SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

S.R.M. Nagar, Kattankulathur - 603203

DEPARTMENT OF MATHEMATICS

QUESTION BANK

IV SEMESTER

B.E- MECHANICAL ENGINEERING

MA3425–Applied Mathematics for Mechanical Engineering

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Prepared by

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DEPARTMENT OF MATHEMATICS

S.No	QUESTIONS	BT Level	Competence	COs
UNIT I-ORDINARY DIFFERENTIAL EQUATIONS **Higher order linear differential equations with constant coefficients – Method of variation of Parameters.**				
Part - A (2 MARK QUESTIONS)				
1.	Solve$(D^2+5D+6)y=0$.	BTL-2	Understanding	CO1
2.	Solve$(D^2+7D+12)y=0$.	BTL-2	Understanding	CO1
3.	Solve $(D^2+3D+2)y = 0$.	BTL-2	Understanding	CO1
4.	Solve$(D-1)^2y=0$.	BTL-2	Understanding	CO1
5.	Find the complementary function of $y''-4y'+4y=0$.	BTL-1	Remembering	CO1
6.	Find the solution $(D^2+2D+1)y = 0$.	BTL-2	Understanding	CO1
7.	Solve$(D^2+1)y=0$.	BTL-2	Understanding	CO1
8.	Solve $(D^2+a^2)y=0$.	BTL-2	Understanding	CO1
9.	Solve $(D^4+D^3+D^2)y=0$.	BTL-2	Understanding	CO1
10.	Solve$(D^4-1)y=0$.	BTL-2	Understanding	CO1
11.	Find the complementary function of$(D^2+4)y=sin2x$.	BTL-1	Remembering	CO1
12.	Estimate the P.I of $(D^3+3\,D^2+3D+1)y=e^{-x}$.	BTL-1	Remembering	CO1
13.	Solve $(D^3-6D^2+11D-6)y = 0$.	BTL-1	Remembering	CO1
14.	Find the particular Integral for$(D^2-2D+1)y=2e^x$.	BTL-2	Understanding	CO1
15.	Estimate the P.I of $(D^2-4D+4)y=e^{2x}$.	BTL-1	Remembering	CO1
16.	Find the P.I of $(D^2+4D+5)y=e^{-2x}$.	BTL-1	Remembering	CO1
17.	Estimate the P.I of$(D^2+5D+4)y=sin2x$.	BTL-2	Understanding	CO1
18.	Find the P.I of$(D^2+1)y=cos2x$.	BTL-1	Remembering	CO1
19.	Find the P.I of$(D^2+2)y=x^2$.	BTL-1	Remembering	CO1
20.	Find the P.I. of $(D-a)^2y=e^{ax}\,sinx$.	BTL-1	Remembering	CO1
21.	Describe method of variation of parameter.	BTL-1	Remembering	CO1
22.	Write the Wronskian in method of variation of parameter.	BTL-1	Remembering	CO1
23.	Write the value of P in finding particular integral in solving ODE using method of variation of parameter.	BTL-1	Remembering	CO1
24.	Write the value of Q in finding particular integral in solving ODE using method of variation of parameter.	BTL-1	Remembering	CO1
25.	Write the formula for finding particular integral in solving ODE using method of variation of parameter.	BTL-1	Remembering	CO1
PART – B (16 MARK QUESTIONS)				
1.(a)	Analyze the solution of $(D^3-6D^2+11D-6)y=e^{-2x}+e^{-3x}$.	BTL-4	Analyzing	CO1
1.(b)	Analyze the solution of $(D^2+2D+2)y=e^{-2x}+cos2x$.	BTL-4	Analyzing	
2.(a)	Analyze the solution of $(D^3-1)y=e^{2x}$.	BTL-4	Analyzing	CO1
2.(b)	Analyze the solution of$(D^2+4)\,y\ =cos2x$+sin3x.	BTL-4	Analyzing	
3.(a)	Analyze the solution of $(2D^3-D^2+4D-2)y=e^x$.	BTL-4	Analyzing	CO1
3.(b)	Analyze the solution of $(D^2+3D+2)y=sin3x$.	BTL-4	Analyzing	
4.(a)	Analyze the solution of $(4D^2+4D-3)y=e^{2x}$.	BTL-4	Analyzing	CO1

4.(b)	Analyze the solution of $(D^2+4)y = sin3x + \cos 2x$.	BTL-4	Analyzing	CO1
5.(a)	Analyze the solution of $(D^2+1)y = sinx\ \sin 2x$.	BTL-4	Analyzing	CO1
5.(b)	Analyze the solution of $(D^2-6D+9)y = 2x^2 - x + 3$.	BTL-4	Analyzing	
6.(a)	Analyze the solution of $(D^2-2D+5)y = e^x\ cos2x$.	BTL-4	Analyzing	CO1
6.(b)	Analyze the solution of $(D^2-4D+4)y = e^{-4x} + 5cos3x$.	BTL-4	Analyzing	CO1
7.(a)	Analyze the solution of $(D^2+5D+4)y = 4e^{-x} + x$.	BTL-4	Analyzing	CO1
7.(b)	Analyze the solution of $(D^2+4D+3)y = e^{-x}sinx$.	BTL-4	Analyzing	
8.(a)	Analyze the solution of $(D^2+2D+1)y = e^{-x}x^2$.	BTL-4	Analyzing	CO1
8.(b)	Analyze the solution of $(D^2+4)y = x^2 \cos 2x$.	BTL-4	Analyzing	CO1
9.(a)	Analyze the solution of $(D^2+4D-12)y = (x-1)e^{2x}$.	BTL-4	Analyzing	CO1
9.(b)	Analyze the solution of $(D^2+1)y = xcosx$.	BTL-4	Analyzing	
10.	Apply method of variation of parameters to solve $y" + y = tanx$.	BTL-3	Applying	CO1
11.	Apply method of variation of parameters to solve $(D^2+a^2)y = tanax$.	BTL-3	Applying	CO1
12.	Apply method of variation of parameters to solve $y" + y = cotx$.	BTL-3	Applying	CO1
13.	Apply method of variation of parameters to solve $(D^2+a^2)y = secax$.	BTL-3	Applying	CO1
14.	Using the method of variation of parameter solve $(D^2-6D+9)\ y = \frac{e^{3x}}{x^2}$.	BTL-3	Applying	CO1
15.	Using the method of variation of parameter solve $(D^2+2D+1)y = \frac{e^{-x}}{x^2}$.	BTL-3	Applying	CO1
16.	Solve the differential equation $y" - 2y' + 2y = e^x tanx$ by method of variation of parameters.	BTL-3	Applying	CO1
17.	Apply method of variation of parameters to solve $(D^2+a^2)y = cosecax$.	BTL-3	Applying	CO1
18.	Apply method of variation of parameters to solve $(D^2+1)y = secx$.	BTL-3	Applying	CO1

UNIT II APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS – ONE DIMENSIONAL WAVE EQUATIONS

Classification of PDE – Solutions of one dimensional wave equation.

