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

SUBJECT CODE : 15PH/MC/MP44

B.Sc. DEGREE EXAMINATION APRIL 2017
BRANCH III - PHYSICS
FOURTH SEMESTER

REG. No._____

COURSE : MAJOR – CORE
PAPER : MATHEMATICAL PHYSICS
TIME : 30 MINS. MAX. MARKS : 30

TO BE ANSWERED ON THE QUESTION PAPER ITSELF
SECTION – A

ANSWER ALL QUESTIONS: (30 x 1 = 30)

I Choose the Correct Answer:

1. Which of the following is a scalar point function?
   (a) Density (b) Gravitational field (c) Electric field (d) Magnetic field

2. The evaluation of ∇r^n is,
   (a) $nr^{n-1}r$ (b) $nr^{n-2}r$ (c) $nr^{n-3}r$ (d) $nr^n r$

3. If r $= a\cos\omega t + b\sin\omega t$, then $r \times \frac{dr}{dt}$ is,
   (a) $-\omega^2(a \times b)$ (b) $\omega(a^2 \times b^2)$ (c) $\omega(a \times b)$ (d) $\omega^2(a \cdot b)$

4. The value of $\nabla(e \cdot r)e$, if e is a unit vector,
   (a) 0 (b) 2 (c) -1 (d) 1

5. u, v and w are point functions and $uv = \nabla\omega$, then $v \cdot curlv$ is,
   (a) Three (b) Two (c) One (d) Zero

6. The gradient of $(a \cdot r)$ if $a = \alpha xi + \beta yj + \gamma zk$ is equal to,
   (a) Zero (b) -a (c) 2a (d) a

7. The workdone by the force is represented by
   (a) $F \times dr$ (b) $F \cdot dr$ (c) φdr (d) Adr

8. A vector field **A** is said to be conservative if there exists a scalar point function φ such that **A** is equal to
   (a) gradφ (b) curlφ (c) grad curlφ (d) div gradφ

9. The condition for an irrotational vector F is,
   (a) div$F=0$ (b) grad curl$F=0$ (c) grad div$F=0$ (d) curl$F=0$

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10. The solution of the differential equation $\frac{dy}{dx} = x + xy$ is,
    (a) $Ae^{-\frac{x^2}{2}}$ (b) $Ae^{\frac{x^3}{2}}$ (c) $Ae^{\frac{x}{2}}$ (d) $Ae^{\frac{x^2}{2}}$

11. A differential equation is of the form $\frac{d^2y}{dx^2} + p_1\frac{dy}{dx} + p_2y = X$ where p_1, p_2 are constants and X is a function of x. The complementary function, if the roots are of the type $\alpha \pm \sqrt{\beta}$, is
    (a) $C_1e^{\alpha x}\cosh\ \overline{\beta x} + C_2$ (b) $C_1e^{\beta x}\cosh\ \overline{\alpha x} + C_2$
    (c) $C_1e^{\alpha x}\sinh\ \overline{\beta x} + C_2$ (d) $C_1e^{\beta x}\sinh\ \overline{\alpha x} + C_2$

12. Which of the following is linear differential equation?
    (a) $ydx - xdy = xydx$ (b) $a + y\ dy = (x - y)dy$
    (c) $\frac{dy}{dx} + 3y = e^{2x}$ (d) None of these

13. The order of the identity element of a group is,
    (a) 1 (b) 2 (c) 3 (d) 4

14. All members of the group can be generated from just one element, such a group is,
    (a) subgroup (b) cyclic group (c) Non-Abelian group (d) finite group

15. For a body of finite extension, only _____ symmetry group of a finite body must leave at least one point of the body fixed
    (a) one (b) two (c) three (d) four

II Fill in the blanks:

16. The magnitude of gradφ at any point is the rate of change of function φ with _____ along the normal to the level surface at the point.
17. The fields of the class, where curl $V = 0$ and div $V \neq 0$ satisfies_____.
18. A theorem which states that 'the flux of $\nabla \times A$ over surface S of any shape is equal to the line integral of A over the boundary of surface, is _____.
19. The order of differential equation, $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = 0$ is_____.
20. Two groups $G = (E, A, B, C, \ldots..)$ and $S = (I, a, b, c, \ldots..)$ are of the same order g. these two groups are said to be _____ if there exists one-to-one correspondence between their elements.

