INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad -500 043

FRESHMAN ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	Numerical Methods for Partial Differential equations
Course Code	:	BCC002
Class	:	M. Tech I Semester CAD/CAM
Branch	:	Mechanical
Year	:	2017 - 2018
Course Coordinator	:	Ms. V Subba Laxmi, Associate Professor

OBJECTIVES

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited.

In line with this, Faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught through this question bank, which will enhance learners learning process.

S No	QUESTION BANK	Blooms taxonomy level	Course Outcomes
	UNIT - I PARABOLIC EQUATIONS		
	Part - A (Short Answer Questions)		
1	Define Partial differential equation.	Remember	1
2	Classify the second order partial differential equations.	Remember	1
3	Define order and degree of a partial differential equation.	Remember	1
4	State one dimensional heat flow equation.	Remember	1
5	Explain different types of methods to solve partial differential equations.	Remember	1
6	State Crank-Nicholson formula.	Remember	1
7	Explain finite difference approximation to derivatives.	Remember	1
8	Give examples of parabolic, elliptic, hyperbolic partial differential equations.	Remember	1
9	Define linear and non linear partial differential equations.	Understand	1
10	Define semilinear and quasilinear partial differential equations and give examples.	Understand	1
11	Describe the two types of physical problems.	Understand	1
12	Discuss dirichlet boundary condition, Neumann boundary condition, mixed boundary conditions.	Understand	1
13	Discuss various methods for solving partial differential equations.	Understand	2

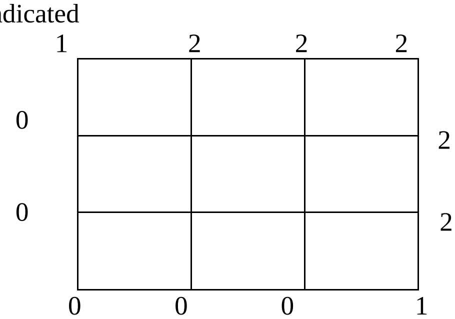
14	State Laplace equation and Poisson equation.	Understand	1
15	Discuss the procedure for implementing derivative boundary conditions.	Understand	1
16	Define finite difference equation.	Understand	1
17	Classify the partial differential equation $u_{xx} + 4u_{yy} + (x^2 + 4y^2)u_{yy} = \sin(x + y)$.	Understand	1
18	State two dimensional Laplace equation ,one dimensional wave equation, one dimensional diffusion equation.	Understand	1
19	Discuss about the significance of classification of partial differential equations.	Understand	1
20	Discuss about the characteristic paths of elliptic,parabolic,hyperbolic partial differential equations.	Understand	2
Part - B (Long Answer Questions)			
1	Explain Crank –Nicholson explicit method.	Understand	2
2	Solve by Crank-Nicholson method the equation $u_{xx} = u_t$ subject to u(x,0) = 0,u(0,t) = 0and u(1,t) = t ,for two steps.	Understand	2
3	Using Crank's –Nicholson's method solve $u_{xx} = 16u_t$,0 <x <1 ,t >0 given u(x,0) = 0,u(0,t) = 0 and u(1,t)=100t taking h = 0.25 for two steps.	Understand	2
4	Using Crank's –Nicholson method solve $u_{xx} = u_t$,0<x<1, t>0 given u(x,0) = 0,u(0,t) = 0 and u(1,t)=t taking h =0.25and k= $\frac{1}{8}$	Understand	2
5	Solve the equation $u_{xx} = 2u_t$ subject to u(x,0) = x(4-x), u(0,t) = 0 and u(4,t) = 0 taking h = 1 .Find the values upto t = 5.	Understand	2
6	Solve by Crank-Nicholson method the equation $u_{xx} = u_t$ 0 < x < 1 , t >0 subject to u(x,0) = 100(1-x), u(0,t) = 0 and u(1,t) = 0 taking h = 0.25.	Understand	2
7	Given $\frac{\partial^2 f}{\partial x^2} = \frac{\partial f}{\partial t}$ f(0,t) = f(5,t) = 0 , f(x,0) = $x^2(25 - x^2)$find f in the range taking h = 1 and upto 5 seconds	Understand	2
8	Solve $\frac{\partial^2 u}{\partial x^2} - 2\frac{\partial u}{\partial t} =$ 0 given u(0,t) = 0 , u(x,0) = x(1-x) . Assume h = 1 . Find the values of u upto t = 5.	Understand	2
9	Solve $u_{xx} = u_t$ given u(0,t) = 0 , u(4,t) = 0, u(x,0) = x(1-x) . Assume h = k = 1 find the values of u upto t = 5.	Understand	2
10	Solve $u_{xx} = u_t$ given u(0,t) = 0 , u(1,t) = 0, u(x,0) = sinπx , $0 \leq x \leq 1$ taking h = 0.2 and α = 1/2	Understand	2
Part - C (Problem Solving and Critical Thinking Questions)			
1	Solve $25u_{xx} = u_t$ 0< x < 1,t > 0 with the boundary conditions u(0,t) = 0 , u(10, t) = 0, u(x,0) = $\frac{1}{25}x(10 - x)$ choosing h = 1, k suitably find u_{ij} for i = 0,1,2.......9, j = 0,1,2,3,4	Understand	2
2	Solve $u_{xx} = u_t$, 0≤x≤1, t > 0 under condition u(0,t) = 0 , u(1,t) = 0 and	Understand	2

