SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

S.R.M. Nagar, Kattankulathur - 603203

DEPARTMENT OF MATHEMATICS

QUESTION BANK

IV SEMESTER

CIVIL ENGINEERING
MA3421- APPLIED MATHEMATICS FOR CIVIL ENGINEERING

Regulation – 2023

Academic Year – 2024 – 2025

Prepared by

Dr.T.Isaiyarasi, Associate Professor/ Mathematics

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203.

DEPARTMENT OF MATHEMATICS

QUESTION BANK

SUBJECT : MA3421 – APPLIED MATHEMATICS FOR CIVIL ENGINEERING

SEM / YEAR: IV SEMESTER /II YEAR (CIVIL ENGINEERING)

UNIT-I: ORDINARY DIFFERENTIAL EQUATIONS

Higher order linear differential equations with constant coefficients – Method of variation of parameters.

PART-A (2 Mark Questions)

Q.No.	Question	Bloom's Taxonomy Level	Competence	Course Outcome
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 $(D^3+3D^2+3D+1)y=e^{-x}$.	BTL-1	Remembering	CO1
13.	Solve $(D^3-6D^2+11D-6)y$	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**	**CO1**
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**	**CO1**
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**	**CO1**
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**	**CO1**
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**	**CO1**
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**	**CO1**
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: APPLICATION OF ORDINARY DIFFERENTIAL EQUATIONS

Solution of ODE related to bending of beams, motion of a particle in a resisting medium and simple harmonic motion

Q.No.	**Question**	**Bloom's Taxono**	**Competence**	**Course Outcome**

		my Level		
PART-A				
1.	What is elastic curve in the theory of bending of beams?	**BTL-1**	**Remembering**	**CO2**
2.	State Bernoulli- Euler law in the theory of bending of beams	**BTL-1**	**Remembering**	**CO2**
3.	Write down the assumptions in bending of beams	**BTL-2**	**Understanding**	**CO2**
4.	Write down different forms of beams	**BTL-2**	**Understanding**	**CO2**
5.	What are the boundary conditions at a freely supported end of a beam?	**BTL-2**	**Understanding**	**CO2**
6.	What are the boundary conditions at the end of a beam fixed horizontally?	**BTL-1**	**Remembering**	**CO2**
7.	What are the boundary conditions at the end of a beam that is perfectly free?	**BTL-1**	**Remembering**	**CO2**
8.	Write down three different forms of the differential equation of motion of a particle which falls under gravity in a resisting medium, in which resistance is proportional to the n^{th} power of its velocity.	**BTL-1**	**Remembering**	**CO2**
9.	Write down three different forms of the differential equation of motion of a particle which is projected vertically upwards in a resisting medium, in which resistance is proportional to the n^{th} power of its velocity.	**BTL-1**	**Remembering**	**CO2**
10.	Define limiting velocity of a particle in a resisting medium and write down its value for a medium (kv^n)	**BTL-2**	**Understanding**	**CO2**
11.	Define simple harmonic motion	**BTL-2**	**Understanding**	**CO2**
12.	Write down the equation of motion of a particle executing SHM?	**BTL-2**	**Understanding**	**CO2**
13.	If a particle executes SHM, write down the expressions for its displacement from the mean position.	**BTL-2**	**Understanding**	**CO2**
14.	If a particle executes SHM, write down the expressions for its velocity t from the mean position.	**BTL-2**	**Understanding**	**CO2**
15.	If a particle executes SHM , what is the period of oscillations	**BTL-2**	**Understanding**	**CO2**
16.	Write down the form of the equation of motion of a particle that executes damped free oscillations.	**BTL-1**	**Remembering**	**CO2**
17.	Write down the form of equation of motion of a particle that executes forced oscillations with damping	**BTL-1**	**Remembering**	**CO2**
18.	A simply supported beam of span 'L' is subjected to a point load 'W' at the center. What is the deflection at the center?	**BTL-1**	**Remembering**	**CO2**
19.	In a cantilever beam, where is the slope and deflection is maximum?	**BTL-1**	**Remembering**	**CO2**
20.	Solve the differential equation $\frac{d^2x}{dt^2} = -kmx$ where , $n^2 = km$.	**BTL-1**	**Remembering**	**CO2**
21.	Assume an object weighing 2 lb stretches a spring 6 in. Find the equation of motion if the spring is released from the equilibrium position with an upward velocity of 16 ft/sec. What is the period of the motion?	**BTL-1**	**Remembering**	**CO2**
22.	What is the differential equation of the simple harmonic motion given by x=Acos (nt+α) ?	**BTL-2**	**Understanding**	**CO2**