PART-A(2 MARK QUESTIONS)

1.	Classify the PDE $u_{xx} + u_{xy} + u_{yy} = 0$	BTL -1	Remembering	CO2
2.	Classify the PDE $Z_{xx} + 2Z_{xy} + (1-y^2)Z_{yy} + xZ_x + 3x^2yz - 2Z = 0$	BTL -1	Remembering	CO2
3.	Classify the PDE $u_{xx} + u_{xy} = f(x,y)$.	BTL -1	Remembering	CO2
4.	Classify the PDE $(1-x^2)z_{xx} - 2xyz_{xy} + (1-y^2)z_{yy} + xy^2z_y - 2z = 0$.	BTL -1	Remembering	CO2
5.	Classify the PDE $u_{xx} = u_{yy}$	BTL -2	Understanding	CO2
6	Classify the PDE $u_{xy} = u_x u_y + xy$	BTL -2	Understanding	CO2
7.	Classify the PDE $4u_{xx} + 4u_{xy} + u_{yy} - 6u_x - 8u_y = 0$	BTL -2	Understanding	CO2
8	Classify the PDE $u_{xx} - y^4 u_{yy} = 2y^3 u_y$	BTL -2	Understanding	CO2
9.	State the assumptions in deriving the one-dimensional heat equation	BTL -2	Understanding	CO2
10	Write down the governing equation of one dimensional wave equation.	BTL -2	Understanding	CO2
11.	What are the various solutions of one-dimensional wave equation	BTL -2	Understanding	CO2
12.	What is the suitable solution for one dimensional wave equation	BTL -1	Remembering	CO2

13.	In the wave equation $\frac{\partial^2 y}{\partial t^2} = C^2 \frac{\partial^2 y}{\partial x^2}$ what does C^2 stand for?	BTL -2	Understanding	CO2
14.	Write the boundary conditions and initial conditions for solving the vibration of string equation , if the string is subjected to initial displacement f(x) and initial velocity g(x)	BTL -2	Understanding	CO2
15.	Write the initial conditions of the wave equation if the string has an initial displacement but no initial velocity.	BTL -2	Understanding	CO2
16.	Write down the initial conditions when a taut string of length $2l$ is fastened on both ends. The midpoint of the string is taken to a height b and released from the rest in that position	BTL -1	Remembering	CO2
17.	A slightly stretched string of length l has its ends fastened at $x = 0$ and $x = l$ is initially in a position given by $y(x,0) = y_0 sin^3 \frac{\pi x}{l}$.If it is released from rest from this position, write the boundary conditions	BTL -2	Understanding	CO2
18.	A tightly stretched string with end points $x = 0$ & $x = l$ is initially at rest in equilibrium position. If it is set vibrating giving each point velocity $\lambda x(l - x)$. Write the initial and boundary conditions	BTL -2	Understanding	CO2
19.	If the ends of a string of length l are fixed at both sides. The midpoint of the string is displaced transversely through a height h and the string is released from rest, state the initial and boundary conditions	BTL -2	Understanding	CO2
20.	A stretched string of length 10 cm is fastened at both ends. The mid-point of the string is taken to a height 5 cm and then released from rest in that position. Write the governing equations with boundary conditions that satisfies to the wave generated.	BTL -2	Understanding	CO2
21.	A tightly stretched string with fixed end points $x = 0$ and $x = l$ is initially in a position given by $y(x,0) = 3x\,(l - x)$. If it is released from this position, write the initial and boundary conditions.	BTL -2	Understanding	CO2
22.	A taut string of length 20 cm fastened at both ends, is disturbed from its position of equilibrium by imparting to each of its points an initial velocity of magnitude $kx(\,20 - x)$ for $0 < x < 20$. Formulate the problem mathematically	BTL -2	Understanding	CO2
23.	A taut string of length 50 cm fastened at both ends, is disturbed from its position of equilibrium by imparting to each of its points an initial velocity of magnitude $kx$for $0 < x < 50$. Formulate the problem mathematically	BTL -1	Remembering	CO2
24.	A tightly stretched string with fixed end points x=0 and x = 50 is initially at rest in its equilibrium position. If it is set to vibrate by giving each point a velocity $v = v_0 sin^3 \frac{\pi x}{l}$. Write the initial and boundary conditions	BTL -2	Understanding	CO2
25.	A tightly stretched string with fixed end points x=0 and x = 50 is initially at rest in its equilibrium position. If it is set to vibrate by giving each point a velocity $v = v_0 sin \frac{\pi x}{50} cos \frac{2\pi x}{50}$. Write the initial and boundary conditions	BTL -1	Remembering	CO2
PART B (16 Mark Questions)				
1.	A string is stretched and fastened to two points that are distinct string l apart. Motion is started by displacing the string into the form $y = k(lx - x^2)$from which it is released at time $t = 0$. Obtain the displacement of any point on the string at a distance of x from one end at time t.	**BTL-3**	**Applying**	CO2