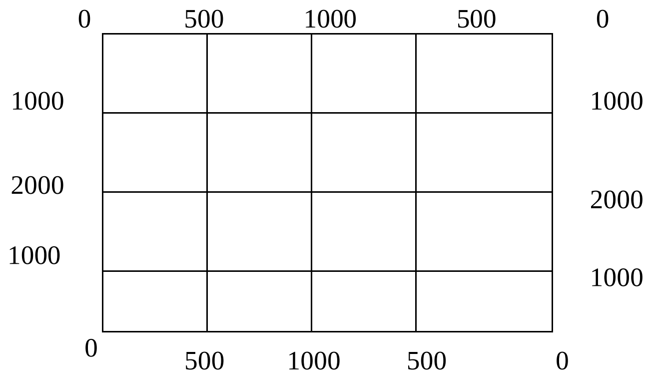
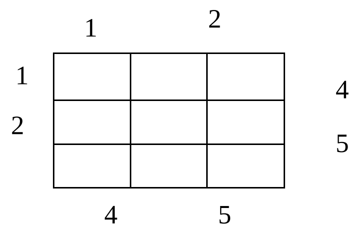
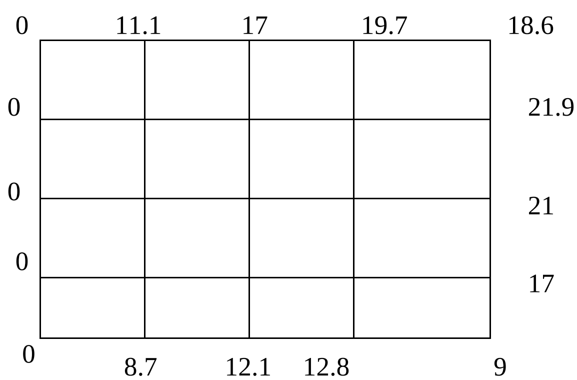
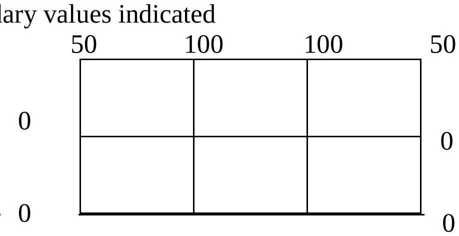
	u(x,0) = $\left\{ \begin{array}{ll} 2x \ for \ 0 \le x \le \frac{1}{2} \\ 2(1-x) \ \ for \ \frac{1}{2} \le x \le 1 \end{array} \right\}$ using Crank-Nicholson method, h =0.1, k =.01, $\lambda = 1$		
3	Using Crank's –Nicholson method solve $u_{xx} = u_t$,0<x<1, t>0 given u(x,0) = 0,u(0,t) = 0 and u(1,t)=t taking h = 0.5and k= $\frac{1}{8}$	Understand	2
4	Using Crank's –Nicholson method solve $u_{xx} = u_t$,0<x<5, t ≥ 0 given u(x,0) = 20,u(0,t) = 0 and u(5,t) = 100 compute u for time step with h = 1 .	Understand	2
5	Solve $u_{xx} = u_t$ given u(0,t) = 0 , u(1,t) = 0, u(x,0) = sinπx , 0 ≤ x ≤ 1 taking h = 1/3 and k = 1/36	Understand	2
6	Given $\frac{\partial^2 f}{\partial x^2} = \frac{\partial f}{\partial t}$ f(0,t) = f(5,t) = 0 , f(x,0) = $x^2(25 - x^2)$find f in the range taking h = 1 and upto 5 seconds	Understand	2
7	Solve $u_{xx} = 32u_t$ given u(x,0) = 0 , u(0,t) = 0 , u(1,t) = t, taking h=0.5for t > 0,0 < x < 1 .	Understand	2
8	Solve $u_{xx} = u_t$ given u(0,t) = 0 , u(5,t) = 60 and u(x,0) = $\left\{ \begin{array}{ll} 20x \ for \ 0 < x \le 3 \\ 60 \ \ for \ 3 < x \le 5 \end{array} \right\}$ for 5 time steps having h = 1 by Schmidt method.	Understand	2
9	Solve $4u_{xx} = u_t$ and the boundary conditions u(0,t) = 0 , u(8,t) = 0, u(x,0) = $4x - \frac{1}{2}x^2$ for points x = 0,1,2.......8, t = $\frac{1}{8}j$, j = 0,1,2,3,4,5	Understand	2
10	Solve $u_{xx} = 2u_t$ given 0 ≤ x≤12 ,0 ≤ t ≤ 12 u(x,0) = $\frac{1}{4}$ x(15-x) , u(0,t) = 0 , u(12,t) = 9, 0 < t < 12 using Schmidt process.	Understand	2
UNIT-II **CONVERGENCE STABILITY AND CONSISTENCY**			
Part – A (Short Answer Questions)			
1	Define tridiagonal matrix .	Remember	3
2	Explain alternating direction implicit method.	Understand	3
3	Explain finite difference in cylindrical and spherical coordinates.	Remember	3
4	Define local truncation error.	Remember	3
5	Define global rounding error.	Remember	3
6	State Lax's equation theorem.	Remember	3
7	Define four important properties of finite difference methods consistency,order, stability, convergence.	Remember	3
8	Define error , rounding-off error, truncation error.	Remember	3
9	State two methods for analysing the stability of finite difference equations.	Understand	3
10	Discuss about convergence and stability.	Understand	3

