

B.Sc. DEGREE EXAMINATION APRIL 2026
BRANCH III - PHYSICS
FOURTH SEMESTER

COURSE : MAJOR – CORE
PAPER : MATHEMATICAL PHYSICS
SUBJECT CODE : 23PH/MC/MP44
TIME : 3 HOURS

MAX. MARKS: 100

Q. No.	SECTION A Answer ALL the questions (20x1=20)	CO	KL
1.	The gradient of scalar field is always _____. a) a scalar b) a vector c) a numeric d) sometimes a scalar & sometimes a vector	CO1	K1
2.	Curl \mathbf{r} is _____. a) 0 b) 1 c) 3 d) \hat{r}	CO1	K1
3.	Poisson's equation is _____. a) $\text{div } \mathbf{E} = \rho / \epsilon_0$ b) $\text{curl } \mathbf{E} = \mathbf{J}$ c) $\nabla^2 \phi = 0$ d) $\nabla^2 \phi = -\rho / \epsilon_0$	CO1	K1
4.	The condition of solenoidal vector field is _____. a) $\text{grad } A = 0$ b) $\text{div } A = 0$ c) $\text{curl } A = 0$ d) $\text{curl } A = \text{finite}$	CO1	K1
5.	The necessary & sufficient condition that the line integral $\oint \mathbf{A} \cdot d\mathbf{r} = 0$ for every closed contour is C a) $\text{div } \mathbf{A} = 0$ b) $\text{curl } \mathbf{A} = 0$ c) $\text{div } \mathbf{A} \neq 0$ d) $\text{curl } \mathbf{A} \neq 0$	CO1	K1
6.	Product of a complex number and its conjugate is a) imaginary b) real c) complex d) zero	CO1	K1
7.	A differential equation of the first order is in the form a) $\frac{dy}{dx} = \frac{y-x}{y+x}$ b) $M(x, y)dx + N(x, y)dy = 0$ c) $\frac{M(x, y)}{N(x, y)} = \text{constant}$ d) $N(x, y)dy + m(x, y)dx = \text{constant}$	CO1	K1
8.	If the fluid is compressible, then a) $\text{div } \mathbf{v} \neq 0$ b) $\nabla \times \mathbf{V} = 0$ c) $\text{grad } V = 0$ d) All of these	CO1	K1
9.	Laplace's equation is applicable to a) $\rho = 0$ b) $\sigma = 0$ c) $\lambda = 0$ d) None of these	CO1	K1
10.	The voltage drop across the inductance L is a) q/c b) RI c) $L (dI/dt)$ d) q/RI	CO1	K1
11.	If two complex numbers $a+ib$ and $c+id$ are equal, then. a) $a=b, c=d$ b) $a=c, b=d$ c) $a=d, b=c$ d) None of these	CO1	K1
12.	The value of i^{49} is a) i b) 1 c) $-i$ d) -1	CO1	K1

13.	The conjugate of complex number $3-4i$ is_____. a) $-3+4i$ b) $3+4i$ c) $3-4i$ d) $-3-4i$	CO1	K1
14.	Which type of differential equations are Poisson's and Laplace's equations? a) Linear ordinary differential equations b) Nonlinear algebraic equations c) Linear partial differential equations d) Integral equations	CO1	K1
15.	Find the value of c , so that $x(t) = ce^{2t}$ satisfies the condition $x(1) = 1$. a) $c = e^2$ b) $c = e^{-2}$ c) $c = 1$ d) $c = 0$	CO1	K1
16.	Laplace's equation is applicable to fluid flow when the fluid is _____. a) Viscous and compressible b) Compressible and rotational c) Incompressible and irrotational d) Turbulent and viscous.	CO1	K1
17.	The equation of a circle with center z and radius r is_____. a) $ z + z_0 = r$ b) $ z z_0 = r$ c) $ z - z_0 = r$ d) $ z_0 = r$	CO1	K1
18.	Which of the following functions is a solution of differential equation $(dy/dx) - 5y = 0$? a) $y = 5$ b) $y = 2e^{5x}$ c) $y = x^5$ d) $y = 5x$	CO1	K1
19.	The surface integral of a vector field $\iint F \cdot dA$ represents_____. a) Work done b) Flux through a surface c) Area of surface d) Divergence of field	CO1	K1
20.	The velocity vector is always a) Tangent to the path of the particle b) Normal to the path of the particle c) Parallel to acceleration of the particle d) Constant	CO1	K1
Q. No.	SECTION B Answer ALL the questions (10x2=20)	CO	KL
21.	Give the vector representation of moment of a force.	CO2	K2
22.	Define the term scalar point function.	CO2	K2
23.	Define double and triple integrals with one example each.	CO2	K2
24.	What are homogeneous and non-homogeneous linear differential equations?	CO2	K2
25.	State the fundamental laws of algebra on complex numbers.	CO2	K2
26.	Find the value of $\int_0^3 R(u)du$ if $R(u) = u \hat{i} + 2u^2 \hat{j} - 3\hat{k}$	CO2	K2
27.	Find the argument and moduli of complex number $z = 1-i / 1+i$	CO2	K2
28.	Give the general solutions of second order differential equations.	CO2	K2