2.	A slightly stretched string of length l has its ends fastened at $x = 0$ and $x = l$ is initially in a position given by $y(x,0) = y_0 sin^3 \frac{\pi x}{l}$. If it is released from rest from this position, Determine the displacement y at any distance x from one end and at any time.	**BTL-3**	**Applying**	CO2
3.	A tightly stretched string with fixed end points $x = 0$ and $x = l$ is initially at rest in its equilibrium position. If it is set vibrating string giving each point a velocity $3x(l - x)$. Determine the displacement of the string.	**BTL-3**	**Applying**	CO2
4.	A uniform string is stretched and fastened to two points l apart motion is started by displacing the string into the form of curve $y = asin\frac{\pi x}{l}$ at time t = 0 .Derive the expression for the displacement of any point of the string at a distance x from one end at time	**BTL-3**	**Applying**	CO2
5.	A tightly stretched string of length $2l$ is fastened at both ends. The Midpoint of the string is displaced by a distance b transversely and the string is released from rest in this position. Derive an expression for the transverse displacement of the string at any time during the subsequent motion.	**BTL-3**	**Applying**	CO2
6.	A string is tightly stretched between $x = 0$ and $x = 20$ is fastened at both ends. The midpoint of the string is taken to be a height and then released from rest in that position. Deduce the displacement of any point of the string x at any time t.	**BTL-3**	**Applying**	CO2
7.	The points of trisection of a tightly stretched string of length 30 cm with fixed ends pulled aside through a distance of 1 cm on opposite sides of the position of equilibrium and the string is released from rest. Analyze expression for the displacement of the string at any subsequent time. Show also that the midpoint of the string remains always at rest.	**BTL-4**	**Analyzing**	CO2
8.	A uniform elastic string of length 60 cms is subjected to a constant tension of 2 kg. If the ends are fixed and the initial displacement $y\ (x, 0), 0 = 60x - x^2, 0 < x < 60$, while the initial is zero, Analyze the displacement function $y(x,t)$	**BTL-4**	**Analyzing**	CO2
9.	A uniform string of density ρ stretched to the tension $\rho\alpha^2$ executes small transverse vibration in a plane through the undisturbed line of the string. The ends $x = 0$ and $x = l$ are fixed. One end is taken at the origin and at a distance b from this end the string is displaced a distance d transversely and is released from rest from this position. Obtain the equation of the subsequent motion by applying Fourier series	**BTL-3**	**Applying**	CO2
10.	A tightly stretched string of length l is initially at rest in this equilibrium position and each of its points is given the velocity $v_0 \sin^3 \frac{\pi x}{l}$. Analyze the displacement $y(x,t)$.	**BTL-4**	**Analyzing**	CO2
11.	A tightly stretched string with fixed end points x=0 and x=l is initially at rest in its equilibrium position. If it is set vibrating giving each point a velocity $v = \begin{cases} \frac{2kx}{l} & in\ (0, l/2) \\ \frac{2k(l-x)}{l} & in\ (l/2, l) \end{cases}$, Derive the displacement of a string at any distance x from one end at any time t.	**BTL-4**	**Analyzing**	CO2
12.	A tightly stretched string of length l with fixed end points initially at rest in its equilibrium position. If it is set vibrating by giving each point a velocity $y_t(x,0) = v_0 sin\left(\frac{3\pi x}{l}\right) cos\left(\frac{\pi x}{l}\right)$ where 0 < x < l. Deduce the	**BTL-4**	**Analyzing**	CO2

	displacement of the string at a point at a distance x from one end at any instant t.			
13.	A tightly stretched string with fixed end points x=0 and x = 50 is initially at rest in its equilibrium position. If it is set to vibrate by giving each point a velocity $v = v_0 sin\frac{\pi x}{50} cos\frac{2\pi x}{50}$. Analyze the displacement of the string at a point at a distance x from one end at any instant t.	**BTL-4**	**Analyzing**	CO2
14.	A taut string of length $2l$, fastened at both ends, is disturbed from its position of equilibrium by imparting to each points an initial velocity of magnitude $k(2lx - x^2)$. Find the displacement function $y(x,t)$ by applying Fourier series	**BTL-3**	**Applying**	CO2
15.	A string is stretched between two fixed points at a distance of 60 cm and the points of the string are given initial velocities v, where $v = \begin{cases} \frac{\lambda x}{30}, & in\ 0 < x < 30 \\ \frac{\lambda}{30}(60 - x), in\ 30 < x < 60 \end{cases}$, X being a distance from an end point. Analyze the displacement of the string at any time.	**BTL-4**	**Analyzing**	CO2
16.	A tightly stretched string with fixed end points x = 0 and x = l is infinitely at rest in the equilibrium position. If it is set vibrating by giving each of its position a velocity $y = \lambda(lx - x^2)$, Obtain $y(x,t)$ by applying Fourier series	**BTL-3**	**Applying**	CO2
17.	Solve the problem of vibrating string for the following boundary conditions$(i) y(0,t) = 0, (ii) y(l,t) = 0, (iii) \frac{\partial y}{\partial t}(x,0) = v_0 sin\frac{\pi x}{l}$ $(iv) y(x,0) = y_0 sin\frac{2\pi x}{l}$	**BTL-3**	**Applying**	CO2
18.	A string is stretched and fastened to two points l apart. Motion is started by displacing the string into the form of the curve $y = x(l - x)$ and also by imparting a constant velocity k to every point of the string in this position at time t = 0. Analyze the displacement function $y(x,t)$	**BTL-4**	**Analyzing**	CO2
UNIT III - APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS – ONE DIMENSIONAL HEAT EQUATIONS **One dimensional equation of heat conduction – zero to zero – Nonzero to zero – Nonzero to nonzero boundary conditions.**				
PART-A(2 Mark Questions)				
1.	In one dimensional heat equation $\frac{\partial u}{\partial t} = C^2 \frac{\partial^2 u}{\partial x^2}$, what does C^2 stand for?	BTL -2	Understanding	CO3
2.	State the assumptions in deriving the one-dimensional heat equation.	BTL -1	Remembering	CO3
3.	What are the possible solutions of one-dimensional heat flow equation?	BTL -1	Remembering	CO3
4.	Write down the governing equation of one-dimensional steady state heat equation.	BTL -1	Remembering	CO3
5.	The ends A and B of a rod of length 20 cm long have their temperature kept 30^0 C and 80^0 C until steady state prevails. Find the steady state temperature on the rod.	BTL -2	Understanding	CO3
6.	An insulated rod of length 60 cm has its ends at A and B maintained at 20^0C and 80^0 C respectively. Find the steady state solution of the rod.	BTL -2	Understanding	CO3
7.	An insulated rod of length l cm has its ends at A and B maintained at 30^0C and 80^0 C respectively. Find the steady state solution of the rod.	BTL -2	Understanding	CO3

