22PHP206N / 22PHP206

PSG COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)

MSc DEGREE EXAMINATION MAY 2024
(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.	Question No.	Question	K Level	CO
1	1	According to Cauchy's Integral Theorem a) Every holomorphic function is continuous b) Every holomorphic function is differentiable c) The line integral of a holomorphic function over a closed curve is zero d) The line integral of a holomorphic function over a closed curve is non-zero	K1	CO1
	2	From the Cauchy's Residue theorem we find that a) The integral of a function over a closed contour is zero if the function is analytic inside the contour b) The integral of a function over a closed contour is equal to $2\pi i$ times the sum of residues of the function inside the contour c) The integral of a function over a closed contour is equal to the value of the function at a point inside the contour d) The integral of a function over a closed contour is equal to the sum of the function's residues inside and on the contour	K2	CO1
2	3	Which property of the Fourier transform allows us to compute the Fourier transform of a derivative? a) Linearity b) Time-scaling c) Frequency-shifting d) Convolution theorem	K1	CO2
	4	What is the relationship between the Fourier transform of a function and its derivative? a) They are equal b) They are inversely proportional c) They are related by a constant factor d) They are related by differentiation	K2	CO2
3	5	Bessel equations represent a class of a) Elliptic equations b) Hyperbolic equations c) Parabolic equations d) Ordinary differential equations	K1	CO3
	6	The differential equation $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} + (x^2 - n^2)y = 0$, where n is a positive constant is , a) Legendre equation b) Bessel equation c) Hermite equations d) Lauguerre equation	K2	CO3
4	7	What does the Heat Flow Equation describe? a) The flow of electricity through a conductor b) The diffusion of mass in a fluid c) The propagation of heat in a conducting medium over time d) The transfer of energy through radiation	K1	CO4
	8	The Heat Flow Equation connects the heat flux density with a) Temperature b) gradient of temperature c) pressure d) gradient of pressure	K2	CO4
5	9	The Bisection Method is primarily a numerical method for a) Solving systems of linear equations b) Finding the derivative of a function c) Finding the roots of a nonlinear equation d) Interpolating data points	K1	CO5
	10	The results obtained are greater than which among the following? a) Prismoidal rule b) Trapezoidal rule c) rectangular rule d) square rule	K2	CO5

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SECTION - B (35 Marks)

Answer **ALL** questions
ALL questions carry **EQUAL** Marks (5 x 7 = 35)

Module No.	Question No.	Question	K Level	CO
1	11.a.	State and prove the Cauchy-Riemann equations.	K2	CO1
		(OR)		
	11.b.	Show that $f(z) = \log(z)$ is an analytic function except at $z = 0$.		
2	12.a.	Find the finite sine transform of (i) $f(x) = e^x$ and *(ii)* $f(x) = \sin(ax)$	K2	CO2
		(OR)		
	12.b.	Find Laplace transform of (i) $\mathcal{L}(sinh(at))$ and (ii) $\mathcal{L}(cosh(at))$		
3	13.a.	Obtain the solution of Laplace's equation in spherical polar coordinates.	K4	CO3
		(OR)		
	13.b.	Prove that $(1 - 2xt + t^2)^{-1/2} = \sum_{n=0}^{\infty} t^n P_{n(x)}$.		
4	14.a.	Explain linear flow in semi-infinite solid.	K3	CO4
		(OR)		
	14.b.	The sides of a brick or rectangular parallelepiped are kept at zero temperature and its internal temperature is given by $f(x,y,z)\|_{t=0}$; Find the subsequent temperature after time t.		
5	15.a.	Find the equation of best fit to a straight line from the following data.	K5	CO5

X	2	4	6	8	10
y	8	12	15	16	18

		(OR)			
	15.b.	Evaluate $\int_4^{5.2} log_e\, x\, dx$ by Simpson's $(3/8)^{th}$ rule.			

SECTION -C (30 Marks)

Answer **ANY THREE** questions
ALL questions carry **EQUAL** Marks (3 × 10 = 30)

Module No.	Question No.	Question	K Level	CO
1	16	The residue at infinity is the negative of the coefficient of 1/z in the expansion of f(z) for values of z in neighbourhood of $z = \infty$.	K2	CO1
2	17	Find Fourier sine and cosine transforms of $f(t) = e^{-pt}$, p>0 Hence evaluate. $\int_0^{\infty} \frac{\cos \omega t}{P^2+\omega^2}\, d\omega$ at $\int_0^{\infty} \frac{\omega \sin \omega t}{P^2+\omega^2}\, d\omega$	K2	CO2
3	18	Find the solution of Bessel's equation. $x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - n^2)y = 0$	K3	CO3
4	19	Discuss the vibrations of a rectangular membrane.	K3	CO4
5	20	Solve the equation for $y(0.2)$ $\frac{dy}{dx} = \frac{y-x}{y+x}$ Assume $y(0) = 1$ and h= 0.2	K4	CO5

Z-Z-Z END