Part - B (Long Answer Questions)			
1	Explain alternate direction implicit method(ADI) method.	Understand	3
2	Explain finite difference approximation to $\frac{\partial u}{\partial t} = \nabla^2 u$ in cylindrical and spherical polar coordinates.	Understand	3
3	Discuss about convergence, stability and consistency.	Understand	3
4	Discuss stability analysis by matrix method.	Understand	3
5	Explain Von Neumann stability method.	Understand	3
6	Define local truncation error and consistency convergence analysis.	Understand	3
7	Discuss stability analysis by eigen value.	Understand	3
8	Explain global rounding error.	Understand	3
9	Demonstrate the relationship between convergence,stability and consistency giving an example.	Understand	4
10	Calculate the order of the local truncation error of the explicit difference approximation to $\frac{\partial u}{\partial t} - \frac{\partial^2 u}{\partial x^2} = 0$ at the point (ih,jk)	Understand	4
Part – C (Problem Solving and Critical Thinking)			
1	Show that the local truncation error at the point (ih,jk) of the Crank-Nicholson approximation to $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ is $O(h^2) + O(k^2)$	Understand	4
2	Solve the equation $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ satisfying the initial condition , u = 1 for $0 \le x \le 1$ when t = 0 and the boundary conditions, $\frac{\partial u}{\partial x} = u$ at x = 0 , for all t, $\frac{\partial u}{\partial x} = -u$ at x = 1, for all t , using an explicit method and employing central differences for the boundary conditions.	Understand	4
3	The equation $\frac{\partial u}{\partial t} - \frac{\partial^2 u}{\partial x^2} = 0$ is approximated at the point (ih,jk) by the difference equation $\frac{u_{i,j+1} - u_{i,j-1}}{2k} - \frac{u_{i+1,j} - 2\{\theta u_{i,j+1} + (1-\theta) u_{i,j-1}\} + u_{i-1,j}}{h^2} = 0$ find the local truncation error at this point . Discuss the consistency of this scheme with the partial differential equation when k = rh where r is a positive constant θ a variable parameter.	Understand	4
4	The equation $\frac{\partial u}{\partial t} - \frac{\partial^2 u}{\partial x^2} = 0$ is approximated at the point (ih,jk) by the difference equation $\frac{u_{i,j+1} - u_{i,j-1}}{2k} - \frac{u_{i+1,j} - 2\{\theta u_{i,j+1} + (1-\theta) u_{i,j-1}\} + u_{i-1,j}}{h^2} = 0$ find the local truncation error at this point .Discuss the consistency of this scheme with the partial differential equation when $k = rh^2$ where r is a positive constant and θ a variable parameter.	Understand	4
5	Explain necessary and sufficient condition for stability.	Understand	4
6	Explain stability criteria for derivative boundary conditions.	Understand	4