III State whether True or false:

21. A scalar potential function $f(x)$ is continuous at a point $x = x_0$ if $f(x)$ is not defined.
22. If the divergence of a vector is zero, then the vector is called solenoidal vector.
23. The integral point function along a curve is called line integral.
24. A function defining y as a function of x in the form $f(x, y) \neq 0$ is said to be an implicit function.
25. Every subgroup of an infinite cyclic group is infinite.

IV Answer briefly:

26. What does the product $a+b \cdot (a-b)$ mean in the case a^2-b^2 ?

27. Find the value of $\int_2^3 \frac{dr}{dt} dt$ if $r\ t = 2i - j + 2k$ when *t=2* and $r\ t = 4i - 2j + 3k$ when $t = 3$.

28. Show that $r^n \cdot r$ is an irrotational.

29. Solve the equation $\frac{dy}{dx} - e^{2x} = 0$.

30. State Lagrange's theorem.

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SECTION – B

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

1. A proton is moving with velocity 10^5 m/s along Z-axis in an electric field of intensity 5×10^4 V along X-axis and magnetic field of intensity 0.4 Tesla along Y-axis. Calculate the magnitude and direction of total force.

2. Find $v \cdot \nabla \times u$ if $u = yz^2i - 3xz^2j + 2xyzk$ and $v = 3xi + 4zj - xyk$.

3. What are Laplace's equations? Give an account on their applications.

4. A resistance R and a 2μF capacitor are connected in series with 200 V direct supply. Across the capacitor, a neon lamp that strikes at 120 V. Calculate the value of R to make the lamp strike 5s after switch is closed.

5. What are symmetry elements? Explain the formation of a group of symmetry with an example.

6. Explain the finding procedure of particular integral and complementary function for a differential equation, $\frac{d^2y}{dx^2} + a_1\frac{dy}{dx} + a_2y = f$. Discuss the different cases of complementary function.

7. Find the workdone in moving a particle in the force field $F = 3x^2i + \ 2xz - y\ j + 2k$ along the curve defined by $x^2=4y$ and $3x^2=8z$ from $x=0$ and $x=2$.

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SECTION – C

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

8. (a) The charges and coordinates of two charged particles held fixed in the *X*-*Y* plane are $q_1 = 3\ \mu C$, $x_1 = 3.5$ cm , $y_1 = 0.5$ cm and $q_2 = -4\ \mu C$, $x_2 = -2\ cm, y_2 = 1.5$ cm. Find the magnitude and direction of the electric force on q_2. (4)

   (b) Calculate the force acting on the proton in a magnetic field of intensity 0.02 tesla directed along Z-axis when the proton moves with velocity 10^8 m/s along X-axis. (4)

   (c) The acceleration of a particle at time $t \geq 0$ is given by $a = t^2 i + 2tj + t^3 k$. If the velocity v and the displacement r be zero at $t = 0$, find the velocity and displacement at any time. (7)

9. (a) Show that *E* and *H* satisfy $\nabla^2 u = \frac{\partial^2 u}{\partial t^2}$, if $\nabla \cdot E = 0$, $\nabla \cdot H = 0$, $\nabla \times E = 0$, and $\nabla \times \mathrm{H} = \frac{\partial E}{\partial t}$. (5)

   (b) Show that the solutions to the Maxwell's equations are $E = -\nabla\varphi - \frac{1}{C}\frac{\partial E}{\partial t}$ and $H = \nabla \times \mathrm{A}$, where A and φ are the vector and scalar potentials respectively, satisfy the equations

   (i) $\nabla \cdot A + \frac{1}{C}\frac{\partial \varphi}{\partial t} = 0$ (ii) $\nabla^2\varphi - \frac{1}{C^2}\frac{\partial^2 \varphi}{\partial t^2} = 4\pi\rho$ (iii) $\nabla^2 A = \frac{\partial^2 A}{\partial t^2}$. (10)

10. (a) Obtain Poisson's equation in electrostatics from Gauss's law. What form does it take when the charge density is zero? (10)

    (b) Show that the potential can't have a maximum or minimum value at any point in space that is not occupied by an electric charge. (5)

11. (a) A spring with mass of 4 kg has natural length 1 m. A force of 25 N is applied and stretched the spring to a length of 1.5 m. If it is released with initial velocity $v = 0$, find the position of mass at any time t. (10)

    (b) A body is propelled straight up with an initial velocity of 500 m/s without air resistance. How long will it take the body to return the ground? Assume that the acceleration due to gravity, $g = 10$ m/s^2. (5)

12. (a) How is group theory applied in IR and Raman active vibrations? Explain with an example. (10)

    (b) Write a short note on SU(2) scheme. (5)