STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2015-16 and thereafter)

SUBJECT CODE : 15PH/MC/MP44

B.Sc. DEGREE EXAMINATION APRIL 2019
BRANCH III - PHYSICS
FOURTH SEMESTER

COURSE	**:**	**MAJOR – CORE**	
PAPER	**:**	**MATHEMATICAL PHYSICS**	
TIME	**:**	**3 HOURS.**	**MAX. MARKS :100**

SECTION – A

ANSWER ALL QUESTIONS: **(30 x 1 = 30)**

I Choose the Correct Answer:

1. If $\vec{r}$ is the position vector of a point, then the value of grad (1/r) is__________ .
   (a) $\vec{r}/r^3$ (b) $-\vec{r}/r^3$ (c) $-1/r^3$ (d) $1/r^3$

2. The gravitation field is the _________ of the gravitational potential
   (a) inverse (b) directional derivative
   (c) negative gradient (d) positive gradient.

3. Work done by a force $\vec{F} = 4\hat{\imath} + \hat{\jmath} - 3\hat{k}$ on a particle when it is displaced through $\vec{r} = 4\hat{\imath} + 2\hat{\jmath} - 2\hat{k}$ is given by __________
   (a) 24 units (b) 12 units (c) $16\hat{\imath} + 2\hat{\jmath} + 6\hat{k}$ (d) $(16\hat{\imath} + 2\hat{\jmath} + 6\hat{k})/\sqrt{296}$

4. A vector is called a solenoidal vector when, _______
   (a) div$\vec{A}$= 0 (b) curl $\vec{A}$ = 0 (c) grad $\vec{A}$ = 0 (d) div curl $\vec{A}$ = 0.

5. If a rigid body is in motion, the curl of its __________ at any point gives twice its angular velocity
   (a) Position vector (b) angular acceleration (c) linear velocity
   (d) linear acceleration

6. According to Maxwell's equation, the divergence of electric field $\vec{E}$ is directly proportional to __________
   (a) magnetic constant (b) charge density (c) current density (d) electric constant

7. If $\vec{A}$ and $\vec{B}$ are irrotational, then $\vec{A}$ X $\vec{B}$ is _________
   (a) solenoidal (b) lamellar (c) conservative (d) irrotational

8. The __________ theorem relates the line and surface integrals.
   (a) Stoke's (b) Gauss (c) Green's (d) Helmholtz

9. The magnetic scalar potential ϕ_B satisfies the __________ equation.
   (a) Poisson's (b) equation of continuity (c) Euler's equation (d) Laplace equation

10. The solutions $y_1(x)$ and $y_2(x)$ of a second order linear differential equation are linearly independent if
    (a) $Ay_1(x) + By_2(x) = 0$ (b) $Ay_1(x) + By_2(x) =$ constant
    (c) $Ay_1(x) + By_2(x) \neq 0$ (d) $Ay_1(x) = By_2(x)$

11. A differential equation of the form $y'' + P(x)\, y' + Q(x) = F(x)$ is called homogeneous if
    (a) $F(x) = 0$ (b) $F(x) \neq 0$ (c) $F(x) =$ a constant (d) $P(x) = Q(x)$

12. The equations of electromotive force in terms of current 'i' for an electrical circuit having resistance R and a condenser of capacity C in series is E = __________
    (a) $Ri + \int i/C.dt$ (b)$Rdi/dt + \int i/C.dt$ (c) $i/R + \int i/C.dt$ (d) $iR + \int iC.dt$

13. The crystallographic point groups are altogether _______ in number.
(a) 64 (b) 14 (c) 32 (d) infinite

14. If a molecule has _________________, then any vibration that is active in IR is inactive in Raman and vice-versa.
    (a) centre of inversion (b) axis of symmetry
    (c) rotational symmetry (d) centre of symmetry

15. Which of the following is a proper symmetry operation?
    (a) 'n' fold axis of rotation, C_n (b) Reflection, σ
    (c) inversion through center of symmetry, i (d) rotary – reflection, S_n

II Fill in the blanks:

16. The gradient of any scalar quantity is a __________.
17. The equation of continuity is __________.
18. If $\nabla^2\phi = 0$ is true for every point of a region, the function ϕ is said to be _________ in the region.
19. When the roots of auxiliary equation of a LCR circuit are imaginary, the condition of oscillation is called __________.
20. If a representation is __________ , it is called as faithful representation.

III State whether True or false:

21. The directional derivative of vector-point function along any line is same as the directional derivative of scalar-point function along the line.
22. For a vector to be irrotational, its curl should be a non-zero quantity.
23. Bernoulli's equation is valid only for non-viscous fluids.
24. The degree of a differential equation is the order of the highest derivative which appears in it.
25. Every group is a subgroup of itself.

IV. Answer briefly:

26. State the rules for partial differentiation of vectors.
27. If $u = yz^2\hat{\imath} - 3xz^2\hat{\jmath} + 2xyz\hat{k}$ and $\phi = xyz$, find u x$(\nabla\phi)$.
28. State Green's theorem.
29. What are the laws to be followed for the formation of differential equation for an electric circuit?
30. State any two group axioms.

SECTION – B

Answer any FIVE of the following: (5 x 5 = 25)

31. Find the rate of change of $\phi = xyz$ in the direction normal to the surface $x^2y + y^2x + yz^2 = 3$ at the point (1, 1, 1).
32. Find div grad r^m.
33. Find the value of a, b and c such that $\vec{F}= (3x- 4y + az)\,\hat{\imath} + (cx + 5y - 2z)\hat{\jmath} + (x - by + 7z)\hat{k}$ isirrotational.
34. Calculate the work done in moving a particle in the force field $\vec{F} = 3x^2\hat{\imath} + (2xz-y)\hat{\jmath} + z\hat{k}$ along the curve defined by $x^2 = 4y$ and $3x^2 = 8z$ from x =0 to x = 2
35. State Gauss divergence theorem and explain its physical significance.
36. 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.
37. Write a note on 2 dimensional rotational groups.

SECTION – C

Answer any THREE of the following: (3x15 =45)

38. (a) Write a note on (i) level surfaces (ii) gradient of a scalar field.

(b) Let **f(x, y,z)** = xy.exp(x^2+z^2–5). Calculate the gradient of **f**at the point (1, 3, -2)and calculate the directional derivative at the point (1, 3, -2) in the direction of the vector$\vec{\mathbf{v}}$ = (3, -1, 4)

39. (a) Define curl of a vector function. Explain the physical significance of curl of a vector function.
    (b) Show that curl $(\phi\mathbf{A}) = \phi\,(\nabla \times \mathbf{A}) + (\nabla\phi \times \mathbf{A})$.
40. Obtain the equation of continuity and the equation of motion for the flow of an incompressible fluid using vector methods.
41. Form the differential equation for a spring system under undampedforced oscillations and discuss the different ways amplitude of oscillations vary according to frequency variations.
42. Explain how symmetry operations determine the IR and Raman active vibrations, giving suitable examples.

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