?	BTL -1	Remembering
17.	Compare Gauss seidel method, Gauss Elimination method.	BTL -4	Analyzing
18.	Explain Power method to find the dominant Eigen value of a square matrix A	BTL -2	Understanding
19.	How will you find the smallest Eigen value of a matrix A.	BTL -4	Analyzing
20.	Find the dominant Eigen value of $A = \begin{pmatrix} 2 & 3 \\ 5 & 4 \end{pmatrix}$ by power method up	BTL -3	Applying

	to 1 decimal place accuracy. Start with $X^{(0)} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$		
21.	Write the other name of Newton Raphson method?	BTL -1	Remembering
22.	When Gauss Elimination method fails?	BTL -1	Remembering
23.	Give two indirect methods to solve system of linear equations.	BTL -1	Remembering
24.	Is the Iteration method, a self-correcting method always?	BTL -4	Analyzing
25.	Find the root of the equation $x^3 - 2x - 5 = 0$.	BTL -3	Applying
PART – B			
1.	Find the positive real root of $\log_{10} x = 1.2$ using Newton – Raphson method.	BTL -3	Applying
2.(a)	Evaluate the inverse of the matrix $\begin{pmatrix} 1 & 3 & 3 \\ 1 & 4 & 3 \\ 1 & 3 & 4 \end{pmatrix}$ using Gauss Jordan method.	BTL -5	Evaluating
2.(b)	Evaluate the positive real root of $x^2 - 2x - 3 = 0$ using Iteration method, Correct to 3 decimal places.	BTL -5	Evaluating
3.(a)	Find the inverse of the matrix $\begin{pmatrix} 2 & 2 & 3 \\ 2 & 1 & 1 \\ 1 & 3 & 5 \end{pmatrix}$ using Gauss Jordan method.	BTL -3	Applying
3.(b)	Solve by Gauss Elimination method $3x + y - z = 3$; $2x - 8y + z = -5$; $x - 2y + 9z = 8$	BTL -3	Applying
4.	Find the dominant Eigen value and vector of $A = \begin{pmatrix} 3 & 2 & 4 \\ -1 & 4 & 10 \\ 1 & 3 & -1 \end{pmatrix}$ using Power method.	BTL -3	Applying
5. (a)	Solve by Gauss Jordan method $10x + y + z = 12$; $2x + 10y + z = 13$; $x + y + 5z = 7$.	BTL -3	Applying
5.(b)	Find the positive r root of $\cos x = 3x - 1$ correct to 3 decimal places using fixed point iteration method.	BTL -3	Applying
6.	Apply Gauss seidel method to solve system of equations $x - 2y + 5z = 12$; $5x + 2y - z = 6$; $2x + 6y - 3z = 5$ (Do up to 4 iterations)	BTL -3	Applying
7.	Using Newton's method find the iterative formula for $\frac{1}{N}$ where N is positive integer and hence find the value of $\frac{1}{26}$	BTL -1	Remembering
8.	By Gauss seidel method to solve system of equations $x + y + 54z = 110$; $27x + 6y - z = 85$; $6x + 15y - 2z = 72$.	BTL -4	Analyzing
9.	Find the real root of $\cos x = x e^x$ using Newton - Raphson method by using initial approximation $x_0 = 0.5$.	BTL -3	Applying
10.	Evaluate the dominant Eigen value and vector of $A = \begin{pmatrix} 25 & 1 & 2 \\ 1 & 3 & 0 \\ 2 & 0 & -4 \end{pmatrix}$ using Power method.	BTL -5	Evaluating
11.	Determine the largest eigenvalue and the corresponding	BTL -6	Creating

	eigenvectors of the matrix $\begin{pmatrix}1&3&-1\\3&2&4\\-1&4&10\end{pmatrix}$		
12.	Using Gauss-Jordan method, find the inverse of the matrix $\begin{pmatrix}8&-4&0\\-4&8&-4\\0&-4&8\end{pmatrix}$	BTL -3	Applying
13.	Find the positive root of e^x -3x = 0 correct to 3 decimal places using fixed point iteration method.	BTL -3	Applying
14.	Solve using Gauss-Seidal method $8x - 3y + 2z = 20,\ 4x + 11y - z = 33,\ 6x + 3y + 12z = 35$.	BTL -3	Applying
15.	Solve by Gauss Elimination method x +3y +3z = 16 ; x +4y +3z = 18 ; x +3y +4z =19.	BTL -3	Applying
16.	Solve by Gauss Jordan method 10 x -2y + 3z =23 ; 2x + 10y -5z = -33; 3x -4y + 10z =41.	BTL -3	Applying
17.	Using Gauss-Jordan method, find the inverse of the matrix $\begin{pmatrix}1&1&3\\1&3&-3\\-2&-4&-4\end{pmatrix}$	BTL -3	Applying
18.	Find the positive real root of $x\log_{10} x = 12.34$ using Newton – Raphson method start with $x_0 = 10$.	BTL -3	Applying
	PART – C		
1.	Derive the iterative formula for $\sqrt{N}$ where N is positive integer using Newton's method and hence find the value of $\sqrt{142}$.	BTL -4	Analyzing
2.	Solve using Gauss-Seidal method 4x + 2y + z =14, x + 5y - z = 10, x + y + 8z = 20	BTL -4	Analyzing
3.	Find all possible Eigen values by Power method for A = $\begin{pmatrix}1&6&1\\1&2&0\\0&0&3\end{pmatrix}$	BTL -2	Understanding
4.	Using Power method , Find all the Eigen values of $\boldsymbol{A} = \begin{pmatrix}5&0&1\\0&-2&0\\1&0&5\end{pmatrix}$	BTL -2	Understanding
5.	Solve by Gauss Elimination method 3.15x -1.96y + 3.85z =12.95 ; 2.13x + 5.12y -2.89z = -8.61; 5.92x +3.05y + 2.15z =6.88.	BTL -3	Applying

UNIT -II INTERPOLATION AND APPROXIMATION: Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines - Difference operators and relations - Interpolation with equal intervals - Newton's forward and backward difference formulae.