23.	Write the equation that represents a simple harmonic motion? The displacement of the system from the equilibrium position is x at time t and α is a positive constant.	**BTL-2**	**Understanding**	**CO2**
24.	What is the time period of the simple harmonic motion represented by the equation $\frac{d^2x}{dt^2} + \alpha x = 0$?	**BTL-2**	**Understanding**	**CO2**
25.	The equation of simple harmonic motion of a particle is $\frac{d^2x}{dt^2} + 0.2\frac{dx}{dt} + 35x = 0$. What is its time period approximately?	**BTL-2**	**Understanding**	**CO2**
	PART-B (16 Mark Questions)			
1.	The differential equation satisfied by a beam with a uniform loading w kg/m with one end fixed and the other end subject tensile force P is given by $EI\,\frac{d^2y}{dx^2} = Py - \frac{1}{2}wx^2$. Find the equation to the elastic curve subject to the boundary conditions y= 0 at x = 0 and $\frac{dy}{dx} = 0$ at x = 0	**BTL-3**	**Applying**	**CO2**
2.	A beam of length 2l with uniform load w per unit length is supported at both ends. The deflection y at a distance x is given by$EI\,\frac{d^2y}{dx^2} = \frac{wx}{2}(x - 2l)$. Assuming y = 0 at x = 0 and x=2l. Show that the maximum deflection is $\frac{5wl^4}{24EI}$	**BTL-3**	**Applying**	**CO2**
3.	A light horizontal strut of length l is freely pinned at the two ends. Two equal and opposite compressive forces P at the ends and a concentrated load W act at the center. The differential equation satisfied by the deflection of the strut is $EI\,\frac{d^2y}{dx^2} = -Py - \frac{1}{2}wx$. Analyze the deflection at the mid-point and magnitude of the maximum bending moment.	**BTL-4**	**Analyzing**	**CO2**
4.	A horizontal tie-rod is freely pinned at each end. It carries uniform load w kg per unit length and has a horizontal pull P. The differential equation satisfied by the rod is $EI\,\frac{d^2y}{dx^2} - Py = \frac{w}{2}(x^2 - lx)$. Analyze the central deflection and the maximum bending moment, taking the origin as the one of its ends.	**BTL-3**	**Applying**	**CO2**
5.	A cantilever beam of length l and weighing ω lb / unit is subjected to a horizontal compressive force P applied at the free end. Taking the origin at the free end and y – axis upwards establish the differential equation of the beam and hence find the maximum deflection.	**BTL-4**	**Analyzing**	**CO2**
6.	A beam of the length 2a ft. has its ends fixed horizontally carrying a load of $\omega\ lb$. Per foot. The deflection y at a distance x from one end is given by the equation $\frac{d^2y}{dx^2} = \frac{\omega}{6EI}(2a^2 - 6ax + 3x^2)$. Find one the maximum deflection.	**BTL-3**	**Applying**	**CO2**
7.	A uniform horizontal strut of length, l freely supported at both ends, carries a uniformly distributed load w per unit length . If the thrust at each end is P. Derive the maximum deflection and also the magnitude maximum bending moment.	**BTL-4**	**Analyzing**	**CO2**
8.	A concentrated vertical load W is suspended at the midpoint a horizontal beam of length 2l with a uniform load ω per unit	**BTL-3**	**Applying**	**CO2**

