

STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086
(FOR candidates admitted from the academic year 2019-2020 & thereafter)
SUBJECT CODE : 19PH/MC/MP44
B.Sc. DEGREE EXAMINATION – APRIL 2023
BRANCH III – PHYSICS
FOURTH SEMESTER

COURSE : MAJOR CORE
PAPER : MATHEMATICAL PHYSICS
TIME : 3 HOURS

MAX. MARKS : 100

SECTION – A

ANSWER ALL QUESTIONS:

I CHOOSE THE CORRECT ANSWER:

(10 x 1 = 10)

1. The magnitude of _____ at any point is the rate of change of the function Φ with distance along the normal to the level surface at the point and is directed along unit vector.
(a) $\text{Curl } \Phi$ (b) $\text{grad } \Phi$ (c) $\text{div } \Phi$ (d) $\text{curl.grad } \Phi$
2. $\text{Grad} \left(\frac{1}{r}\right)$ is equal to _____.
(a) $\left(\frac{\vec{r}}{r^2}\right)$ (b) $1/r^2$ (c) $-\vec{r}/r^2$ (d) $-\vec{r}/r^3$
3. The divergence of a vector field is always _____.
(a) a scalar (b) a vector (c) a pseudoscalar (d) a constant
4. For a position vector $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$, the value of $\text{curl } \vec{r} =$ _____.
(a) 0 (b) 1 (c) xyz (d) 3
5. The Poisson's equation is $\nabla^2\Phi =$ _____.
(a) ρ/ϵ_0 (b) ρ^2/ϵ_0 (c) $-\rho/\epsilon_0$ (d) $\text{div}(\rho/\epsilon_0)$
6. If the line integral $\int \vec{A} \cdot d\vec{r}$ is independent of path, then the vector field $\vec{A}(x, y, z)$ is said to be a _____ field.
(a) Conservative (b) non-conservative (c) lamellar (d) solenoidal
7. In an L-R series circuit, if 'I' is the current flowing in the circuit containing resistance R and inductance L in series with voltage source E, then, at any time t, according to voltage law, $E =$ _____.
(a) $RI - L \cdot dI/dt$ (b) $RI + L \cdot dI/dt$ (c) $q + L \cdot dI/dt$ (d) $LR + q \cdot dI/dt$
8. In a damped LCR circuit, when the roots are equal, the condition is called _____.
(a) Overdamped (b) underdamped (c) critically damped (d) oscillatory
9. The difference of a complex number and its conjugate is _____.
(a) A real number (b) an imaginary number (c) an indefinite number (d) zero
10. Any function which satisfies the Laplace's equation is known as _____ function.
(a) Harmonic (b) analytic (c) holomorphic (d) orthogonal

II FILL IN THE BLANKS:

(5 x 1 = 5)

11. If \vec{r} and \vec{s} are functions of x, y and z, then $\partial/\partial x (\vec{r} \times \vec{s}) =$ _____.
12. Complete the vector identity: $\text{curl} (\Phi \vec{A}) =$ _____.

13. According to Gauss divergence theorem, $\iint_S \vec{A} \cdot d\vec{s} = \text{_____}$.
14. The general solution of a linear differential equation with constant coefficients is the sum of particular integral and _____.
15. The value of i^8 is _____.

III. ANSWER BRIEFLY**(5 x 2 = 10)**

16. Differentiate scalar and vector point function.
17. Write Gauss's law in differential form.
18. State Green's theorem.
19. Differentiate between damped and forced oscillations.
20. What is argand diagram?

SECTION – B**ANSWER ANY FIVE QUESTIONS:****(5 x 6 = 30)**

21. A particle moves along the curve $x = 2t^2$, $y = t^2 - 4t$, $z = 3t - 5$, where t is the time. Find component of its velocity and acceleration at $t = 1$ in the direction $\vec{i} - 3\vec{j} + 2\vec{k}$.
22. If a rigid body is in motion, show that the curl of its linear velocity at any point gives twice its angular velocity.
23. Find the work done in moving a particle in the force field $\vec{F} = 3x^2\vec{i} + (2xz - y)\vec{j} + z\vec{k}$ along the curve defined by $x^2 = 4yj$ and $3x^2 = 8z$ from $x = 0$ to $x = 2$.
24. An inductor of H henry and a capacitor of C farad are in series with a generator of E volt. At $t = 0$, the charge on the capacitor and the current are zero. Find the charge on the capacitor at any time $t > 0$, if $E = E_0$ is a constant.
25. Find the modulus and principal argument of complex number, $(1 + \cos \alpha + i \sin \alpha)$, where $0 < \alpha < \pi/2$.
26. Prove that (i) $\text{div} \cdot \text{curl } A = 0$, and (ii) $\text{curl} \cdot \text{grad} \Phi = 0$.
27. Derive the expression for equation of motion of a spring in free oscillation.

SECTION – C**ANSWER ANY THREE QUESTIONS:****(3 x 15 = 45)**

28. What is Newton's law of gravitation? Derive the expression for gravitational potential and show that the intensity of gravitational field at a point is equal to negative gradient of potential.
29. Write the Maxwell's equations in differential form. Show that electric potential satisfies the Poisson's equation and magnetic potential satisfies the Laplace equation.
30. Derive the Euler's equation of motion in vector form using Gauss divergence theorem.
31. Find the equation of motion of a body falling vertically under gravity and encounters resistance of the atmosphere. If the resistance varies as its velocity, show that the equation of motion is given by $du/dt = g - ku$, where u is the velocity and k is a constant. Also show that as 't' increases, u approaches the value g/k .
32. Derive the Cauchy-Reimann equations for a function $f(z)$ to be analytic. Determine whether the function $\frac{1}{z}$ is analytic or not.