Q.No.	Question	BT Level	Competence
	PART – A		
1.	Define Interpolation.	BTL -1	Remembering
2.	Define inverse Lagrange's interpolation formula.	BTL -1	Remembering
3.	Create Forward interpolation table for the following data X : 0 5 10 15 Y : 14 379 1444 3584	BTL -6	Creating

4.	Write the Lagrange's formula for y, if three sets of values $(x_0, y_0), (x_1, y_1), (x_2\ y_2)$ are given?	BTL -1	Remembering
5.	Create the divided difference table for the following data (0,1), (1, 4), (3,40) and (4,85) .	BTL -6	Creating
6.	Write the divided differences with arguments a , b , c if $f(x) = 1/x^2$.	BTL -2	Understanding
7.	Estimate the divided differences of $f(x) = x^3 + x + 2$ for the arguments 1, 3, 6, 11.	BTL -3	Applying
8.	Create the divided difference table for the following data X : 4 5 7 10 11 13 f(x) : 48 100 294 900 1210 2028 .	BTL-6	Creating
9.	State any two properties of divided differences.	BTL -2	Understanding
10.	Estimate f(a, b) and f(a, b, c) using divided differences ,if f(x) = 1/x.	BTL -2	Understanding
11.	Identify the cubic Spline S(x) which is commonly used for interpolation.	BTL -1	Remembering
12.	Find $\Delta^4 y_0$, given $y_0 = 3$, $y_1 = 12$, $y_2 = 81$, $y_3 = 200$ $y_4 = 100$	BTL -3	Applying
13.	Define cubic spline.	BTL -1	Remembering
14.	Give the condition for a spline to be cubic.	BTL -2	Understanding
15.	Write any two applications of Newton's backward difference formula?	BTL -1	Remembering
17.	Find y, when x = 0.5 given x : 0 1 2 y: 2 3 12	BTL -4	Analyzing
18.	Evaluate y (0.5) given x : 0 1 2 y: 4 3 24	BTL -5	Evaluating
19.	Write Newton's forward formula up to 3rd finite differences.	BTL -1	Remembering
20.	Estimate the Newton's difference table to the given data: x : 1 2 3 4 f(x) : 2 5 7 8	BTL -2	Understanding
21.	State Lagrange's interpolation formula.	BTL -1	Remembering
22.	State Gregory- Newton's Backward difference formula.	BTL -1	Remembering
23.	Create the divided difference table for the following data X : 2 5 10 f(x) : 5 29 109	BTL-6	Creating
24.	What is the order of convergence of cubic spline.	BTL -4	Analyzing
25.	Estimate the Newton's difference table to the given data: x : 2 4 6 f(x) : 3 6 12	BTL -2	Understanding

PART –B

1.(a)	Find f(3), Using Lagrange's interpolation method, x: 0 1 2 5 y: 2 3 12 147	BTL -3	Applying
1. (b)	Using Newton's divided difference formula from the following table, Find f(1) from the following x: -4 -1 0 2 5 f(x): 1245 33 5 9 1335	BTL -3	Applying
2. (a)	Using Newton's divided difference formula From the following table, find f (8) x: 3 7 9 10 f(x): 168 120 72 63	BTL -3	Applying

2.(b)	Evaluate f(1) using Lagrange's method x: -1 0 2 3 y: -8 3 1 12	BTL -5	Evaluating
3. (a)	Use Newton divided difference method find y(3) given y(1) = -26, y(2) = 12, y(4) = 256, y(6) = 844.		
3.(b)	Use Lagrange's Inverse formula to find the value of x for y = 7given x: 1 3 4 y: 4 12 19	BTL -3	Applying
4.	Find the natural cubic spline for the function given by X: 0, 1, 2 f(x): 1, 2, 33	BTL -4	Analyzing
5. (a)	Estimate x when y = 20 from the following table using Lagrange's method x: 1 2 3 4 y: 1 8 27 64	BTL -3	Applying
5.(b)	Using Lagrange's formula fit a polynomial to the data x: -1 1 2 y: 7 5 15	BTL -3	Applying
6.	Using Newton's divided difference formula find the missing value from the table: X: 1, 2, 4, 5, 6 f(x): 14, 15, 5, --, 9	BTL -3	Applying
7	Obtain root of f(x) = 0 by Lagrange's Inverse interpolation formula given that f(30) = -30, f(34) = -13, f(38) =3, f(42) =18	BTL -2	Understanding
8.	Using Newton's interpolation formula find the value of 1955 and 1975 from the following table x: 1951 1961 1971 1981 y: 35 42 58 84	BTL -3	Applying
9.	Evaluate f(7.5) from the following table Using Newton's backward formula X : 1 2 3 4 5 6 7 8 Y : 1 8 27 64 125 216 343 512	BTL -5	Evaluating
10.	Fit the following four points by the cubic splines. x : 1 2 3 4 y : 1 5 11 8, Use the end conditions $y_0'' = y_3''= 0$. Hence compute (i) y (1.5) (ii) y'(2) .	BTL -5	Evaluating
11.	Using Suitable Newton's f interpolation formula find the value of y(46) and y(61) from the following X: 45 50 55 60 65 Y: 114.84 96.16 83.32 74.48 68.48	BTL -4	Analyzing
12.	Calculate the pressure t = 142 and t =175, from the following data taken from steam table, Using suitable formula. Temp : 140 150 160 170 180 Pressure: 3.685 4.854 6.302 8.076 10.225	BTL -4	Analyzing
13.	Determine by Newton's interpolation method, the number. of patients over 40 years using the following data Age (over x years) : 30 35 45 55 Number(y)patients: 148 96 68 34	BTL -3	Applying

