

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

M.Sc., DEGREE EXAMINATION NOVEMBER 2023
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	CO	KL
	Answer ALL the questions: (10x 3=30marks)		
1	Differentiate between interpolation and extrapolation giving suitable example.	CO1	K1
2	What are the quantities that are estimated in Runge-Kutta method? What is the disadvantage of the method?	CO1	K1
3	Which of the following two functions are analytic functions of complex variables? a. $ Z $ b. $\text{Re}Z$	CO1	K1
4	Write the Taylor's series. On what condition will Taylor's series become Maclaurin series?	CO2	K2
5	What are ket and bra vectors? State the rules governing them.	CO2	K2
6	What are orthonormal sets?	CO2	K2
7	What are the indicial and Einstein's summation convention used in tensors?	CO2	K2
8	Show that the outer product of two tensors is a tensor whose rank is the sum of the ranks of given tensors.	CO3	K3
9	Show that beta function is symmetric.	CO3	K3
10	What is gamma function? Write its different forms.	CO3	K3
Q. No.	SECTION B (30 marks)	CO	KL
	PART A		
	Answer any TWO questions: (2x 5 = 10 marks)		
11	Derive Fourier's equation of heat flow in solids using vector methods.	CO3	K3
12	Apply tensors to analyse rigid body motion and express moment of inertia of rigid body in tensor form.	CO3	K3
13	Using modified Euler method, find $y(0.2)$, $y(0.1)$ given $dy/dx = x^2 + y^2$, $y(0) = 1$.	CO3	K3
	PART - B		
	Answer any FOUR questions: (4x 5 = 20 marks)		
14	Derive the Newton-Gregory formula for forward interpolation.	CO4	K4
15	Show that the real and imaginary parts of the function $\log Z$ satisfy the Cauchy-Riemann equations when Z is not zero. Also find the derivative of $\log Z$.	CO4	K4

16	State and prove the expansion theorem.	CO4	K4
17	What are covariant and contravariant tensors? If A^μ and B_μ are any two vectors, one contravariant and the other covariant, then prove that $A^\mu B_\mu$ is invariant.	CO4	K4
18	$P_n^{m+1}(x) - 2m \frac{x}{\sqrt{1-x^2}} P_n^m(x) + \{n(n+1) - m(m-1)\} P_m^{m-1}(x) = 0$	CO4	K4
Q. No.	SECTION C	CO	KL
	Answer the following: (2 x20=40 marks)		
19.	(a) Use Runge-Kutta method to solve the equation $\frac{dy}{dx} = \frac{y-x}{y+x}$ with initial conditions $x_0 = 0$ and $y_0 = 1$. (10 marks) (b) Obtain the general quadratic formula and use it to derive Simpson's one-third rule. (10 marks)	CO5	K5 K6
	(OR)		
	(c) From the set of vector (1, 0, 1), (0, 0, 1) and (1, 1, 0) construct a set of orthonormal vectors. (10 marks) (d) Discuss Euler's equation of motion using vector notations. (10 marks)	CO5	K5 K6
20.	(a) Explain raising and lowering of indices in tensors using suitable examples. What are associated tensors? (10 marks) (b) Discuss the application of tensors in elasticity and express stress-strain relation in tensor notation. (10 marks)	CO5	K5 K6
	(OR)		
	(c) Derive the Rodrigue's formula for Legendre's polynomial. (10 marks) (d) Obtain the generating function of Legendre's polynomial. (10 marks)	CO5	K5 K6