	length, when it is freely supported at both ends. If the differential equation of the deflection y of any point of the beam, that is at a distance of x from one end , is given by $EI\ \frac{d^2y}{dx^2} = \frac{wx^2}{2} - (\frac{W}{2} + l\omega)x$. Find the maximum deflection , assuming y=0 when x =0 and $\frac{dy}{dx} = 0$ when x = l.			
9.	A cantilever beam of length l, with uniform load ω per unit length has a concentrated load W at the free end. Taking the origin at the fixed end the differential equation is given by $EI\ \frac{d^2y}{dx^2} = W(l-x) + \frac{\omega(l-x)^2}{2}$.Determine the maximum deflection , assuming $y = 0$ when $x = 0$ and $\frac{dy}{dx} = 0$ when $x = 0$.	**BTL-3**	**Applying**	**CO2**
10	The differential equation $\frac{d^2x}{dt^2} + 5\frac{dy}{dx} + 4x = 0$ represents the damped harmonic oscillations of a particle is at a distance of 1 unit from the origin and its speed away from the origin is 2 units. Prove that the particle will be at its greatest distance from the origin after a time $\frac{1}{3}log2$. Find the greatest distance	**BTL-4**	**Analyzing**	**CO2**
11.	The differential equation of motion of a particle, which executes forced oscillations without damping is $\frac{d^2x}{dt^2} + k^2x = k^2asinnt$.Find the displacement x of the particle at time t, when n $\neq k$ given that the particle starts from rest from the origin initially.	**BTL-4**	**Analyzing**	**CO2**
12	The differential equation of motion of a particle, which executes forced oscillations with damping is $\frac{d^2x}{dt^2} + k\frac{dx}{dt} + n^2x = n^2asinnt$ (k<2n). If the particle starts from rest the origin initially, find the displacement of the particle at time t.	**BTL-3**	**Applying**	**CO2**
13.	A particle is projected with velocity V directly away from a fixed point at a distance b from it. If the acceleration be **μ** times the distance from the fixed point and is always directed towards the fixed point, find the amplitude of the SHM.	**BTL-4**	**Analyzing**	**CO2**
14.	A particle is executing a Simple Harmonic Motion about the origin 0, from which the distance x of the particle is measured. Initially $x = 20$ and velocity = 0 and the equation of motion is $\ddot{x} + x = 0$; Solve for x and find period and amplitude	**BTL-3**	**Applying**	**CO2**
15.	Assume an object weighing 2 lb stretches a spring 6 in. Find the equation of motion if the spring is released from the equilibrium position with an upward velocity of 16 ft/sec. What is the period of the motion?	**BTL-4**	**Analyzing**	**CO2**
16.	A body weighing 20 kg is hung from a spring. A pull of 40 kg weight will stretch the spring by 10 cm. The body is pulled down by 20 cm below the static equilibrium position and then released. Find the displacement of the body from its equilibrium position at time t seconds, the maximum velocity and the period of oscillation.	**BTL-3**	**Applying**	**CO2**
17.	In case of a stretched elastic horizontal string which has one end fixed and a particle of mass m attached to the other, find the equation of motion of the particle given that f is the natural length	**BTL-3**	**Applying**	**CO2**

	of the string and e is the elongation due to weight mg. Also , find the displacement of particle when initially $s = 0, v = 0$.			
18.	A particle of mass m lying on a smooth horizontal table is attached to two elastic strings whose natural lengths are l_1 and l_2 and moduli $\lambda_1$and λ_2 respectively. The other ends of the strings are fixed to two points on the table at a distance greater than $l_1 + l_2$. Show that if the particle vibrates in the line of the string , its period will be $2\pi\sqrt{\frac{m}{\left(\frac{\lambda_1}{l_1}+\frac{\lambda_2}{l_2}\right)}}$	**BTL-4**	**Analyzing**	**CO2**

