STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2023 – 2024 & thereafter)

M.Sc. DEGREE EXAMINATION NOVEMBER 2024
PHYSICS
FIRST SEMESTER

COURSE : MAJOR CORE
PAPER : MATHEMATICAL PHYSICS – I
SUBJECT CODE : 23PH/PC/MP14
TIME : 3 HOURS **MAX. MARKS : 100**

Q. No.	SECTION A Answer ALL the questions: (10x 3=30 marks)	CO	KL
1	Enumerate the properties of the operators Δ and E.	CO1	K1
2	Give the values of derivatives of an analytic function of complex variable z = x + iy.	CO1	K1
3	Introduce the contravariant and covariant tensors of second rank.	CO1	K1
4	Define isomorphism of vector space.	CO2	K2
5	Show that the process of raising and lowering of indices are reciprocal to each other.	CO2	K2
6	Give the three other forms of Gamma functions.	CO2	K2
7	Define Integrals of trigonometric functions of cosθ and sinθ and explain the integration around the unit circle.	CO2	K2
8	Give the relation between ket and bra vectors and inner products.	CO3	K3
9	Check whether log z is an analytic function of complex variable z = x + iy.	CO3	K3
10	Applying the Legendre polynomial $P_n(x)$, show that $P_{2m+1}(0) = 0$.	CO3	K3
Q. No.	**SECTION B (30 marks)**	**CO**	**KL**
	PART A **Answer any TWO questions: (2x 5 = 10 marks)**		
11	Transform $ds^2 = dx^2 + dy^2 + dz^2$ in spherical coordinates.	CO3	K3
12	S.T if f(z) = u +iv is an analytic function and **F** = u**i** + u**j** is a vector, then div**F** =0 and curl **F** =0 are equivalent to Cauchy – Reimann equations.	CO3	K3
13	Prove the recurrence relation, $XJ_n'(x) = xJ_n(x) – X J_{n+1}(X)$	CO3	K3
	PART - B **Answer any FOUR questions: (4x 5 = 20 marks)**		
14	What is the method of Iteration? Explain the condition for convergence of Iterations.	CO4	K4
15	Use Rodrigue’s formula, to find first four Legendre polynomials.	CO4	K4
16	Expand f(z) = sinz into a Taylor series about z = π/4	CO4	K4
17	Explain the outer product and inner product of tensors.	CO4	K4
18	Apply vector methods, to derive an equation of heat flow in solids.	CO4	K4

Q. No.	**SECTION C** **Answer the following: (2 x20=40 marks)**	CO	KL
19.	**A)** Derive the Newton – Gregory formula for forward and backward interpolation.	**CO5**	**K5**
	B) Explain the Gram Schmidt orthogonalization process and use it to construct an orthonormal set of vectors from the set $X_1 = (1,2,1)$ X2 = (2,1,4) & $X_3 = (4,5,6)$	**CO5**	**K6**
	(OR)		
	C) Establish the orthogonal properties of Legendre's polynomials.	**CO5**	**K5**
	D) State and prove Cauchy Integral formula and thereby solve the integral $\oint \frac{dz}{(Z^2+Z}$, where C is a circle defined by $\|Z\| = \|R > 1\|$	**CO5**	**K6**
20.	**A)** Show that $A\begin{pmatrix} -xy & -y^2 \\ x^2 & xy \end{pmatrix}$ is a tensor whereas $B\begin{pmatrix} -xy & -y^2 \\ x^2 & -xy \end{pmatrix}$ is not a tensor.	**CO5**	**K5**
	B) Find the numerical solution of dy/dx = x+y from x = 0 to 0.2 by Euler's method and modified Euler's method with the initial conditions $x_0 = 0$, $y_0 = 1$.	**CO5**	**K6**
	(OR)		
	C) Prove that $\Gamma(2m) = 2^{2m-1}(\pi)^{-1/2}\,\Gamma m\,\Gamma(m+1/2)$. Hence show that $(m+1/2)! = \pi^{1/2}\,(2m+1)!!/\,2^{m+1}$ where $(2m+1)!! = 1.3.5\ldots(2m-1)\,(2m+1)$	**CO5**	**K5**
	D) Applying tensors deduce Lagrange's equations of motion and there by extend it to a conservative force system.	**CO5**	**K6**

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