7	Investigate the stability of the linear difference equation $\frac{1}{k}(u_{p,q+1}-u_{p,q})=\frac{a}{h^2}(u_{p-1,q}-2u_{p,q}+u_{p+1,q})+bu_{p,q}$ approximating parabolic equation $\frac{\partial u}{\partial t}=a\frac{\partial^2 u}{\partial x^2}+bu$ at the point (ph,qk) where a and b are positive constant.	Understand	3
8	The equation $\frac{\partial u}{\partial t}-\frac{\partial^2 u}{\partial x^2}=0$ is approximated at the point (ih,jk) by the difference equation $\left(\frac{u_{i,j+1}-u_{i,j-1}}{2k}\right)+(1-\theta)\left(\frac{u_{i,j}-u_{i,j-1}}{k}\right)-\frac{1}{h^2}\delta_x{}^2u_{i,j}=0$ find the truncation error at this point .	Understand	3
UNIT-III HYPERBOLIC EQUATIONS			
Part - A (Short Answer Questions)			
1	Discuss the general features of hyperbolic partial differential equations.	Understand	5
2	Describe the concepts underlying Lax-Wendroff type methods.	Understand	5
3	State the explicit formula to solve the wave equation.	Understand	5
4	State first order quasi linear equation.	Understand	5
5	Give an example of hyperbolic equation.	Remember	5
6	Explain CFI condition wendroff's implicit approximation.		6
7	Explain discontinuous initial derivatives		6
8	Determine the characteristics of the equation $\frac{\partial^2 u}{\partial x^2}-\frac{\partial^2 u}{\partial x\partial y}-6\frac{\partial^2 u}{\partial y^2}=0$		6
9	Discuss about the characteristic paths of elliptic partial differential equations.		6
10	Discuss the numerical solution of hyperbolic equations by method of characteristics.		6
Part – B (Long Answer Questions)			
1	Solve $4u_{xx}=u_{tt}$ 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) taking h = 1(for 4 time steps).	Understand	6
2	Solve $25u_{xx}=u_{tt}$ for u at the pivotal points given u(0,t) = 0 , u(5,t) = 0 and $u_t(x,0)=0$ u(x,0) = $\begin{Bmatrix} 2x \;\; for\; 0\le x\le 2.5 \\ 10-2x \;\; for\; 2.5<x\le 5\end{Bmatrix}$ for one half period of vibration.	Understand	6
3	Discuss the method of numerical integration along a characteristic.	Understand	5
4	Explain Lax-Wendroff method.	Understand	5
5	Explain analytical solution of first order quasi linear equation.	Understand	5
6	Solve $25u_{xx}=u_{tt}$ for u at the pivotal points given u(0,t) = 0 , u(5,t) = 0 and	Understand	6