UNIT – III Classification of PDE - Solutions of one dimensional wave equation

Q.No.	Question	Bloom's Taxonomy Level	Competence	Course Outcome
	PART-A (2 Mark Questions)			
1.	Classify the PDE $u_{xx} + u_{xy} + u_{yy} = 0$	**BTL -2**	**Understanding**	**CO 3**
2.	Classify the PDE $Z_{xx} + 2Z_{xy} + (1 - y^2)Z_{yy} + xZ_x + 3x^2yz - 2Z = 0$	**BTL -2**	**Understanding**	**CO 3**
3.	Classify the PDE $u_{xx} + u_{xy} = f(x, y)$.	**BTL -2**	**Understanding**	**CO 3**
4.	Classify the PDE $(1 - x^2)z_{xx} - 2xyz_{xy} + (1 - y^2)z_{yy} + xy^2z_y - 2z = 0$.	**BTL -2**	**Understanding**	**CO 3**
5.	Classify the PDE $u_{xx} = u_{yy}$	**BTL -2**	**Understanding**	**CO3**
6.	Classify the PDE $u_{xy} = u_x u_y + xy$	**BTL -2**	**Understanding**	**CO3**
7.	Classify the PDE $4u_{xx} + 4u_{xy} + u_{yy} - 6u_x - 8u_y = 0$	**BTL -2**	**Understanding**	**CO3**
8.	Classify the PDE $u_{xx} - y^4u_{yy} = 2y^3u_y$	**BTL -1**	**Remembering**	**CO3**
9.	State the assumptions in deriving the one-dimensional heat equation	**BTL -1**	**Remembering**	**CO3**
10.	Write down the governing equation of one dimensional wave equation.	**BTL -1**	**Remembering**	**CO3**
11.	What are the various solutions of one-dimensional wave equation	**BTL -1**	**Remembering**	**CO3**
12.	What is the suitable solution for one dimensional wave equation	**BTL -2**	**Understanding**	**CO3**
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**	**CO 3**
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**	**CO3**
15.	Write the initial conditions of the wave equation if the string has an initial displacement but no initial velocity.	**BTL -2**	**Understanding**	**CO3**
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 -2**	**Understanding**	**CO3**
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	**BTL -2**	**Understanding**	**CO3**

	$y(x,0) = y_0 sin^3 \frac{\pi x}{l}$.If it is released from rest from this position, write the boundary conditions			
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**	**CO3**
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**	**CO3**
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**	**CO3**
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**	**CO3**
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**	**CO3**
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 -2**	**Understanding**	**CO3**
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**	**CO3**
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 -2**	**Understanding**	**CO3**
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**	**CO3**
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**	**CO3**

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**	**CO3**
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**	**CO3**
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**	**CO3**
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**	**CO3**
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**	**CO3**
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**	**CO3**
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**	**CO3**
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**	**CO3**
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	**BTL-4**	**Analyzing**	**CO3**

	the displacement of a string at any distance x from one end at any time t.			
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 displacement of the string at a point at a distance x from one end at any instant t.	**BTL-4**	**Analyzing**	**CO3**
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**	**CO3**
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**	**CO3**
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**	**CO3**
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**	**CO3**
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**	**CO3**
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**	**CO3**

UNIT-IV: APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS - ONE DIMENSIONAL HEAT EQUATIONS

One dimensional equation of heat conduction- Zero and Non zero boundary conditions.

Q.No.	Question	Bloom's Taxono	Competence	Course Outcome

		my Level		
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**	**CO4**
2.	State the assumptions in deriving the one-dimensional heat equation.	**BTL -1**	**Remembering**	**CO4**
3.	What are the possible solutions of one-dimensional heat flow equation?	**BTL -1**	**Remembering**	**CO4**
4.	Write down the governing equation of one-dimensional steady state heat equation.	**BTL -1**	**Remembering**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
9.	State Fourier law of heat conduction.	**BTL -1**	**Remembering**	**CO4**
10.	Explain the initial and boundary value problems.	**BTL -2**	**Understanding**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
15.	Explain steady state and unsteady state differential equations.	**BTL -2**	**Understanding**	**CO4**
16.	Write the solution in respect of one-dimensional heat conduction problem in steady state.	**BTL -1**	**Remembering**	**CO4**
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**	**CO4**
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**	**CO4**

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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**