8	How many boundary conditions are required to solve $\frac{\partial u}{\partial t} = C^2 \frac{\partial^2 u}{\partial x^2}$?	BTL -1	Remembering	CO3
9.	State Fourier law of heat conduction.	BTL -1	Remembering	CO3
10.	Explain the initial and boundary value problems.	BTL -2	Understanding	CO3
11.	An insulated rod of length 50 cm has its ends at A and B maintained at 20^0C and 70^0 C respectively. Find the steady state solution of the rod.	BTL -2	Understanding	CO3
12.	The ends A and B of a rod of length 10 cm long have their temperature kept 50^0 C and 100^0 C until steady state prevails. Find the steady state temperature on the rod.	BTL -2	Understanding	CO3
13.	An insulated rod of length 30 cm has its ends at A and B maintained at 40^0C and 90^0 C respectively. Find the steady state solution of the rod.	BTL -2	Understanding	CO3
14.	An insulated rod of length l cm has its ends at A and B maintained at 60^0C and 180^0 C respectively. Find the steady state solution of the rod.	BTL -2	Understanding	CO3
15.	Explain steady state and unsteady state differential equations.	BTL -2	Understanding	CO3
16.	Write the solution in respect of one-dimensional heat conduction problem in steady state.	BTL -1	Remembering	CO3
17.	A bar 20 cm long with insulated sides has its ends A and B maintained at temperature 20^0C and 40^0C respectively until steady state conditions prevail. Find the steady state temperature of the rod.	BTL -2	Understanding	CO3
18.	A rod 30 cm long has its ends A and B kept at 20^0 and 80^0 respectively until steady state conditions prevail. The temperature at each end is then suddenly reduced to 0^0C and kept so. Write down the boundary and initial conditions?	BTL -2	Understanding	CO3
19.	Two ends A and B of a rod of length 20cm have the temperatures at 30^0C and 80^0C respectively until steady state conditions prevail. Then the temperatures at the ends A and B are changed to 40^0C and 60^0C respectively. Write down the boundary and initial conditions?	BTL -2	Understanding	CO3
20.	A rod of length $'l'$ has its ends A and B kept at 0^0C and 120^0C respectively until steady state conditions prevail. If the temperature at B is reduced to 0^0C and kept so while that of A is maintained. Write down the boundary and initial conditions?	BTL -1	Remembering	CO3
21.	A bar 10 cm long with insulated sides has its ends A and B maintained at temperature 50^0C and 100^0C respectively until steady state conditions prevail. The temperature at A is suddenly raised to 90^0C and at the same time lowered to 60^0C at B. Write down the boundary and initial conditions?	BTL -2	Understanding	CO3
22.	Two ends A and B of a rod of length 30cm have the temperatures at 25^0C and 85^0C respectively until steady state conditions prevail. Then the temperatures at the ends A and B are changed to 30^0C and 70^0C respectively. Write down the boundary and initial conditions?	BTL -1	Remembering	CO3
23.	A rod of length 50 cm has its ends A and B kept at 35^0C and 55^0C respectively until steady state conditions prevail. If the temperature at B is reduced to 0^0C and kept so while that of A is maintained. Write down the boundary and initial conditions?	BTL -2	Understanding	CO3
24.	Two ends A and B of a rod of length 100cm have the temperatures at 250^0C and 500^0C respectively until steady state conditions prevail. Then the temperatures at the ends A and B are changed to 300^0C and 450^0C respectively. Write down the boundary and initial conditions?	BTL -1	Remembering	CO3
25.	The ends A and B of a rod 20 cm long have the temperature at 30^0C and 90^0C respectively until steady state conditions prevail. If the temperature at B is reduced to 0^0C and kept so while that of A is maintained. Write down the boundary and initial conditions?	BTL -2	Understanding	CO3