29.	Show that $\nabla \times (\nabla \phi) = 0$.	CO2	K2
30.	Show that acceleration $a = v \, dv/dx$	CO2	K2
Q. No.	SECTION C Answer any TWO questions (2x10=20)	CO	KL
31.	Show that $\mathbf{A} = (2xy + z^3) \hat{i} + x^2 \hat{j} + 3xz^2 \hat{k}$ is a conservative force field. Find the scalar potential.	CO3	K3
32.	State Gauss' divergence theorem. Use the theorem to solve $\iiint [\mathbf{A} \cdot d\mathbf{s}]$ where $\mathbf{A} = x^2 \hat{i} + y^2 \hat{j} + z^2 \hat{k}$ taken over the cube of side one unit.	CO4	K4
33.	Discuss the three properties of moduli of complex numbers.	CO3	K3
34.	Find the polar form of (1-i) and (1+3i)	CO4	K4
Q. No.	SECTION D Answer any TWO questions (2x10=20)	CO	KL
35.	Obtain an expression for the curl of a vector and give its physical significance.	CO3	K3
36.	Using Maxwell's 2nd and 3rd equations, Prove that $\nabla \cdot \mathbf{D} = \rho$ and $\nabla \cdot \mathbf{B} = 0$.	CO4	K4
37.	Derive the necessary condition for a complex function to be analytic.	CO3	K3
38.	Obtain an expression for second order differential equation for RLC circuit.	CO4	K4
	SECTION D Answer any FOUR questions (4 x 5= 20)		
39.	An RL circuit has a resistance of 10 ohms and inductance of 1.5 Henries, an applied emf of 9 volts and an initial current of 6 amps. Find (a) the current in the circuit at any time t and (b) its transient component.	CO5	K5
40.	A particle moves along a curve whose parametric equations are $x = 3e^{-2t}$, $y = 4 \sin 3t$, $z = 5 \cos 3t$ where 't' is the time. Find the magnitudes of the velocity and acceleration at $t = 0$.	CO5	K5
41.	Find the work done in moving a particle in the field $\mathbf{F} = 2x(y^2 + z^3) \hat{i} + 2x^2y \hat{j} + 3x^2z^2 \hat{k}$ from the point (-1, 2, 1) to (2, 3, 4).	CO5	K5
42.	A spring for which $k = 50 \text{ Nm}^{-1}$ hang in a vertical position with its upper end fixed. A mass of 5 kg is attached to the lower end. After coming to rest, the mass is pulled down 0.05m and released. Discuss the resulting motion of the mass, neglecting air-resistance.	CO5	K5
43.	Check if the function $u = y^3 - 3x^2y$ is harmonic and find its harmonic conjugate v.	CO5	K5
44.	Determine the divergence of $\mathbf{F} = 30 \hat{i} + 2xy \hat{j} + 5xz^2 \hat{k}$ at (1, 1, -0.2) and state the nature of the field.	CO5	K5