

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 2018
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:

- Torque (or moment of force) is an example for,
(a) scalar multiplication (b) scalar product (c) vector product (d) scalar triple product
- The term $(\int \vec{F} \cdot d\vec{r})$ in Physics is,
(a) torque (b) power (c) acceleration (d) work
- For a vector field \vec{F} , the expression, $\vec{\nabla} \times (\vec{\nabla}\phi)$ is,
(a) 0 (b) ϕ (c) $\vec{\phi}$ (d) 1
- The equation $\nabla^2\phi = 0$ is,
(a) Poisson's equation (b) Laplace's equation (c) Gauss equation (d) Stoke's equation
- The term ϕ in the equation $\vec{A} = \vec{\nabla}\phi$ is called,
(a) scalar potential (b) vector potential (c) pseudo vector (d) vector field
- “Line integral is path independent” – this statement holds good for,
(a) constant field (b) conservative field (c) non-conservative field (d) all fields
- The order of the differential equation, $(2x - y + 3)dx + (y - 2x - 2)dy = 0$ is,
(a) 0 (b) 1 (c) 2 (d) 3
- The solution for the differential equation $\frac{dy}{dx} + 2xy = y$ is,
(a) $y = C e^{x-x^2}$ (b) $y = C e^{x^2} - x$ (c) $y = C e^x$ (d) $y = C e^{-x^2}$
- If any two elements A and B of a group commute, then the group is said to be,
(a) subgroup (b) cyclic group (c) non-Abelian group (d) Abelian group
- If E is the identity element of the group G and A any element in the same group, then
(a) $A + E = A$ (b) $A E = 0$ (c) $A E = A$ (d) $A E = E$

11. The first order differential equation for radioactive decay $dN / dt = \underline{\hspace{2cm}}$
 a) N b) $-N$ c) λN d) $-\lambda N$
12. Voltage drop across capacitance is
 a) C/q b) q/C c) R/C d) q/v
13. A closed surface in space enclosing a volume V denotes
 a) Surface integral b) line integral c) volume integral d) integration
14. A vector V is solenoidal if its divergence is $\underline{\hspace{2cm}}$
 a) -1 b) 0 c) 1 d) infinity
15. A scalar field ϕ which is independent of time is called $\underline{\hspace{2cm}}$
 a) stationary field b) imaginary field c) vector field d) linear field.

II Fill in the blanks:

16. If \vec{A} is a constant vector, then $\vec{\nabla}(\vec{r} \cdot \vec{A})$ is $\underline{\hspace{2cm}}$.
17. The divergence of a vector field is a $\underline{\hspace{2cm}}$.
18. A theorem that relates a line and a surface integrals is, $\underline{\hspace{2cm}}$.
19. The order of differential equation, $\frac{d^2y}{dx^2} + 3\frac{dy}{dx} - 5y = 0$ is $\underline{\hspace{2cm}}$.
20. The number of elements in a group is called $\underline{\hspace{2cm}}$ of the group.

III State whether True or false:

21. Gradient of a scalar is a vector.
22. If the curl of a vector is zero, then the vector is solenoidal.
23. Gauss divergence theorem relates volume and surface integrals.
24. The equation $\frac{d^2y}{dt^2} = -c y$ is oscillatory in nature for $c = \text{constant}$.
25. Set of all rational negative numbers forms a group under multiplication.

IV. Answer briefly:

26. Give the gradient of the scalar field, $= x^2y + xyz$.
27. Prove that, $\vec{r} = 3yz^2\hat{i} + 4xz\hat{j} - 3xy\hat{k}$ is solenoidal.
28. Give the expression of Gauss divergence theorem.
29. Solve the equation $\frac{dy}{dx} = x$,
30. What is a subgroup?

SECTION – B

Answer any FIVE of the following:

(5 x 5 = 25)

31. What should be the velocity of a proton so that it travels un-deviated in a cross electric and magnetic field of intensities of 2 NC^{-1} and 0.4 Tesla respectively?
32. Discuss the four types of vector fields with examples. (i) $\text{curl } \vec{A} = 0, \text{div } \vec{A} = 0$;
(ii) $\text{curl } \vec{A} = 0, \text{div } \vec{A} \neq 0$; (iii) $\text{curl } \vec{A} \neq 0, \text{div } \vec{A} = 0$; (iv) $\text{curl } \vec{A} \neq 0, \text{div } \vec{A} \neq 0$.
33. What are Poisson's and Laplace's equations? Give a brief account of their applications.
34. Solve the differential equation, $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 0$.
35. What are symmetry elements? Explain the formation of a group of symmetry with an example.
36. Show that the force field, $\vec{F} = (2xy + z^3)\hat{i} + x^2\hat{j} + 3xz^2\hat{k}$ is a conservative field.
37. Find the angle between the two surfaces, $x^2 + y^2 + z^2 = 9$ and $x^2 + y^2 - z = 3$ at the point $(2, -1, 2)$.

SECTION – C

Answer any THREE of the following:

(3x15 =45)

38. (a) Three masses 1 kg , 2 kg , and 3 kg are kept at the vertices of an equilateral triangle of side 1 m . Calculate the direction and magnitude of the gravitational force acting on 1 kg mass. (8)
- (b) Calculate the force acting on an electron in a magnetic field of intensity 0.1 tesla directed along Z-axis when the electron has a velocity 10^4 ms^{-1} along X-axis. (7)
39. (a) Obtain Maxwell's equations from fundamental laws of electrostatics and magnetism. (10)
- (b) Using Maxwell's equations obtain electromagnetic wave equation. (5)
40. (a) State and Prove Gauss divergence theorem. (10)
- (b) Obtain the differential form of Gauss law in electrostatics. (5)
41. (a) A spring of negligible mass and force constant k and natural length l is suspended vertically with its one end. A mass m is attached to its other end and released gently. What is the type of motion of the mass. Find the position of mass at any time t . (10)
- (b) A stone is thrown straight up with an initial velocity of 100 ms^{-1} from a 50 m tall building. How long will it take for the stone to return to the ground? Assume there is no air resistance. Take acceleration due to gravity, $g = 10 \text{ m s}^{-2}$. (5)
42. (a) Explain with examples how group theory is applied in IR & Raman active vibrations. (10)
- (b) Write a short note on application of group theory in elementary particles. (5)