PART-B (16 Marks Questions)				
1.	The initial temperature in a bar with ends $x = 0$ and $x = \pi$ is $u = \sin x$. If the lateral surface is insulated and the ends are held at zero temperature, find the temperature $u(x,t)$.	BTL -3	Applying	CO3
2.	Solve $\frac{\partial u}{\partial t} = C^2 \frac{\partial^2 u}{\partial x^2}$ subject to the conditions (i) u(0,t)=0 for all $t \geq 0$ (ii) $u(\pi, t) = 0\ for\ all\ t \geq 0$ (iii) $u(x,0) = \begin{cases} x, & 0 < x \leq \frac{\pi}{2} \\ \pi - x, & \frac{\pi}{2} < x \leq \pi \end{cases}\ for\ all\ x \geq 0$	BTL -4	Analyzing	CO3
3.	Solve $\frac{\partial u}{\partial t} = C^2 \frac{\partial^2 u}{\partial x^2}$ subject to the conditions (i) u(0,t)=0 for all $t \geq 0$ (ii) $u(l, t) = 0\ for\ all\ t \geq 0$ (iii) $u(x,0) = kx(l - x)\ for\ all\ x \geq 0$	BTL -3	Applying	CO3
4.	Solve $\frac{\partial u}{\partial t} = C^2 \frac{\partial^2 u}{\partial x^2}$ subject to the conditions (i) u(0,t)=0 for all $t \geq 0$ (ii) $u(l, t) = 0\ for\ all\ t \geq 0$ (iii) $u(x,0) = \begin{cases} x, & 0 < x \leq \frac{l}{2} \\ l - x, & \frac{l}{2} < x \leq l \end{cases}\ for\ all\ x \geq 0$	BTL -4	Analyzing	CO3
5.	Solve $\frac{\partial u}{\partial t} = C^2 \frac{\partial^2 u}{\partial x^2}$ subject to the conditions (i) u(0,t)=0 for all $t \geq 0$ (ii) $u(l, t) = 0\ for\ all\ t \geq 0$ (iii) $u(x,0) = 3\ sin\frac{\pi x}{l}\ for\ all\ x \geq 0$	BTL -3	Applying	CO3
6.	Solve $\frac{\partial u}{\partial t} = C^2 \frac{\partial^2 u}{\partial x^2}$ subject to the conditions (i) u(0,t)=0 for all $t \geq 0$ (ii) $u(l, t) = 0\ for\ all\ t \geq 0$ (iii) $u(x,0) = 5\ sin\frac{n\pi x}{l}\ for\ all\ x \geq 0$	BTL -4	Analyzing	CO3
7.	A rod 30 cm long has its ends A and B kept at 20^0 and 80^0 respectively until steady state conditions prevail. The temperature at each end is then suddenly reduced to 0^0C and kept so. Find the resulting temperature function u(x, t) taking x = 0 at A.	BTL -3	Applying	CO3
8.	A rod of length $'l'$ has its ends A and B kept at 0^0C and 120^0C respectively until steady state conditions prevail. If the temperature at B is reduced to 0^0C and kept so while that of A is maintained, find the temperature distribution of the rod.	BTL -4	Analyzing	CO3
9.	The ends A and B of a rod 20 cm long have the temperature at 30^0C and 90^0C respectively until steady state conditions prevail. If the temperature at B is reduced to 0^0C and kept so while that of A is maintained, find the temperature distribution of the rod at any subsequent time.	BTL -4	Analyzing	CO3
10.	The ends A and B of a rod 50 cm long have the temperature at 0^0C and 100^0C respectively until steady state conditions prevail. If the temperature at B is reduced to 0^0C and kept so while that of A is maintained, find the temperature distribution of the rod at any subsequent time.	BTL -4	Analyzing	CO3
11.	A rod of length $'l'$ has its ends A and B kept at 0^0C and 250^0C respectively until steady state conditions prevail. If the temperature at B	BTL -4	Analyzing	CO3

	is reduced to 0^0C and kept so while that of A is maintained, find the temperature distribution of the rod.			
12.	A rod of length $'l'$ has its ends A and B kept at 60^0C and 180^0C respectively until steady state conditions prevail. If the temperature at B is reduced to 0^0C and kept so while that of A is maintained, find the temperature distribution of the rod.	BTL-4	Analyzing	CO3
13.	A bar 10 cm long with insulated sides has its ends A and B maintained at temperature 50^0C and 100^0C respectively until steady state conditions prevail. The temperature at A is suddenly raised to 90^0C and at the same time lowered to 60^0C at B. Find the temperature distributed in the bar at time t.	BTL -3	Applying	CO3
14.	Two ends A and B of a rod of length 20cm have the temperatures at 30^0C and 80^0C respectively until steady state conditions prevail. Then the temperatures at the ends A and B are changed to 40^0C and 60^0C respectively. Find the temperature distribution of the rod at any time t.	BTL-3	Applying	CO3
15.	A bar 20 cm long with insulated sides has its ends A and B maintained at temperature 20^0C and 40^0C respectively until steady state conditions prevail. The temperature at A is suddenly raised to 50^0C and at the same time lowered to 10^0C at B. Find the temperature distributed in the bar at time t.	BTL-4	Analyzing	CO3
16.	Two ends A and B of a rod of length 50cm have the temperatures at 0^0C and 100^0C respectively until steady state conditions prevail. Then the temperatures at the ends A and B are changed to 30^0C and 75^0C respectively. Find the temperature distribution of the rod at any time t.	BTL -3	Applying	CO3
17.	A bar 50 cm long with insulated sides has its ends A and B maintained at temperature 10^0C and 90^0C respectively until steady state conditions prevail. The temperature at A is suddenly raised to 30^0C and at the same time lowered to 80^0C at B. Find the temperature distributed in the bar at time t.	BTL-4	Analyzing	CO3
18.	Two ends A and B of a rod of length 30cm have the temperatures at 25^0C and 85^0C respectively until steady state conditions prevail. Then the temperatures at the ends A and B are changed to 30^0C and 70^0C respectively. Find the temperature distribution of the rod at any time t.	BTL -3	Applying	CO3

UNIT –IV APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS – TWO-DIMENSIONAL HEAT EQUATIONS

Steady state solution of two-dimensional equation of heat conduction in infinite plates (excluding insulated edges) and circular plates.

	PART-A (2 Mark Questions)			
1.	Write down the governing equation of two-dimensional steady state heat equation.	BTL -1	Remembering	CO4
2.	Write down the three possible solutions of Laplace equation in two dimensions.	BTL -1	Remembering	CO4
3.	Write any two solutions of Laplace equation $u_{xx} + u_{yy} = 0$ involving exponential terms in $x\ or\ y$.	BTL -1	Remembering	CO4
4.	How many boundary conditions are required to solve $u_{xx} + u_{yy} = 0$?	BTL -2	Understanding	CO4
5.	Write the Laplace equation in polar coordinates.	BTL -2	Understanding	CO4
6.	Write down the transient state equation of two-dimensional heat equation.	BTL -1	Remembering	CO4
7.	State Fourier law of heat conduction.	BTL -1	Remembering	CO4
8.	What is the separable solution of Laplace equation in polar coordinates suitable for a circular disc?	BTL -1	Remembering	CO4