	$u_t(x,0)=0$ u(x,0) = $\begin{cases} 20x \ for\ 0\le x\le 1 \\ 5(5-x) \quad for\ 1\le x\le 5 \end{cases}$		
7	Find the solution of the vibrating string problem $u_{tt}=u_{xx}$, given u(x,0) = $x(1-x), u_t(x,0)=0$, u(0,t) =0 and u(1,t) = 0. Take h=k =0.1. Find the solution upto t=0.3 .	Understand	6
8	Solve $4u_{xx}=u_{tt}$ 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) taking h = 1(for 4 time steps).	Understand	6
9	A laterally insulated homogeneous bar with ends at x = 0 and x = 1 has initial temperature 0.its left end is kept at 0 whereas the temperature at the right end varies sinusoidally according to u(t,1) g(t) = sin $\frac{25}{3}\pi t$ .find the temperature u(x,t) in the bar with h = 0.2and r = 0.5(one period that is 0 $\le t\le 0.24$	Understand	6
10	Explain numerical solution of hyperbolic equations by method of characteristics.	Understand	6
Part - C (Problem Solving and Critical Thinking Questions)			
1	The function u satisfies the equation $\frac{\partial u}{\partial t}+\frac{\partial u}{\partial x}=0$, 0 < x< ∞ , t > 0 and the boundary condition u(0,t) = 2t , t > 0, and the initial conditions u(x,0) = x(x-2) , 0 ≤ x ≤ 2, u(x,0) = 2(x-2) , 2 ≤ x calculate the analytical solution.	Understand	5
2	The function u satisfies the equation $\sqrt{x}\frac{\partial u}{\partial x}+u\frac{\partial u}{\partial y}=-u^2$ and the condition u=1 on y = 0 , 0 < x < ∞ .Use a finite difference method to calculate a first approximation to the solution.	Understand	5
3	The function u satisfies the equation $x^2u\frac{\partial u}{\partial x}+e^{-y}\frac{\partial u}{\partial y}=-u^2$ and the condition u=1 on y = 0 , 0 < x < ∞ .Use a finite difference method to calculate a first approximation to the solution.	Understand	5
4	The function u satisfies the equation $\frac{\partial u}{\partial t}+\frac{\partial u}{\partial x}=0$, 0 < x< ∞ , t > 0 and the boundary condition u(0,t) = 2t , t > 0, and the initial conditions u(x,0) = x(x-2) , 0 ≤ x ≤ 2, u(x,0) = 2(x-2) , 2 ≤ x calculate the numerical solution using the explicit Lax-Wendroff equation.	Understand	5
5	Describe the concepts underlying Lax-Wendroff type methods.	Remember	5
6	Use the method of characteristics to derive a solution of the quasi linear equation $\frac{\partial^2 u}{\partial x^2}-u^2\frac{\partial^2 u}{\partial y^2}=0$ at the first characteristic grid point between x = 0.2 and 0.3 y > 0 where u satisfies the conditions u = 0.2 + 5 x^2 and	Understand	6