<table>
<tr><td>14.</td><td>Using Newton’s Forward interpolation formula find the Polynomial f(x) to the following data, and find f(2)
x : 0 5 10 15
f(x): 14 397 1444 3584</td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>15.</td><td>Estimate y when x = 9 from the following table using Lagrange’s method
x: 5 7 11 13 17
y: 150 392 1452 2366 5202</td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>16.</td><td>Using Newton’s divided difference formula find f(1.5) from the table:
<table><tr><td>X</td><td>1</td><td>1.3</td><td>1.6</td><td>1.9</td><td>2.2</td></tr><tr><td>f(x)</td><td>0.7652</td><td>0.6200</td><td>0.4554</td><td>0.2818</td><td>0.1104</td></tr></table></td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>17.</td><td>Find the natural cubic spline for the function given by
<table><tr><td>X</td><td>1</td><td>2</td><td>3</td></tr><tr><td>f(x)</td><td>-8</td><td>-1</td><td>18</td></tr></table>Also find y(1.5).</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>18.</td><td>Use Suitable formula to find f(5) and f(9) from the table:
<table><tr><td>X</td><td>4</td><td>6</td><td>8</td><td>10</td></tr><tr><td>f(x)</td><td>1</td><td>3</td><td>8</td><td>10</td></tr></table></td><td>BTL -3</td><td>Applying</td></tr>
<tr><td colspan="4">PART – C</td></tr>
<tr><td>1.</td><td>The population of a town is as follows
Year (x): 1941 1951 1961 1971 1981 1991
Population in lakhs (y): 20 24 29 36 46 51
Estimate the population increase during the period 1946 to 1976.</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>2.</td><td>Find the number of students who obtain marks between 40 and 45, using Newton’s formula
Marks : 30 – 40 40 -50 50 – 60 60 – 70 70 – 80
No of students : 31 42 51 35 31</td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>3.</td><td>Evaluate f(2),f(8) and f(15) from the following table using Newton’s divided difference formula
x: 4 5 7 10 11 13
y: 48 100 294 900 1210 2028</td><td>BTL -5</td><td>Evaluating</td></tr>
<tr><td>4.</td><td>The following table gives the values of density of saturated water for various temperature of saturated steam. Find density at the temperature T = 125, and T= 275.
<table><tr><td>Temp $T^{\circ}C$</td><td>100</td><td>150</td><td>200</td><td>250</td><td>300</td></tr><tr><td>Density hg/m^3</td><td>958</td><td>917</td><td>865</td><td>799</td><td>712</td></tr></table></td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>5.</td><td>Using Newton’s divided difference formulas find the polynomial from the table. Also find f(3).
<table><tr><td>X</td><td>-4</td><td>-1</td><td>0</td><td>2</td><td>5</td></tr><tr><td>f(x)</td><td>1245</td><td>33</td><td>5</td><td>9</td><td>1335</td></tr></table></td><td>BTL -3</td><td>Applying</td></tr>
</table>

UNIT – III NUMERICAL DIFFERENTIATION AND INTEGRATION: Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson’s 1/3 rule – Romberg’s Method – Evaluation of double integrals by Trapezoidal and Simpson’s 1/3 rules.

Q.No.	Question	BT Level	Competence
	PART – A		

1.	Write down the first two derivatives of Newton's forward difference formula at the point $x = x_0$	BTL -1	Remembering
2.	State Newton's backward differentiation formula to find $\left(\frac{dy}{dx}\right)_{x=x_n}$ and $\left(\frac{d^2y}{dx^2}\right)_{x=x_n}$	BTL -1	Remembering
3.	Find $\frac{dy}{dx}$ at x=50 from the following table: X: 50, 51, 52 Y: 3.6840, 3.7084, 3.7325	BTL -2	Understanding
4.	Find y '(0)from the following table X : 0 1 2 3 4 5 Y: 4 8 15 7 6 2	BTL -2	Understanding
5.	Why is Trapezoidal rule so called?	BTL -1	Remembering
6.	State the formula for trapezoidal rule of integration.	BTL -1	Remembering
7.	State Simpson's one third rule of integration.	BTL -1	Remembering
8.	Find $\frac{dy}{dx}$ at x = 1, from the following table. X: 1, 2, 3, 4 Y: 1, 8, 27, 64	BTL -1	Remembering
9.	Write down the trapezoidal double integration formula.	BTL -2	Understanding
10.	Write down the order of the errors of trapezoidal rule.	BTL -1	Remembering
11.	State Newton's forward differentiation formula to find $\left(\frac{dy}{dx}\right)_{x=x_n}$ and $\left(\frac{d^2y}{dx^2}\right)_{x=x_n}$	BTL -1	Remembering
12.	If the range is not (-1, 1) then what is the idea to solve the Gaussian Quadrature problems.		
13.	Apply Simpson's 1 /3 rd rule to find $\int_0^4 e^x dx$ given that $e^0 = 1, e^1 = 2.72, e^2 = 7.39, e^3 = 20.09, e^4 = 54.6$.	BTL -3	Applying
14.	Calculate $\int_1^4 f(x)dx$ from the table by Simpson's 1/3 rd rule x : 1 2 3 4 f(x): 1 8 27 64	BTL -3	Applying
15.	Write down the Simpson's 1/3rd rule for double integration formula.	BTL -3	Applying
16.	Compare trapezoidal rule and Simpson's one third rule.	BTL -4	Analyzing
17.	In numerical integration , what should be the number of intervals to apply Simpson's one – third rule and trapezoidal rule – Justify	BTL -2	Understanding
18.	State Romberg's integration formula to find the value of I = $\int_a^b f(x)dx$ using h & h / 2.	BTL -1	Remembering
19.	Which one is more reliable, Simpson's one – third rule or trapezoidal rule?	BTL -5	Evaluating
20.	Give the order and error of Simpson's one third rule.	BTL -1	Remembering
21.	How the accuracy can be increased in trapezoidal rule of evaluating a given definite integral?	BTL -4	Analyzing
22.	When Numerical Differentiation can be used?	BTL -4	Analyzing
23.	Find h for the function f(x) = 1/x in (1/2,1) for Simpson's rule.	BTL -3	Applying
24.	What approximation is used in deriving Simpson's rule of integration?	BTL -3	Applying