9.	Write down the equation of steady state heat conduction in a plate?	BTL -1	Remembering	CO4
10.	What is the general solution for the steady state temperature at an internal point $P(r,\theta)$ of the annuals.	BTL -1	Remembering	CO4
11.	What are the different types of problems that occur in two-dimensional steady state heat equation.	BTL -2	Understanding	CO4
12.	How do you assume the solution of the Laplace equation in polar coordinates, if the solution inside a circular region is required?	BTL -2	Understanding	CO4
13.	Define temperature gradient.	BTL -1	Remembering	CO4
14.	Write the 2D heat equation in cartesian form and also state the equation when steady state exists.	BTL -2	Understanding	CO4
15.	An infinitely long rectangular plate with insulated surface is 10cm wide. The two long edges and one short edge are kept at 0^0C, while the other short edge x=0 is kept at temperature $u = \begin{cases} 20y, & 0 \le y \le 5 \\ 20(10-y), & 5 \le y \le 10 \end{cases}$. Write down the boundary and initial conditions?	BTL -2	Understanding	CO4
16.	A square metal plate is bounded by the lines x=0, x=a, y=0, y=a. The edges x=a, y=0, x=0 are kept at 0^0 temperatures while the temperature at the edge y = a is100^0 temperature. Write down the boundary and initial conditions?	BTL -1	Remembering	CO4
17.	An infinitely long plane uniform plate is bounded by two parallel edges x=0 and x=l and an end at right angles to them. The breadth of this edge y=0 is l and is maintained at temperature $f(x)$. All the other three edges are at temperature zero. Write down the boundary and initial conditions?	BTL -2	Understanding	CO4
18.	A square plate is bounded by the lines $x = 0, y = 0, x = 20$ $y = 20$. Its faces are insulated. The temperature along the upper horizontal edge is given by $u(x,20) = x(20-x)$ when $0 < x < 20$ while the other three edges are kept at 0^0 C. Write down the boundary and initial conditions?	BTL -2	Understanding	CO4
19.	A rectangular plate with insulated surface is 10 cm wide and so long compared to its width that it may be considered infinite in length without introducing appreciable error. The temperature at short edge y=0 is given by $u = (10x - x^2), 0 < x < 10$ and all the other three edges are kept at 0^0C. Write down the boundary and initial conditions?	BTL -2	Understanding	CO4
20.	A long rectangular plate with insulated surface is $l$cm. If the temperature along one short edge y=0 is u(x,0) =K (l x -x^2) degrees, for 0 < x < l, while the other 2 edges x=0 and x=l as well as the other short edge are kept at 0^0C. Write down the boundary and initial conditions?	BTL -2	Understanding	CO4
21.	A rectangular plate with insulated surface is 10 cm wide and so long compared to its width that it may be considered infinite in length without introducing appreciable error. The temperature at short edge y=0 is given by $u = \begin{cases} 10x, & 0 \le x \le 2.5 \\ 10(5-x), & 2.5 \le x \le 5 \end{cases}$ and all the other three edges are kept at 0^0C. Write down the boundary and initial conditions?	BTL -2	Understanding	CO4
22.	An infinitely long plane uniform plate is bounded by two parallel edges x=0 and x=π and an end at right angles to them. The breadth of this edge y=0 is π and is maintained at temperature u_0. All the other three edges are at temperature zero. Write down the boundary and initial conditions?	BTL -2	Understanding	CO4
23.	A rectangular plate with insulated surfaces 8cm wide and so long compared to its width that it may be considered infinite in length. If the	BTL -2	Understanding	CO4

	temperature along one short edge $y = 0$ is given by $u(x,0) = 100sin\frac{\pi x}{8}$, $0 < x < 8$, while the two long edges $x = 0$ and $x = l$, as well as the other short edge are kept at 0^0C. Write down the boundary and initial conditions?			
24.	A square plate is bounded by the lines $x = 0, y = 0, x = a, y = a$. Its faces are insulated. The temperature along the upper horizontal edge is given by $u(x,a) = bx\,(a - x)$ when $0 < x < a$ while the other three edges are kept at 0^0 C. Write down the boundary and initial conditions?	BTL -2	Understanding	CO4
25.	A long rectangular plate with insulated surface is $l$cm. If the temperature along one short edge y=0 is u(x,0) =3(l x -x^2) degrees, for 0 < x < l, while the other 2 edges x=0 and x=l as well as the other short edge are kept at 0^0C. Write down the boundary and initial conditions?	BTL -2	Understanding	CO4
	PART-B (16 Mark Questions)			
1.	A rectangular plate with insulated surface is 10 cm wide and so long compared to its width that it may be considered infinite in length without introducing appreciable error. The temperature at short edge y=0 is given by $u = \begin{cases} 20x & , \quad 0 \le x \le 5 \\ 20(10 - x), & 5 \le x \le 10 \end{cases}$ and all the other three edges are kept at 0^0C. Find the steady state temperature at any point in the plate.	BTL -3	Applying	CO4
2.	An infinitely long rectangular plate with insulated surface is 10cm wide. The two long edges and one short edge are kept at 0^0C, while the other short edge x=0 is kept at temperature $u = \begin{cases} 20y & , \quad 0 \le y \le 5 \\ 20(10 - y), & 5 \le y \le 10 \end{cases}$. Find the steady state temperature distribution in the plate.	BTL -4	Analyzing	CO4
3.	An infinitely long plane uniform plate is bounded by two parallel edges x=0 and x=l and an end at right angles to them. The breadth of this edge y=0 is l and is maintained at temperature $f(x)$. All the other three edges are at temperature zero. Find the steady state temperature at any interior point of the plate.	BTL -3	Applying	CO4
4.	A long rectangular plate with insulated surface is $l$cm. If the temperature along one short edge y=0 is u(x,0) =K (l x -x^2) degrees, for 0 < x < l, while the other 2 edges x=0 and x=l as well as the other short edge are kept at 0^0C. Find the steady state temperature function $u(x,y)$.	BTL -3	Applying	CO4
5.	An infinitely long plane uniform plate is bounded by two parallel edges x=0 and x=π and an end at right angles to them. The breadth of this edge y=0 is π and is maintained at temperature u_0. All the other three edges are at temperature zero. Find the steady state temperature at any interior point of the plate.	BTL -3	Applying	CO4
6.	A rectangular plate with insulated surfaces 8cm wide and so long compared to its width that it may be considered infinite in length. If the temperature along one short edge $y = 0$ is given by $u(x,0) = 100sin\frac{\pi x}{8}$, $0 < x < 8$, while the two long edges $x = 0$ and $x = 8$, as well as the other short edge are kept at 0^0C, find the steady state temperature $u(x,y)$ at any point of the plate.	BTL -3	Applying	CO4
7.	A rectangular plate with insulated surface is 10 cm wide and so long compared to its width that it may be considered infinite in length without introducing appreciable error. The temperature at short edge y=0 is given	BTL -4	Analyzing	CO4

