22PHP206N

PSG COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)

MSc DEGREE EXAMINATION MAY 2025
(Second Semester)

Branch- **PHYSICS**

MATHEMATICAL PHYSICS WITH NUMERICAL METHODS

Time: Three Hours Maximum: 75 Marks

SECTION-A (10 Marks)

Answer **ALL** questions

ALL questions carry **EQUAL** marks (10 × 1 = 10)

Module No.	Q No.	Question	K Level	CO
1	1	Cauchy's Integral Theorem will be valid if the function is a) continuous b) differentiable c) analytic d) bounded	K1	CO1
	2	The residue of a function at a point refers to a) the value of the function at that point b) the limit of the function as it approaches that point c) the coefficient of the term with the highest power of (z−a) in the Laurent series expansion of the function around d) the value of the function at the point multiplied by the derivative of the function at that point	K2	
2	3	The Fourier transform of a derivative is a) always zero b) equal to the derivative of the Fourier transform c) equal to the original function d) equal to the Fourier transform of the original function multiplied by the derivative of the frequency	K1	CO2
	4	The Fourier transform of the derivative of a function causes the a) magnitude of the Fourier transforms to decrease b) magnitude of the Fourier transforms increases c) phase of the Fourier transforms changes d) Fourier transform remains unchanged	K2	
3	5	Bessel functions are typically useful to solve problems involving: a) Linear algebra b) Spherical harmonics c) Circular and cylindrical symmetries d) Fourier transforms	K1	CO3
	6	Which of the following is a property of Bessel functions? a) Orthogonality b) Exponential growth c) Non-differentiability d) Linearity	K2	
4	7	The physical principle that governs the Heat Flow Equation is conservation of a) mass b) energy c) momentum d) charge	K1	CO4
	8	The numerical method most commonly used to solve the Heat Flow Equation is a) Finite difference method b) Laplace transform method c) Finite element method d) Fourier transform method	K2	
5	9	If the initial interval contains exactly one root, then the Bisection Method will a) converge to the root b) converge to a local minimum c) diverge d) converge to a local maximum	K1	CO5
	10	Which of the following is a disadvantage of the Bisection Method compared to some other root-finding methods? a) It always converges to the exact root b) It requires the function to be differentiable c) It converges slower than other methods d) It is computationally expensive	K2	

Cont...

SECTION - B (35 Marks)

Answer ALL questions

ALL questions carry EQUAL Marks (5 × 7 = 35)

Module No.	Q No.	Question	K Level	CO
1	11.a.	State and prove the Cauchy's integral formula.	K3	CO1
		(OR)		
	11.b.	Find the residue of $f(z) = \frac{e^z}{z^2+a^2}$ at its singularities.		
2	12.a.	Find finite Fourier sine and cosine transforms of the function $F(x) = x^2,\ 0 < x < 4$	K2	CO2
		(OR)		
	12.b.	Find (i) $\mathcal{L}(sin\ (at))$ and (ii)$\mathcal{L}(cos(at))$		
3	13.a.	Obtain the solution of Laplace's equation in Cartesian coordinates.	K4	CO3
		(OR)		
	13.b.	Prove that $P_n(x) = \frac{1}{2^n n!}\frac{d^n}{dx^n}(x^2-1)^n$.		
4	14.a.	Derive the Fourier Equation for heat flow.	K3	CO4
		(OR)		
	14.b.	Find the displacement of a square membrane at unit length and unit wave velocity along it with initial velocity and initial amplitude as $v(0) = 0$ and $A(0) = A_o\ sin\ 2\pi x\ sin 2\pi y$ respectively.		
5	15.a.	Fit a straight line to the following data with x as independent variable	K5	CO5

x	0	1	2	3	4
y	1.0	1.8	3.3	4.5	6.3

		(OR)			
	15.b.	Find the value of π from $\int_0^1 \frac{dx}{1+x^2}$ taking 4 equal intervals and using Simpson's one- third rule.			

SECTION -C (30 Marks)

Answer ANY THREE questions

ALL questions carry EQUAL Marks (3 × 10 = 30)

Module No.	Q No.	Question	K Level	CO
1	16	State and prove Taylor theorem for a complex function.	K2	CO1
2	17	Use the method the displacement y(x,t) of an infinite string, given that the string is initially at rest, with the initial displacement f(x), $-\infty < x < \infty$, Show that the solution can also be put in the form y (x,t) = $\frac{1}{2}[f(x+vt) + f(x-vt)]$.	K2	CO2
3	18	Find the solution of the Legendre equation $(1-x^2)\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + n(n+1)y = 0$ where n is positive integer.	K3	CO3
4	19	Discuss the equation of motion for a vibrating string.	K3	CO4
5	20	Use Runge- kutta IV order method to solve the equation $\frac{dy}{dx} = x + y$ with initial conditions $x_0 = 0$, $y_0 = 1$ from x = 0 to x= 0.4 with interval h=0.1	K4	CO5

Z-Z-Z END