<table>
<tr><td>25.</td><td>If $I_1 = 0.7083$, $I_2 = 0.6970$ find I using Romberg's Method.</td><td>BTL -3</td><td>Applying</td></tr>
<tr><td colspan="4">PART –B</td></tr>
<tr><td>1.</td><td>Evaluate $\int_0^6 \frac{1}{1+x^2}dx$, using trapezoidal and Simpson's 1/3rd rules.</td><td>BTL -5</td><td>Evaluating</td></tr>
<tr><td>2. (a)</td><td>Using Romberg's method, Evaluate $\int_0^2 \frac{dx}{x^2+4}$..</td><td>BTL -5</td><td>Evaluating</td></tr>
<tr><td>2.(b)</td><td>Obtain first and second derivative of y at x = 0.96 from the data
x : 0.96 0.98 1 1.02 1.04
y : 0.7825 0.7739 0.7651 0.7563 0.7473</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>3.</td><td>Using backward difference, find y'(2.2) and y''(2.2) from the following table
x : 1.4 1.6 1.8 2.0 2.2
y : 4.0552 4.9530 6.0496 7.3891 9.0250</td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>4.</td><td>Evaluate $\int_1^{1.4}\int_2^{2.4} \frac{1}{xy}\,dx\,dy$ by using, Simpson's 1/3rd rule, by considering h = k = 0.1</td><td>BTL -5</td><td>Evaluating</td></tr>
<tr><td>5. (a)</td><td>The table given below reveals the velocity of the body during the time t specified. Find its acceleration at t =1.1
t : 1.0 1.1 1.2 1.3 1.4
v: 43.1 47.7 52.1 56.4 60.8</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>5.(b)</td><td>Using Romberg's method to find $\int_0^6 \frac{dx}{1+x^2}$.</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>6.</td><td>Calculate $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ at x = 1.35 from the following data:
<table>
<tr><td>X</td><td>1.1</td><td>1.2</td><td>1.3</td><td>1.4</td><td>1.5</td><td>1.6</td></tr>
<tr><td>f(x)</td><td>-1.62628</td><td>0.15584</td><td>2.45256</td><td>5.39168</td><td>9.125</td><td>13.83072</td></tr>
</table></td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>7. (a)</td><td>By dividing the range into 10 equal parts, evaluate $\int_0^{\pi} \sin x dx$ using Simpson's 1/3 rule.</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>7.(b)</td><td>Evaluate $\int_1^2 \frac{1}{x^3}dx$, using trapezoidal and Simpson's 1/3rd rules.</td><td>BTL -5</td><td>Evaluating</td></tr>
<tr><td>8.</td><td>Evaluate $\int_1^2\int_1^2 \frac{dx\,dy}{x+y}$ h = k = 0.25 using trapezoidal, Simpson's rule, and justify.</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>9</td><td>Find the value of f ' (8) from the table given below
x : 6 7 9 12
f (x) : 1.556 1.690 1.908 2.158 using suitable formula.</td><td>BTL - 3</td><td>Applying</td></tr>
<tr><td>10</td><td>From the following table, find the value of x for which y is minimum.
<table>
<tr><td>X</td><td>-2</td><td>-1</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td>Y</td><td>2</td><td>-0.25</td><td>0</td><td>-0.25</td><td>2</td><td>15.75</td><td>56</td></tr>
</table></td><td>BTL -5</td><td>Evaluating</td></tr>
</table>

11.	Evaluate $\int_0^1 \int_0^1 \frac{dx\,dy}{1+xy}$ using, Trapezoidal and Simpson's 1/3 rd rule, given that h = k = 0.25.	BTL -4	Analyzing
12.	Use Romberg method to estimate the integral from x = 1.6 to x = 3.6 from the data given below. x : 1.6 1.8 2.0 2.2 2.4 2.6 2.8 y: 4.953 6.050 7.389 9.025 11.023 13.464 16.445 x : 3.0 3.2 3.4 3.6 y: 20.056 24.533 29.964 36.598	BTL -4	Analyzing
13.(a)	Using the following data, find f'(5), f''(5) and the maximum value of f(x). X: 0, 2, 3, 4, 7, 9 f(x): 4, 26, 58, 112, 466, 922	BTL -4	Analyzing
13.(b)	Evaluate $\int_0^1 \frac{dx}{1+x^2}$ using Trapezoidal rule with h = 0.2, hence obtain an approximate value of π .	BTL -5	Evaluating
14.	Evaluate $\int_0^1 e^{-x^2}\,dx$ by dividing the range into 4 equal parts using (a) Trapezoidal rule (b) Simpson's 1/3 rd rule.	BTL -5	Evaluating
15.	Calculate $f'(3)$ and $f''(3)$ from the following data: X: 3.0, 3.2, 3.4, 3.6, 3.8, 4.0 f(x): -14, -10.032, -5.296, -0.256, 6.672, 14	BTL -3	Applying
16.	Evaluate $\int_1^2 \frac{1}{1+x^3}dx$, using trapezoidal and Simpson's 1/3rd rules.	BTL -5	Evaluating
17.	Evaluate $\int_0^1 \int_0^1 \frac{dx\,dy}{1+x+y}$ using, Simpson's 1/3 rd rule, given that (i) h = k = 0.25 , (ii) h = k = 0.5.	BTL -4	Analyzing
18.	Evaluate $\int_0^1 \int_0^1 e^{x+y}\,dxdy$ using, Trapezoidal and Simpson's 1/3 rd rule, given that h = k = 0.5.	BTL -4	Analyzing
	PART- C		
1.	A Jet fighters position on an air craft carries runway was timed during landing t ,sec : 1.0 1.1 1.2 1.3 1.4 1.5 1.6 y , m : 7.989 8.403 8.781 9.129 9.451 9.750 10.03 where y is the distance from end of carrier estimate the velocity and acceleration at t = 1.0.	BTL -2	Understanding
2.	Using the given data find the first and second derivative at x = 5 and x = 6 by suitable formula to the given data: x : 0 2 3 4 7 9 f (x) : 4 26 58 112 466 992	BTL -4	Analyzing
3.	The Velocity v(km/ min) of a moped which starts from rest, is given at fixed intervals of time (min) as follows. T : 0 2 4 6 8 10 12 V : 4 6 16 34 60 94 131 Estimate approximate distance covered in 12 minutes, by Simpson's 1 / 3 rd rule, also find the acceleration at t = 2 seconds.	BTL -2	Understanding
4.	Use Romberg's method to compute $\int_0^1 \frac{dx}{1+x^2}$ by taking h = 0.5, 0.25,	BTL -5	Evaluating