	by $u = (10x - x^2), 0 < x < 10$ and all the other three edges are kept at 0^0C. Find the steady state temperature at any point in the plate.			
8.	A rectangular plate with insulated surface is *'b'* cm wide and so long compared to its width that it may be considered infinite in length without introducing appreciable error. The temperature at short edge y=0 is given by $u(x,0) = \lambda x$ and all the other three edges are kept at 0^0C that is $u(0,y) = 0, u(a,y) = 0, u(x,\infty) = 0$.Find the steady state temperature at any point in the plate.	BTL -4	Analyzing	CO4
9.	A rectangular plate with insulated surfaces 25cm wide and so long compared to its width that it may be considered infinite in length. If the temperature along one short edge $y = 0$ is given by $u(x,0) = 200 sin\frac{\pi x}{25}$, $0 < x < 25$, while the two long edges $x = 0$ and $x = l$, as well as the other short edge are kept at 0^0C, find the steady state temperature $u(x,y)$ at any point of the plate.	BTL -4	Analyzing	CO4
10.	A long rectangular plate with insulated surface is $l$cm. If the temperature along one short edge y=0 is u(x,0) =3(l x -x^2) degrees, for 0 < x < l, while the other 2 edges x=0 and x=l as well as the other short edge are kept at 0^0C. Find the steady state temperature function $u(x,y)$.	BTL -4	Analyzing	CO4
11.	A square metal plate is bounded by the lines x=0, x=a, y=0, y=a. The edges x=a, y=0, x=0 are kept at 0^0 temperatures while the temperature at the edge y = a is100^0 temperature. Find the steady state temperature distribution at in the plate.	BTL -4	Analyzing	CO4
12.	A square plate is bounded by the lines $x = 0, y = 0, x = 20$ $y = 20$. Its faces are insulated. The temperature along the upper horizontal edge is given by $u(x,20) = x\,(20 - x)$ when $0 < x < 20$ while the other three edges are kept at 0^0 C. Find the steady state temperature in the plate.	BTL -3	Applying	CO4
13.	A square plate is bounded by the lines $x = 0, y = 0, x = a, y = a$. Its faces are insulated. The temperature along the upper horizontal edge is given by $u(x,a) = bx\,(a - x)$ when $0 < x < a$ while the other three edges are kept at 0^0 C. Find the steady state temperature $u(x,y)$ in the plate at any point.	BTL -4	Analyzing	CO4
14.	Solve $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$, which satisfies the conditions $u(0,y) = u(l,y) = u(x,0) = 0$ and $u(x,a) = \sin\frac{n\pi x}{l}$.	BTL -3	Applying	CO4
15.	A rectangular plate is bounded by the lines $x = 0, y = 0, x = b, y = b$. Its surfaces are insulated. The temperature at the edges are given by $u(0,y) = 0$ for $0 < y < b$, $u(x,0) = 0$ for $0 < x < b$, $u(b,y) = 0$ for $0 < y < b$, $u(x,b) = 50\sin\frac{\pi x}{b}$ for $0 < x < b$ Find the steady state temperature $u(x,y)$ in the plate at any point.	BTL -4	Analyzing	CO4
16.	A rectangular plate is bounded by the lines $x = 0, y = 0, x = a, y = b$. Its surfaces are insulated. The temperature at the edges are given by $u(0,y) = 0$ for $0 < y < b$, $u(x,b) = 0$ for $0 < x < a$, $u(a,y) = 0$ for $0 < y < b$, $u(x,0) = sin^3\frac{\pi x}{a}$ for $0 < x < a$. Find the steady state temperature $u(x,y)$ in the plate at any point.	BTL -4	Analyzing	CO4
17.	Solve $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$, which satisfies the conditions $u(0,y) = u(10,y) = u(x,\infty) = 0$ and $u(x,0) = 8 sin\frac{\pi x}{10}$.	BTL -3	Applying	CO4

18.	A rectangular plate is bounded by the lines $x = 0, y = 0, x = a, y = b$. Its surfaces are insulated. The temperature at the edges are given by $u(0, y) = 0\ for\ 0 < y < b$, $u(x, b) = 0\ for\ 0 < x < a$, $u(a, y) = 0\ for\ 0 < y < b$, $u(x, 0) = 5sin\frac{5\pi x}{a} + 3sin\frac{3\pi x}{a}\ for\ 0 < x < a$. Find the steady state temperature $u(x, y)$ in the plate at any point.	BTL -3	Applying	CO4
UNIT –V: BOUNDARY VALUE PROBLEMS IN PARTIAL DIFFERENTIAL EQUATIONS **One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.**				
PART-A (2 Mark Questions)				
1.	Define Boundary value problem.	BTL -1	Remembering	CO5
2.	Write down the explicit finite difference method for solving one dimensional wave equation.	BTL -2	Understanding	CO5
3.	Write down one-dimensional wave equation and its boundary conditions.	BTL -1	Remembering	CO5
4.	State the implicit finite difference scheme for one dimensional wave equation.	BTL -2	Understanding	CO5
5.	State whether the Cranck Nicholson's scheme is an explicit or implicit scheme. Justify?	BTL -2	Understanding	CO5
6	State one dimensional heat equation and its boundary conditions.	BTL -2	Understanding	CO5
7.	Name at least two numerical methods that are used to solve one dimensional diffusion equation.	BTL -1	Remembering	CO5
8.	Write the Crank Nicholson formula to solve parabolic equations.	BTL -1	Remembering	CO5
9.	Give an example of a parabolic equation.	BTL -2	Understanding	CO5
10.	Give an example of a hyperboloic equation.	BTL -2	Understanding	CO5
11.	Classify the PDE $y\, U_{xx} + U_{yy} = 0$.	BTL -2	Understanding	CO5
12.	Classify the PDE $x\, U_{xx} + y\, U_{yy} = 0,\ x>0,\ y>0$.	BTL -2	Understanding	CO5
13.	Classify the PDE $u_{xx} + u_{xy} + u_{yy} = 0$.	BTL -2	Understanding	CO5
14.	Express $\frac{\partial^2 u}{\partial t^2} = a^2 \frac{\partial^2 u}{\partial x^2}$ in terms of difference quotients?	BTL -1	Remembering	CO5
15.	State the implicit finite difference scheme for finite dimensional heat equation?	BTL -2	Understanding	CO5
16.	Classify the PDE $U_{xx} = U_{yy}$.	BTL -1	Remembering	CO5
17.	Classify the PDE $U_{xy} = U_x U_y + xy$..	BTL -2	Understanding	CO5
18.	Classify the PDE $Au_{xx} + Bu_{xy} + Cu_{yy} + Du_x + Eu_y + Fu = G$, where A,B,C,D,E,F,G are functions of *x* and *y* only.	BTL -2	Understanding	CO5
19.	Classify the PDE $5U_{xx} - 3U_{xy} + 2U_{yy} = 0$.	BTL -1	Remembering	CO5
20.	Classify the PDE $3U_{xx} + 4U_{xy} + 6U_{yy} - 2U_x + U_y - U = 0$.	BTL -2	Understanding	CO5
21.	Classify the PDE $U_{xx} + 2U_{xy} + U_{yy} = 0$.	BTL -1	Remembering	CO5
22.	Classify the PDE $x^2 Uxx + (1-y^2) U_{yy} = 0, -\infty < x < \infty, -1 < y < 1$.	BTL -1	Remembering	CO5
23.	Write down the Bender-Schmidt recurrence relation for one dimensional heat equation?	BTL -2	Understanding	CO5
24.	Write a note on the stability and convergence of the solution of the difference equation corresponding to the hyperbolic equation.	BTL -1	Remembering	CO5
25.	Write down the implicit formula to solve one dimensional heat flow equation.	BTL -2	Understanding	CO5
PART-B (16 Mark Questions)				
1.	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 two time steps, taking $h = \Delta x = \frac{1}{3}$ and $k = \Delta t = \frac{1}{36}$.	BTL -3	Applying	CO5