	$\frac{\partial u}{\partial y}$ = 3x along the initial line y = 0 , for $0 \le x \le 1$.		
7	Explain propagation of discontinuities in first order equations.	Understand	6
8	Solve $u_{tt} = u_{xx}$, given u(x,0) = $\frac{1}{2}x(4-x)$, u_t(x,0) = u(0,t) =0 and u(4,t) = 0. Take h=1.Find the solution upto 5 steps in t-direction.	Understand	6
9	Solve $u_{tt} = u_{xx}$,0 < x < 1 t > 0given u(x,0) = u_t(x,0) = u(0,t) =0 and u(1,t) = 100sinπt. Compute u for u for 4 times with h = 0.25.	Understand	6
10	Solve $u_{tt} = u_{xx}$, given u(x,0) = $10x(4-x), u_t(x,0) = 0$, u(0,t) =0 and u(1,t) = 0. Take h=k =0.1.Find the solution upto t=0.5 .	Understand	6
	UNIT-IV **ELLIPTIC EQUATIONS**		
Part - A (Short Answer Questions)			
1	Explain finite differences in polar coordinates.	Remember	7
2	Give the formulae for derivatives near a curved boundary .	Remember	7
3	Give standard five point formula.	Remember	7
4	Give diagonal five point formula	Remember	7
5	Explain discretization error.	Remember	7
6	State Laplace equation.	Remember	7
7	State Poisson's equation.	Remember	7
8	Discuss general features of elliptic partial differential equations.	Remember	7
9	Explain numerical solution of dirichlet problem.	Remember	7
10	Explain about Neumann and mixed problems.	Remember	7
Part – B (Long Answer Questions)			
1	Solve the elliptic equation at the nodal points of the following square grid using the boundary values indicated 	Understand	8
2	Solve $u_{xx} + u_{yy} = 8x^2y^2$ for the square mesh with $u(x,y) = 0$ on the 4 boundaries dividing the square into 16 subsquares and mesh length=1	Understand	8
3	Solve $u_{xx} + u_{yy} = -10(x^2 + y^2 + 10)$ over the square with sides $x = 0 = y, x = 3 = y$ and $u = 0$ on the boundary and mesh length=1	Understand	8

<table>
<tr><td>4</td><td>Solve the Laplace equation $u_{xx} + u_{yy} = 0$.
for the following square region having the boundary conditions

</td><td>Understand</td><td>8</td></tr>
<tr><td>5</td><td>Solve the elliptic partial differential equation $u_{xx} + u_{yy} = 0$ at the pivoted points of the lower square mesh to four decimals by any numerical method .

</td><td>Understand</td><td>8</td></tr>
<tr><td>6</td><td>Solve the Laplace equation $u_{xx} + u_{yy} = 0$.
for the following square region having the boundary conditions

</td><td>Understand</td><td>8</td></tr>
<tr><td>7</td><td>Summarize the analysis of the discretization error of the five point difference approximation to Poisson's equation over a rectangle.</td><td>Understand</td><td>8</td></tr>
<tr><td>8</td><td>Solve the elliptic equation $\nabla^2 u = 0$ at the nodal points of the following square grid using the boundary values indicated

</td><td>Understand</td><td>8</td></tr>
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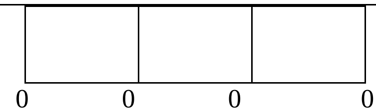
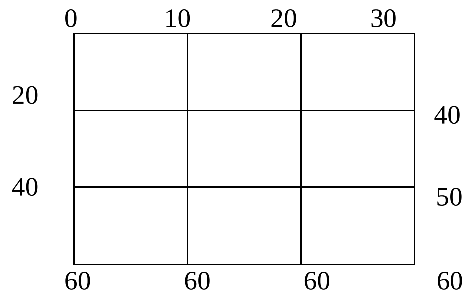
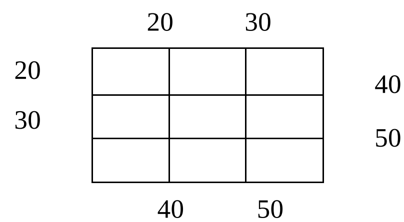
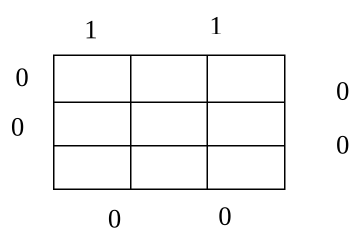
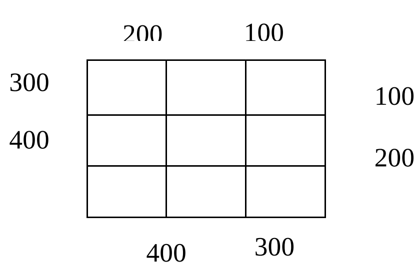
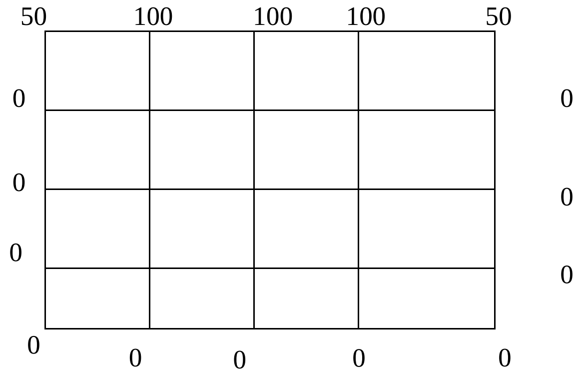
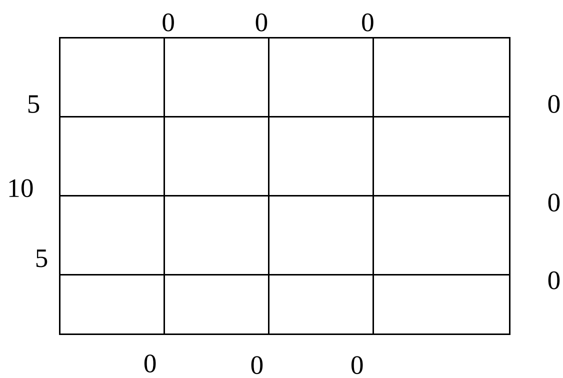
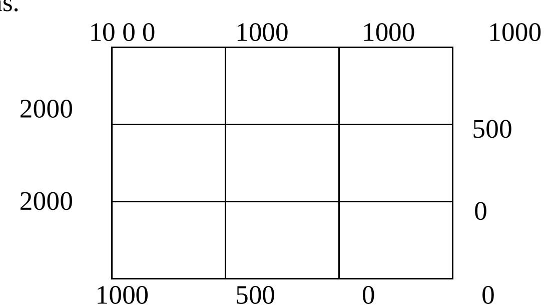
			