	0.125 and. Hence deduce an approximate value of π.		
5.	Evaluate $\int_0^1 \int_1^2 \frac{2xy\,dx\,dy}{(1+x^2)(1+y^2)}$ using, Trapezoidal and Simpson's 1/3 rd rule, given that h = k = 0.25.	BTL -4	Analyzing

X	0	0.125	0.25	0.375	0.5	0.675	0.75	0.875	1
Y	1	0.9846	0.9412	0.8767	0.8	0.7191	0.64	0.5664	0.5

UNIT – IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS

Single step methods - Taylor's series method - Euler's method - Modified Euler's method – Fourth order Runge - Kutta method for solving first order equations - Multi step methods - Milne's and Adams - Bash forth predictor corrector methods for solving first order equations.

Q.No.	Question	BT Level	Competence
	PART A		
1.	Give Euler's iteration formula for ordinary differential equation.	BTL -2	Understanding
2.	Estimate $\boldsymbol{y}\,(\mathbf{1.25})$ if $\frac{dy}{dx} = x^2 + y^2$, $\boldsymbol{y}\,(\mathbf{1}) = \mathbf{1}$ taking $\boldsymbol{h} = \mathbf{0.25}$, using Euler's method.	BTL -5	Evaluating
3.	Estimate $\boldsymbol{y}\,(\mathbf{0.2})$ given that $\boldsymbol{y' = x + y}, \boldsymbol{y}(\mathbf{0}) = \mathbf{1}$, using Euler's method.	BTL -5	Evaluating
4.	Using Euler's method, compute y(0.1) given $\frac{dy}{dx} = 1 - y$, y(0) = 0	BTL -2	Understanding
5.	Define initial value problems.	BTL -1	Remembering
6.	Write the Euler's modified formula for solving $\frac{dy}{dx} = f(x, y), y(x_0) = y_0$	BTL -1	Remembering
7.	Using modified Euler's method to find y (0.4) given $\boldsymbol{y' = xy}$, $\boldsymbol{y}(\mathbf{0}) = \mathbf{1}$	BTL -5	Evaluating
8.	Write the merits and demerits of the Taylor's method.	BTL -1	Remembering
9.	Find y(0.1), if $\frac{dy}{dx} = y^2 + x$ given $\boldsymbol{y}\,(\mathbf{0}) = \mathbf{1}$, by Taylor series method.	BTL -3	Applying
10.	Using Taylor series formula to find y (x_1) for solving $\frac{dy}{dx} = f(x, y), y(x_0) = y_0$.	BTL -2	Understanding
11.	Using Taylor's series up to x^3 terms for $\mathbf{2}\,\boldsymbol{y' + y = x} + \mathbf{1}$, $\boldsymbol{y}(\mathbf{0}) = \mathbf{1}$.	BTL -3	Applying
12.	Using Taylor series for the function $\frac{dy}{dx} = x + y$ when $\boldsymbol{y}(\mathbf{1}) = \mathbf{0}$ find $\boldsymbol{y}$ ***at*** $\boldsymbol{x} = \mathbf{1.2}$ with $\boldsymbol{h} = \mathbf{0.1}$.	BTL -3	Applying
13.	Explain Runge – Kutta method of order 4 for solving initial value problems in ordinary differential equation.	BTL -1	Remembering
14.	Find k_1 given $\boldsymbol{y' = xy}, \boldsymbol{y}(\mathbf{0}) = \mathbf{1}$, using R-K method of fourth order.	BTL -3	Applying
15.	Using fourth order Runge – Kutta method to find y (0.1) given	BTL -2	Understanding

	$\frac{dy}{dx}=x+y$ y (0) = 1, h = 0.1		
16.	State Adam- Bashforth predictor and corrector formulae to solve first order ordinary differential equations.	BTL -2	Understanding
17.	State Milne's predictor corrector formula.	BTL -2	Understanding
18.	What are the single step methods available for solving ordinary differential equations.	BTL -1	Remembering
19.	What are the advantages of R-K method over taylor's method.	BTL -1	Remembering
20.	Prepare the multi-step methods available for solving ordinary differential equation.	BTL -4	Analyzing
21.	Write the Error for Adam- Bashforth predictor and corrector method.	BTL -1	Remembering
22.	Estimate $\boldsymbol{y}\,(\mathbf{0.1})$ given that $\boldsymbol{y' = x\,y}, \boldsymbol{y}(\mathbf{0}) = \mathbf{2}$, using Euler's method.	BTL -5	Evaluating
23.	Using modified Euler's method to find y (0.5) given $\boldsymbol{y' = x + y}$, $\boldsymbol{y}(\mathbf{0}) = \mathbf{1}$	BTL -5	Evaluating
24.	Using Taylor series for the function $\frac{dy}{dx}=2x+3y$ when $\boldsymbol{y}(\mathbf{1}) = \mathbf{0}$ find $\boldsymbol{y}$ $\boldsymbol{at}$ $\boldsymbol{x} = \mathbf{1.5}$ with $\boldsymbol{h} = \mathbf{0.5}$.	BTL -3	Applying
25.	Find k_1 given $\boldsymbol{y' = x^3 + y}, \boldsymbol{y}(\mathbf{0}) = \mathbf{1}$, using R-K method of fourth order.	BTL -3	Applying
	PART –B		
1.(a)	Apply Euler method to find y (0.2) given $\frac{dy}{dx} = y - x^2 + 1$ and y(0) = 0.5.	BTL -3	Applying
1. (b)	Find the values of y at x = 0.1 given that $\frac{dy}{dx} = x^2 - y$, y(0) = 1 by Taylor's series method.	BTL -5	Evaluating
2. (a)	Using Taylor series method find y at x = 0.1 given $\frac{dy}{dx} = x^2\,y - 1$, y (0) = 1.	BTL -3	Applying
2.(b)	Using Euler Method to find y(0.2) and y(0.4) from $\frac{dy}{dx} = x + y$, y (0) = 1 with h = 0.2.	BTL -3	Applying
3.	Examine 2y' –x – y = 0 given y(0) = 2 , y(0.5) = 2.636, y(1) = 3.595, y(1.5) = 4.968 to get y(2) by Adam's method.	BTL -4	Analyzing
4.	By Euler method for the function $\frac{dy}{dx}=\log_{10}(x+y)$, y(0) = 2 find the values of y(0.2) y(0.4) and y(0.6) by taking h = 0.2.	BTL -3	Applying
5.(a)	Find y(2) by Milne's method $\frac{dy}{dx}=\frac{1}{2}(x+y)$, given y(0) = 2 , y(0.5) = 2.636, y(1.0) = 3.595 and y(1.5) = 4.968.	BTL -3	Applying
5.(b)	Interpret y(0.1) given $\frac{dy}{dx} = x^2 + y^2$ y(0) =1 using modified Euler methods.	BTL -3	Applying
6. (a)	Given $\frac{dy}{dx} = x^2(1+y)$, y(1) = 1 , y(1.1) = 1.233, y(1.2) = 1.548 ,	BTL -5	Evaluating

