STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086
(FOR candidates admitted from the academic year 2019-2020 & thereafter)

B.Sc. DEGREE EXAMINATION – APRIL 2024
BRANCH III – PHYSICS
FOURTH SEMESTER

COURSE : MAJOR CORE
PAPER : MATHEMATICAL PHYSICS
SUBJECT CODE : 19PH/MC/MP44
TIME : 3 HOURS **MAX. MARKS : 100**

SECTION – A

ANSWER ALL QUESTIONS:
I CHOOSE THE CORRECT ANSWER: **(10 x 1 = 10)**

1. If the fluid is compressible, then
   a) $div\vec{v} = 0$ b) $\vec{v} \nabla \times \vec{V} = 0$ c) grad V=0 d) All of these
2. The example for a scalar point function is
   a) Temperature b) Gravitational force c) velocity of a fluid d) Electric Intensity
3. The time varying electric field produces a magnetic field .This phenomenon is called.
   a) Kircchoff's law b) Faraday's law c) Ampere-Maxwell's law d) Hertz law
4. _____ .is the amount of work done to move a unit charge from infinity to a specific point in an electric field.
   a) Electric field b) kinetic energy c) Electrostatic potential d) potential energy
5. Laplace's equation is applicable to
   a) $\rho=0$ b) $\sigma=0$ c) $\lambda=0$ d) None of these
6. Green's theorem is used to
   a) Transform the line integral in the x-y plane to a surface integral in the same x-y plane
   b) transform double integrals in to the triple integral in a region **v** c) transform surface integral in to a line integral d) All of these
7. The voltage drop across the inductance L is
   a) q/c b) RI c) L (dI/dt) d) q/RI
8. The ……in the string balances the mass mg hanging at the end.
   a) Tension b) downward acceleration c) downward force d) Friction
9. 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
10. The value of i^{49} is
    a) i b) 1 c) -i d) -1

II. FILL IN THE BLANKS **(5 x 1 = 5)**

11. If $\phi_1$and ϕ_2 are orthogonal, then normal's are _____ to each other.
12. A surface r=f (u,v) is called _____ if f (u,v) possess continuous first order partial derivatives.
13. The circulation of vector F around a closed C is equal to the _____ of the curve of the vector through the surface bounded by the curve.
14. The algebraic sum of the voltage drop around any closed circuit is equal to the _____ E.m.f in the circuit.
15. Two complex numbers which differ only in the sign of imaginary parts are called _____ of each other.

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

16. Define moment of a force.
17. Write Maxwell's equations.
18. Define double and triple integrals with one example each.
19. What are homogeneous and non-homogeneous linear differential equations?
20. State the fundamental laws of algebra on complex numbers.

SECTION – B

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

21. Find the directional derivative of $\phi(x, y, z) = x^2yz + 4xz^2$ at (1,-2, 1) in the direction of $2\hat{i} - \hat{j} - 2\hat{k}$.
22. Deduce Gauss' law in differential form.
23. Find the divergence and curl of $\vec{v} = (xyz)\hat{i} + (3x^2y)\hat{j} + (xz^2 - y^2z)\hat{k}$ at (2,-1,1).
24. A vector field is given by $\vec{F} = (\sin y)\hat{i} + (1 + \cos y)\hat{j}$. .Evaluate the line integral over a circular path $x^2+y^2=a^2$, z=0
25. An inductance of 2 Henry and a resistance of 20 Ohms are connected in series with an Emf E volts. As the current is zero when t=0, find the current at the end of 0.01 sec if E=100 volts.
26. Geometrically represent and explain the addition and subtraction of complex numbers.
27. Show that the function e^x (cos y +i sin y) is an analytic function. Also, find its derivative.

SECTION – C

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

28. A particle moves along the curve $\vec{r} = (t^3 - 4t)\hat{i} + (t^2 + 4t)\hat{j} + (8t^2 - 3t^3)\hat{k}.$ where "t" is the time . Find the magnitude of the tangential components of its acceleration at t=2.
29. A fluid motion is given by $\vec{v} = (y + z)\hat{i} + (z + x)\hat{j} + (x + y)\hat{k}.$ Show that the motion is irrotational and hence find the velocity potential.
30. State Gauss divergence theorem. Use Gauss divergence theorem to evaluate $\iint_S \vec{A}ds$ where $\vec{A} = x^3\hat{i} + y^3\hat{j} + z^3\hat{k}$ and S is the surface of the sphere $x^2+y^2+z^2=a^2$
31. A particle falls under gravity in a resisting medium whose resistance varies with velocity. Find the relation between distance and velocity if initially the particle starts from rest.
32. Prove that $u = x^2 - y^2 - 2xy - 2x + 3y$ is harmonic. Find a function v such that f (z) = u+iv is analytic. Also express f (z) in terms of z.

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