9	Solve $\nabla^2 u = 0$ at the nodal points of the following square region given the boundary conditions. 	Understand	8
10	Solve $\nabla^2 u = 0$ for the square region with the given boundary conditions . 	Understand	8
Part - C (Problem Solving and Critical Thinking Questions)			
1	Solve $\nabla^2 u$ = 0 over the square mesh of side 4 units satisfying the following boundary conditions (i) u(0,y) = 0 for $0 \le y \le 4$ (ii) u(4,y) = 12 + y for $0 \le y \le 4$ (iii) u(x,0) = 3x for $0 \le x \le 4$ (iv) u(x , 4) = x^2 for $0 \le x \le 4$	Understand	8
2	Solve the elliptic partial differential equation $u_{xx} + u_{yy} = 0$ in the following square region with the boundary conditions as shown in the figure 	Understand	8
3	Solve the elliptic partial differential equation $u_{xx} + u_{yy} = 0$ in the following square region with the boundary conditions as shown in the figure 	Understand	8

4	Solve the Laplace equation $u_{xx} + u_{yy} = 0$. for the following square region with given boundary conditions .  	Understand	8
5	Explain about finite differences in polar coordinates.	Understand	8
6	Discuss about the formulae for derivatives near a curved boundary .	Understand	8
7	Explain analysis of the discretization error of the five point approximation to Poissons equation.	Understand	8
8	Solve $\nabla^2 u = 0$ in the square region bounded by x=0 ,x = 4, y = 0,y = 4 and with the boundary conditions u(0,y) = 0 u(4,y) = 8 +2y , u(x,0) = $\frac{1}{2}x^2$ and u(x,4)= x^2 taking h = k = 1	Understand	8
9	Solve the Laplace equation $u_{xx} + u_{yy} = 0$. for the following square region having the boundary conditions  	Understand	8
10	Solve $\nabla^2 u = 0$ at the nodal points of the following square region given the boundary conditions.  	Understand	8