	y(1.3) = 1.979, evaluate y(1.4) By Adam's Bash forth predictor corrector method.		
6.(b)	Solve the equation $\frac{dy}{dx} = \log(x + y)$, y(0) = 2 find y at x = 0.2 using Modified Euler's method .	BTL -4	Analyzing
7.	Evaluate the value of y at x = 0.2 and 0.4 correct to 3decimal places given $\frac{dy}{dx} = xy^2 + 1$, y(0) =1, using Taylor series method	BTL -5	Evaluating
8. (a)	Calculate y(0.4) by Milne's predictor – corrector method , Given $\frac{dy}{dx} = \frac{1}{2}(1 + x^2)y^2$ and y(0) = 1, y(0.1) = 1.06, y(0.2) = 1.12, y(0.3) = 1.21,	BTL -5	Evaluating
8.(b)	Find the values of y at x = 0.1 given that $\frac{dy}{dx} = x^2 - y$, y(0) = 1 by modified Euler method.	BTL -4	Analyzing
9.	Find y(4.4) given 5xy' + y^2 – 2 = 0 , y(4) = 1; y(4.1) =1.0049; y(4.2) = 1.0097 ; and y(4.3) =1.0143. Using Milne's method.	BTL -4	Analyzing
10.	Find y(0.4) by Milne's method, Given $\frac{dy}{dx} = xy + y^2$, y(0) = 1, y(0.1) = 1.1169, y(0.2) = 1.2773 Find i) y(0.3) by Runge –kutta method of 4^{th} order and ii) y(0.4) by Milne's method.	BTL -3	Applying
11	Solve $\frac{dy}{dx} = 1 - y$ with the initial condition x= 0, y= 0 using Euler's algorithm and tabulate the solutions at x= 0.1, 0.2, 0.3, 0.4. Using these results, Find y(0.5) using Adam's – Bash forth Predictor and corrector method.	BTL -3	Applying
12.	Solve $\frac{dy}{dx} = y^2 + x$, y(0)=1 (i) By modified Euler method at x=0.1 and x = 0.2. (ii) By Fourth order R-K method at x = 0.3 (iii) By Milne's Predictor-Corrector method at x = 0.4.	BTL -3	Applying
13.	Using Milne's method find y(2) if y(x) is the solution of , $\frac{dy}{dx} = \frac{1}{2}(x + y)$, given y(0) =2, y(0.5) =2.636, y(1) = 3.595 and y(1.5) =4.968.	BTL -3	Applying
14.	Apply fourth order Runge-kutta method, to find an approximate value of y when x= 0.2 given that y'= x + y , y(0)=1 with h=0.2.	BTL -3	Applying
15.	Using Taylor series method find y at x = 0.1, x=0.2 , y (0) = 1, given $\frac{dy}{dx} = x + y$.	BTL -3	Applying
16.	Using Euler Method to find y(0.3) and y(0.4) from $\frac{dy}{dx} = \frac{1}{2}(x^2+1)y^2$, y (0.2) = 1.1114 with h = 0.1.	BTL -3	Applying
17.	Apply fourth order Runge-kutta method, to find an approximate value of y when x= 0.1 given that y'= x + y^2, y(0)=1 with h=0.1.	BTL -3	Applying
18.	Apply fourth order Runge-kutta method, to find an approximate value of y when x= 0.2 given that $y' = \frac{y^2 - x^2}{y^2 + x^2}$, y(0)=1 with h=0.2.	BTL -3	Applying
PART-C			

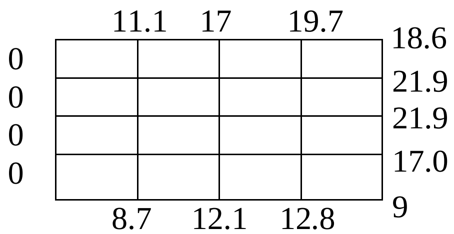
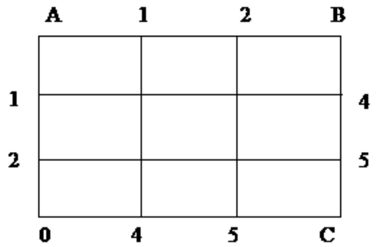
1.	Apply Milne's method find y(0.4) given $\frac{dy}{dx} = xy + y^2$, y(0) =1 ,using Taylor series method find y(0.1) , Euler Method to find y(0.2) and y(0.3)	BTL -3	Applying
2.	By Adam's method, find y (4.4) given, 5xy' + y^2 = 2 , y(4) = 1; Find y(4.1), y(4.2), y(4.3) by Euler's method.	BTL -5	Evaluating
3.	Apply Runge – kutta method of order 4 solve y' = y-x^2, with y(0.6) = 1.7379, h= 0.2 find y(0.8).	BTL -3	Applying
4.	Using Adam's – Bash forth method and Milne's method, find y(0.4) given $\frac{dy}{dx} = \frac{xy}{2}$, y(0) = 1, y(0.1) =1.01, y(0.2) = 1.022, and y(0.3) = 1.023.	BTL -5	Evaluating
5.	Interpret y(1.2) given $\frac{dy}{dx} = (y - x^2)^3$ y(1) =0 , take h = 0.2 using (i) Euler methods, (ii) Modified Euler methods.	BTL -3	Applying