2.	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 -4	Analyzing	CO5
3.	Solve by Crank – Nicholson's method the equation $U_t = U_{xx}$ $u(x, 0) = 0,\ 0 \le x \le 1$, $u(0, t) = 0$ 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	CO5
4.	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 8 steps. Find the values up to 2 decimal accuracy.	BTL -3	Applying	CO5
5.	Using Bender Schmidt method 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 up to $t = 4$.	BTL -4	Analyzing	CO5
6.	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	CO5
7.	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 -4	Analyzing	CO5
8.	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 6 time steps.	BTL -4	Analyzing	CO5
9.	Using Bender Schmidt method 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 8 time steps).	BTL -4	Analyzing	CO5
10.	Using Bender Schmidt method solve $32\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$, given $u(0, t) = 0$, $u(x, 0) = 0$, $u(1, t) = t$, for $t > 0$, $0<x<1$ taking, $h = 0.25$ (for 10 times steps).	BTL -4	Analyzing	CO5
11.	Solve by Crank – Nicholson's method the equation $U_t = U_{xx}$ $u(x, 0) = \sin\frac{\pi x}{2}$ $0 \le x \le 2$, $t > 0$, $u(0, t) = 0$ and $u(2, t) = 0$. Compute two-time steps, taking $h = \Delta x = \frac{1}{2}$ and $k = \Delta t = \frac{1}{4}$.	BTL -4	Analyzing	CO5
12.	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 $\frac{\partial u}{\partial t}(x, 0) = 0$ $u(x, 0) = 100(x - x^2)$ for all in $0 \le x \le 1$. Taking $h=1/4$. Compute u for 8 time steps.	BTL -3	Applying	CO5
13.	Using Bender Schmidt method solve $4\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ with the boundary conditions $u(0,t) = 0$, $u(4,t) = 0$ and the initial conditions $u(x, 0) = x(4 - x)$ by taking $h = 1$(for 6 times steps).	BTL -4	Analyzing	CO5
14.	A string is stretched and its ends are tied to two points 5 feet apart. $u(x,0) = \begin{cases} 20x,\ 0 \le x \le 1 \\ 5(5 - x),\ 1 \le x \le 5 \end{cases}$ and released from rest. Find its displacement at various points on the string, up to one half period of vibration, taking $h = 1$, if the governing equation is $\frac{\partial u}{\partial t} = 25\frac{\partial^2 u}{\partial x^2}$.	BTL -3	Applying	CO5
15.	Solve $\frac{\partial^2 y}{\partial t^2} = \frac{\partial^2 y}{\partial x^2}$ subject to the following conditions $y(0,t)=0$, $y(1,t) = 100\sin \pi t$, $t > 0$ and $\frac{\partial y}{\partial t}(x, 0) = 0$ $y(x, 0) = 0$ for all in $0 \le x \le 1$. Taking $h=0.25$. Compute u for 6 time steps.	BTL -4	Analyzing	CO5

16.	Solve by Crank-Nicolson's method $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ For $0<x<5$, $t>0$, $u(0,t)=0$, $u(5,t)=100$, $U(x,0)=20$. Compute u for two time steps, $h=1/4$.	BTL -4	Analyzing	CO5
17.	Evaluate the pivotal values for half period of vibration by solving $U_{tt} = 25U_{xx}$, $u(0,t) = 0$, $u(10,t) = 0$, $u(x,0) = \begin{cases} 2x\ , & 0 \le x \le 5 \\ (20-2x)\ , & 5 < x \le 10 \end{cases}$ with $h = 1$, $k = 1/5$	BTL -4	Analyzing	CO5
18.	Solve $\frac{\partial^2 y}{\partial t^2} = \frac{\partial^2 y}{\partial x^2}$ subject to the following conditions $y(0,t)=0$, $y(1,t)=0$, $t > 0$ and $\frac{\partial y}{\partial t}(x,0) = 0$ $y(x,0) = 10 + x(1-x)$ for all in $0 \le x \le 1$. Taking $h=0.1$. Compute u for 5 time steps.	BTL -3	Applying	CO5

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