UNIT – V **SYSTEMATIC ITERATIVE METHODS**			
Part - A (Short Answer Questions)			
1	Explain Gauss Siedel iteration method for solving a system of linear algebraic equations.	Understand	9
2	Explain Jacobi iteration method for solving a system of linear algebraic equations.	Understand	9
3	Define the term residual.	Understand	9
4	Explain Successive- Over – Relaxation method.	Understand	9
5	Explain ill –conditioned and well conditioned problem.	Understand	9
6	State necessary and sufficient condition for the convergence of iterative methods.	Understand	9
7	Explain Stone's implicit method.	Understand	9
8	Explain Galerkin's method.	Understand	10
9	Explain finite element method.	Understand	10
10	Define sparse matrix.	Understand	10
Part – B (Long Answer Questions)			
1	Solve the boundary value problem $y'' + 2 = 0, 0 < x < 1, y(0) = y(1) = 0$ by method.	Understand	10
2	Solve the boundary value problem $y'' - y + x = 0, 0 < x < 1, y(0) = 0, y(1) = 1$ by Galerkin method.	Understand	10
3	Solve the boundary value problem $y'' + y = -2x, 0 < x < 1, y(0) = y(1) = 0$ by Galerkin method .	Understand	10
4	Solve the boundary value problem $y'' + y + 2x(1-x) = 0, 0 < x < 1, y(0) = y(1) = 0$ By Galerkin method.	Understand	10
5	Solve the system 8x + y + z + w = 14, 2x+10y+3z+w = -8, x-2y-20z+3w=111,3x+2y+2z+19w = 53 by Gauss Siedel iteration method.	Understand	9
6	The function ϕ satisfies the equation $\frac{\partial^2\phi}{\partial x^2} + \frac{\partial^2\phi}{\partial y^2} + 2 = 0$ at every point inside the square bounded by the straight lines x = ± 1 , y = ± 1 and is zero on the boundary . Calculate a finite difference solution using a square mesh of side $\frac{1}{2}$.	Understand	9
7	Solve the system of equations $\begin{array}{l} x_1 - 0.25x_2 - 0.25x_3 = 50 \\ -0.25x_1 + x_2 \quad - 0.25x_4 = 50 \\ -0.25x_1 + \quad x_3 \quad - 0.25x_4 = 25 \\ -0.25x_2 - 0.25x_3 \quad + x_4 = 25 \end{array}$	Understand	9
8	Solve the following system of equations using Gauss- Siedel iteration method $x_1 + 9x_2 - 2x_3 = 36, 2x_1 - x_2 + 8x_3 = 121, 6x_1 + x_2 + x_3 = 107$	Understand	9
9	Solve the following system of equations using Jacobi iteration method $4x_1 + 5x_3 = 12.5, x_1 + 6x_2 + 2x_3 = 18.5, 8x_1 + 2x_2 + x_3 = -11.5$	Understand	9
10	Solve by Gauss Jacobi method the equations 10x-2y-3z = 205; -2x+10y-2z =154; -2x-y+10z = 120.	Understand	9

Part - C (Problem Solving and Critical Thinking Questions)			
1	Solve by Gauss siedel iteration method the equations $9x-2y + z = 50$; $x + 5y - 3z = 18$; $-2x + 2y +7z = 19$.	Understand	9
2	Solve the Laplace equation inside the square region bounded by the lines x=0,x=4, y=0and y=4 given that u = x^2y^2 on the boundary by using relaxation method.	Understand	9
3	Explain weighted residual method.	Understand	10
4	Discuss variational methods.		
5	Solve the system $8x + y + z + w = 14$, $2x +10y +3z +w = -8$, $x- 2y – 20 z+ 3w=111$, $3x+ 2y +2z+ 19w = 53$ by relaxation method.	Understand	10
6	Solve by Relaxation method the system $9x-y+2z = 9$; $x +10y-2z = 15$; $2x-2y-13z = -17$.	Understand	9
7	Solve by Relaxation method the system $10x+2y -w = 11$; $- x +20y+2z = 49.5$; $-x+10z-w = 27.5$; $-y + 2z +20w = 92.4$.	Understand	9
8	Solve $7.6x -2.4y + 1.3z = 20.396$; $3.7x+7.9y- 2.5z = 35.866$, $1.9x-4.3y+8.2z=32.514$ by Gauss- Jacobi method.	Understand	9
9	Solve the laplace equation inside the square region bounded by the lines x = 0 , x = 4 , y = 0, y = 4 given that u = x^2y^2 on the boundary by using relaxation method.	Understand	9
10	Explain Galerkin's method.	Understand	9

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