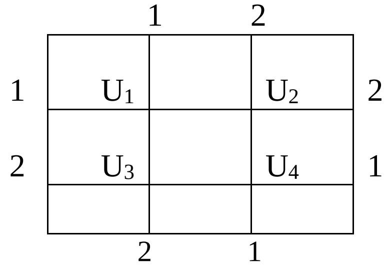
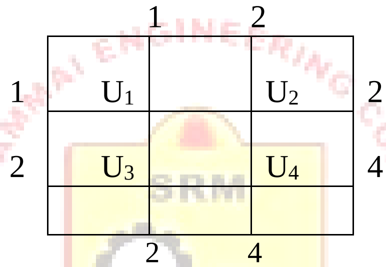
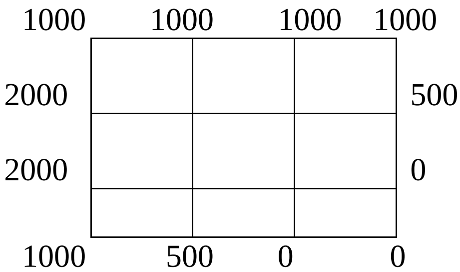
UNIT- V: BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS :

Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

Q.No.	Question	BT Level	Competence
	PART – A		
1.	Obtain the finite difference scheme for $2y''(x) + y(x) = 5$.	BTL -1	Remembering
2.	Write down the finite difference scheme for solving y" + x + y =0: y(0) = y(1) = 0.	BTL -1	Remembering
3.	Write down the finite difference scheme for the differential equation $\frac{d^2y}{dx^2} - 3y = 2$	BTL -2	Understanding
4.	Obtain the finite difference scheme for the differential equation 2 $\frac{d^2y}{dx^2} + y = 5$	BTL -1	Remembering
5.	State the finite difference approximation for $\frac{d^2y}{dx^2}$ and state the order of truncation error.	BTL -1	Remembering
6.	Classify the PDE $y\,U_{xx} + U_{yy} = 0$.	BTL -2	Understanding
7.	Classify the PDE $x\,U_{xx} + y\,U_{yy} = 0,\ x>0,\ y>0$.	BTL -1	Remembering
8.	Write down the standard five point formula in Laplace equation $U_{xx} + U_{yy} = 0$.	BTL -2	Understanding
9.	Write the Crank Nicholson formula to solve parabolic equations.	BTL -1	Remembering
10.	State one dimensional wave equation and its boundary conditions	BTL -1	Remembering
11.	Write down the two dimensional Laplace's equation and Poisson's equation.	BTL -1	Remembering
12.	Write down Poisson's equation and its finite difference analogue.	BTL -1	Remembering
13.	What is the order and error in solving Laplace and Poisson's	BTL -2	Understanding

	equation by using finite difference method?		
14.	State the finite difference scheme for solving the Poisson's equation.	BTL -4	Analyzing
15.	State one dimensional heat equation and its boundary conditions.	BTL -4	Analyzing
16.	Name at least two numerical methods that are used to solve one dimensional diffusion equation.	BTL -4	Analyzing
17.	State the implicit finite difference scheme for one dimensional heat equation.	BTL -4	Analyzing
18.	Write down the finite difference scheme for $u_t = u_{xx}$.	BTL -2	Understanding
19.	Define difference quotient of a function y(x).	BTL -1	Remembering
20.	Evaluate the explicit finite difference scheme for one dimensional wave equation $\frac{\partial^2 u}{\partial t^2} = \alpha^2 \frac{\partial^2 u}{\partial x^2}$.	BTL -5	Evaluating
21.	Write the classification of $f_x - f_{yy} = 0$?	BTL -1	Remembering
22.	What is the purpose of Liebmann's process?	BTL -1	Remembering
23.	Write down the diagonal five point formula in Laplace equation $U_{xx} + U_{yy} = 0$.	BTL -2	Understanding
24.	How many number of conditions required to solve the Laplace equations?	BTL -2	Understanding
25.	Write a note on the stability and convergence of the solution of the difference equation corresponding to the hyperbolic equation.	BTL -1	Remembering
	PART –B		
1.(a)	Evaluate the pivotal values of the equation $U_{tt} = 16\, U_{xx}$ taking $\Delta x = 1$ up to $t = 1.25$. The boundary conditions are $u(0,t) = u(5,t) = 0$, $u_t(x,0) = 0$ & $u(x,0) = x^2(5-x)$	BTL -5	Evaluating
1. (b)	Solve $y'' - y = x$, $0 < x < 1$, given $y(0) = y(1) = 0$, using finite difference method dividing the interval into 4 equal parts.	BTL -4	Analyzing
2. (a)	Solve by Crank – Nicholson's method the equation $16\, U_t = U_{xx}$ $0 < x < 1$ and $t > 0$ subject to $u(x,0) = 0$, $u(0,t) = 0$ and $u(1,t) = 100\,t$. Compute one time step, taking $\Delta x = ¼$ and $\Delta t = 1$.	BTL -3	Applying
2.(b)	Solve $y_{tt} = 4y_{xx}$ subject to the condition $y(0,t) = 0$; $y(2,t) = 0$; $y(x,0) = x(2-x)$; $u_t(x,0) = 0$, Do 4 steps. Find the values up to 2 decimal accuracy.	BTL -2	Understanding
3. (a)	Solve the boundary value problem $x^2 y'' - 2y + x = 0$ subject to $y(2) = 0 = y(3)$, find y (2.25) by finite difference method.	BTL -2	Understanding
3.(b)	Solve $25\frac{\partial^2 u}{\partial x^2} = \frac{\partial^2 u}{\partial t^2}$, $\frac{\partial u}{\partial t}(x,0) = 0$ $u(0,t) = 0$, $u(5,t) = 0$ $u(x,0) = \begin{cases} 2x, & 0 \le x \le 2.5 \\ 10 - 2x, & 2.5 \le x \le 5 \end{cases}$ by the method derived above taking h =1 and for one period of vibration , (i.e. up to t =2)	BTL -3	Applying
4.	Solve the elliptic equation $U_{xx} + U_{yy} = 0$ for the following square mesh with boundary values as shown , using Liebman's iteration procedure.	BTL -3	Applying