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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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 is reduced to 0^0C and kept so while that of A is maintained, find the temperature distribution of the rod.	**BTL -4**	**Analyzing**	**CO4**
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**	**CO4**
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**	**CO4**

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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**
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**	**CO4**

UNIT-V: 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) - Cartesian plates only

Q.No.	**Question**	**Bloom's Taxonomy Level**	**Competence**	**Course Outcome**
	PART – A			
1.	Write down the governing equation of two-dimensional steady state heat equation.	**BTL -1**	**Remembering**	**CO5**
2.	Write down the three possible solutions of Laplace equation in two dimensions.	**BTL -1**	**Remembering**	**CO5**
3.	Write any two solutions of Laplace equation $u_{xx} + u_{yy} = 0$ involving exponential terms in $x \text{ or } y$.	**BTL -1**	**Remembering**	**CO5**
4.	How many boundary conditions are required to solve $u_{xx} + u_{yy} = 0$?	**BTL -2**	**Understanding**	**CO5**
5.	Write the Laplace equation in polar coordinates.	**BTL -2**	**Understanding**	**CO5**
6.	Write down the transient state equation of two-dimensional heat equation.	**BTL -1**	**Remembering**	**CO5**
7.	State Fourier law of heat conduction.	**BTL -1**	**Remembering**	**CO5**
8.	What is the separable solution of Laplace equation in polar coordinates suitable for a circular disc?	**BTL -1**	**Remembering**	**CO5**

9.	Write down the equation of steady state heat conduction in a plate?	**BTL -1**	**Remembering**	**CO5**
10.	What is the general solution for the steady state temperature at an internal point $P(r,\theta)$ of the annuals.	**BTL -1**	**Remembering**	**CO5**
11.	What are the different types of problems that occur in two-dimensional steady state heat equation.	**BTL -2**	**Understanding**	**CO5**
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**	**CO5**
13.	Define temperature gradient.	**BTL -1**	**Remembering**	**CO5**
14.	Write the 2D heat equation in cartesian form and also state the equation when steady state exists.	**BTL -2**	**Understanding**	**CO5**
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 $u = \begin{cases} 20y & , \quad 0 \le y \le 5 \\ 20(10-y), & 5 \le y \le 10 \end{cases}$. Write down the boundary and initial conditions?	**BTL -2**	**Understanding**	**CO5**
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**	**CO5**
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**	**CO5**
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**	**CO5**
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**	**CO5**
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**	**CO5**
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 $u = \begin{cases} 10x & , \quad 0 \le x \le 2.5 \\ 10(5-x), & 2.5 \le x \le 5 \end{cases}$ and all the other three edges are kept at 0^0C. Write down the boundary and initial conditions?	**BTL -2**	**Understanding**	**CO5**

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**	**CO5**
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 temperature along one short edge $y = 0$ is given by $u(x,0) = 100 sin\frac{\pi x}{8}$, $0 < x < 8$, 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?	**BTL -2**	**Understanding**	**CO5**
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**	**CO5**
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**	**CO5**
	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**	**CO5**
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**	**CO5**
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**	**CO5**
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**	**CO5**
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	**BTL -3**	**Applying**	**CO5**

	u_0. All the other three edges are at temperature zero. Find the steady state temperature at any interior point of the plate.			
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 $u(x,0) = 100 sin\frac{\pi x}{8}, 0 < x < 8$, 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**	**CO5**
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 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.	**BTL -4**	**Analyzing**	**CO5**
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**	**CO5**
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**	**CO5**
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**	**CO5**
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**	**CO5**
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**	**CO5**
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**	**CO5**
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**	**CO5**

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**	**CO5**
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**	**CO5**
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**	**CO5**
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 $u(0, y) = 0 \; for \; 0 < y < b$, $u(x, b) = 0 \; for \; 0 < x < a$, $u(a, y) = 0 \; for \; 0 < y < b$, $u(x, 0) = 5 sin \frac{5\pi x}{a} + 3 sin \frac{3\pi x}{a} \; for \; 0 < x < a$. Find the steady state temperature $u(x, y)$ in the plate at any point.	**BTL -3**	**Applying**	**CO5**