			
5.	Solve the equation $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ subject to the initial conditions u (0 , t) = u (1 , t) = 0 , u(x ,0) = sin πx, $0 \le x \le 1$, using Crank-Nicolson method.	BTL -4	Analyzing
6.	Solve the Laplace equation $U_{xx}+ U_{yy} = 0$ for the following square mesh with the boundary values as shown in the figure below. 	BTL -2	Understanding
7.	Solve $U_{xx} + U_{yy} = 0$ over the square region of side 4, satisfying the boundary conditions (i) u (0,y) = 0, $0 \le x \le 4$, (ii) u (4,y) = 12 + y, $0 \le x \le 4$, (iii) u (x, 0) = 3x, $0 \le x \le 4$, (iv) u (x,4) = x^2, $0 \le x \le 4$, By dividing the square into 16 square meshes of side 1 and always correcting the computed values to two places of decimals, obtain the values of u at 9 interior pivotal points.	BTL -5	Evaluating
8.	Solve the equation $\nabla^2 u = -10(x^2 + y^2 + 10)$ over the square mesh with sides x = 0, y = 0 ,x = 3 and y = 3 with u = 0 on the boundary and mesh length is 1.	BTL -4	Analyzing
9.	Solve $\frac{\partial u}{\partial t} = 4\frac{\partial^2 u}{\partial x^2}$ with the boundary conditions u(0,t) = 0 , u(4,t) = 0 and the initial conditions u_t (x , 0) = 0 & u(x ,0) = x (4 –x) by taking h = 1 (for 4 times steps)	BTL -3	Applying
10.	Solve : $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$, given u (0 ,t) = 0,u(4, t) =0,u(x ,0)= x(4–x), taking h = 1 (for 4 times steps)	BTL -3	Applying
11.	Solve the Poisson equation $U_{xx} + U_{yy} = -81xy$, 0<x<1, 0<y<1 given that u(0,y)=0, u(1,y)=100, u(x,0)=0, u(x,1)=100 and h=1/3.	BTL -3	Applying
12.	Solve $\nabla^2 u = 8x^2 y^2$ Over the square x=-2, x=2, y=-2, y=2 with u=0 on the boundary and mesh length =1.	BTL -3	Applying
13.	Solve by Crank-Nicolson's method $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ For 0<x<1, t>0, u(0,t)=0, u(1,t)=0, U(x,0)=100(x-x^2). Compute u for one time step. h=1/4.	BTL -3	Applying

14.	Solve $U_{xx} + U_{yy} = 0$ in $0 \le x \le 4$, $0 \le y \le 4$ given that $u(0,y)=0$, $u(4,y) = 8+2y$, $u(x,0) = x^2/2$, $u(x,4) = x^2$ taking h=k=1. Obtain the result correct of 1 decimal.	BTL -3	Applying
15.	Solve $U_{xx} + U_{yy} = 0$ numerically for the following mesh with boundary conditions as shown below. 	BTL -3	Applying
16.	Solve by Crank – Nicholson's method the equation $U_t = U_{xx}$ $u(x,0) = \sin \pi x$ $0 \le x \le 1$, $u(0,t)=0$ and $u(1,t) = 0$ .Compute one time step , taking $h=\Delta x = \frac{1}{3}$ and $k = \Delta t = \frac{1}{36}$.	BTL -3	Applying
17.	Solve $U_{xx} + U_{yy} = 0$ numerically for the following mesh with boundary conditions as shown below. 	BTL -3	Applying
18.	Derive standard five point formula to solve Laplace equation.	BTL -2	Understanding
	PART C		
1.	Given the values of u(x, y) on the boundary of the square in figure, evaluate the function u(x,y) satisfying the Laplace equation $U_{xx} + U_{yy} = 0$ at the pivotal points of this figure by Gauss seidel method 	BTL -5	Evaluating
2.	Solve $\frac{\partial^2 u}{\partial t^2} = \frac{\partial^2 u}{\partial x^2}$ subject to the following conditions $u(0,t)=0$, $u(1,t)=0$, $t>0$ and $\frac{\partial u}{\partial t}(x,0) = 0$ $u(x,0) = \sin^3 \pi x$ for all in $0 \le x \le 1$. Taking h=1/4. Compute u for 4 time steps.	BTL -3	Applying
3.	Using Bender Schmidt formula solve : $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ given $u(0,t)=0$, $u(5,t)=0$, $u(x,0) = x^2(25 - x^2)$, assuming $\Delta x = 1$. Find the value of u upto t =5.	BTL -3	Applying
4.	Solve $U_{xx} + U_{yy} = 8x^2y^2$ in the square mesh given u= 0 on the four	BTL -3	Applying

	boundaries dividing the square into 16 sub squares of length 1 unit.		
5.	Solve by Crank – Nicholson's method the equation $U_t = U_{xx}$ $u(x, 0) = 0, 0 \leq x \leq 1$, $u(0, t) = 0$ and $u(1,t) = t$ .Compute two time steps , taking $h = \Delta x = \frac{1}{4}$ and $k = \Delta t = \frac{1}{16}$.	BTL -3	Applying