STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2008-09)

SUBJECT CODE : PH/MC/MP34

B.Sc. DEGREE EXAMINATION NOVEMBER 2009
BRANCH III - PHYSICS
THIRD SEMESTER

REG. No._____

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

SECTION – A

TO BE ANSWERED IN THE QUESTION PAPER ITSELF

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

I CHOOSE THE CORRECT ANSWER:

1. A vector $\vec{A}$ is said to be solenoidal if
   a) $\nabla \times \vec{A} = 0$ b) $\nabla . \vec{A} = 0$ c) $\nabla . \vec{A} = a$ constant d) None of these

2. If $\vec{r} = \vec{i}x + \vec{j}y + \vec{k}z$, then $\nabla . \vec{r}$ is equal to
   a) 1 b) 2 c) 3 d) 4

3. The area of a parallelogram with sides $\vec{A}$ and $\vec{B}$ is
   a) $\left|\vec{A} \times \vec{B}\right|$ b) $\vec{A}.\vec{B}$ c) $\vec{A} + \vec{B}$ d) $\left|\vec{A}\right|\left|\vec{B}\right|$

4. The value of 'a' for which $\vec{A} = 2\vec{i} + a\vec{j} + \vec{k}$ and $\vec{B} = 4\vec{i} - 2\vec{j} - 2\vec{k}$ are perpendicular is
   a) 1 b) 2 c) 3 d) 4

5. The angle between $\vec{A} = 2\vec{i} + 2\vec{j} - \vec{k}$ and $\vec{B} = 6\vec{i} - 3\vec{j} + 2\vec{k}$ is
   a) 41^o b) 60^o c) 12^o d) 79^o

6. Laplace's equation is
   a) $\nabla \times \nabla \phi = 0$ b) $\nabla . \nabla \phi = 0$ c) $\nabla . (\nabla \times \vec{A}) = 0$ d) $\nabla \times (\nabla \times \vec{A}) = 0$

7. If $\vec{R} = (\sin t)\vec{i} + (\cos t)\vec{j} + t\vec{k}$, then $\left|\frac{d\vec{R}}{dt}\right|$ is
   a) 1 b) $\sqrt{2}$ c) $\sqrt{3}$ d) 2

8. The angle between the vector $\vec{A} = 3\vec{i} - 6\vec{j} + 2\vec{k}$ and the X - axis is
   a) 30^o b) 65^o c) 17^o d) 90^o

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9. If $\vec{F}$ is a conservative force-field, then

a) $\nabla \times \vec{F} = 0$ b) $\nabla . \vec{F} = 0$ c) $\nabla . \vec{F} = a$ constant d) None of these

10. The area of the ellipse $x = a\cos\theta$, $y = b\sin\theta$ is

a) $\frac{1}{2}(\pi ab)$ b) πab c) $ab\sin\theta$ d) $ab\cos\theta$

11. The solution of the equation $\frac{dR}{dt} = R^2 t^2$ is [Given $R = 1$ when $t = 1$]

a) $R = \frac{1}{4 - t^3}$ b) $R = \frac{3}{4 - t^3}$ c) $R = \frac{4}{3 - t^3}$ d) $R = \frac{1}{3 - t^3}$

12. The value of $\left(\frac{1}{D-2}\right)e^{4x}$ is $\left\{D = \frac{d}{dx}\right\}$

a) $\frac{1}{4}e^{2x}$ b) $\frac{1}{2}e^{4x}$ c) e^{2x} d) e^{4x}

13. The value of $\lceil 1/2 \rceil$ is

a) 1.7728 b) 0.8864 c) 1.5786 d) 3.14

14. If $P_n(x)$ is the Legendre polynomial of degree '*n*', then the value of $P_1(x)$ is

a) 1 b) 0 c) -1 d) ∞

15. The expression for $P_2(x)$ is

a) x b) $x^2 - 1$ c) $\frac{1}{2}(x^2 - 1)$ d) $\frac{1}{2}(3x^2 - 1)$

II FILL IN THE BLANKS:

16. A particle is acted on by a force $\vec{F} = 2\vec{\imath} - \vec{\jmath} - \vec{k}$. If the displacement, $\vec{S} = 3\vec{\imath} + 2\vec{\jmath} - 5\vec{k}$ then the work done is _____.

17. If $\vec{A} = \vec{\jmath}$ and $\vec{B} = 2\vec{\imath} - 3\vec{\jmath} + \vec{k}$, then $\vec{A} \cdot \vec{B}$ is _____.

18. The volume of a parallelo piped with sides $\vec{A} = 3\vec{\imath} - \vec{\jmath}$, $\vec{B} = \vec{\jmath} + 2\vec{k}$, $\vec{C} = \vec{\imath} + 5\vec{\jmath} + 4\vec{k}$ is _____.

19. A necessary and sufficient condition that $Mdx + Ndy = 0$ be exact is _____.

20. The volume of $\lceil 0 \rceil$ is _____

III STATE WHETHER TRUE OR FALSE:

21. For every scalar ϕ, $Curl(grad\phi) = 0$.

22. Gauss' divergence theorem relates Line Integral with volume Integral.

23. The solution of the equation $\left(\frac{dy}{dx}\right) = 2y$ is $y = ce^{x}$.

24. $\beta(m,n) = \beta(n,m)$.

25. $\left|\overline{3/2}\right| = 0.886$.

IV ANSWER BRIEFLY:

26. Prove that $\overline{A} \cdot (\overline{A} \times \overline{C}) = 0$.

27. State Green's theorem in a plane.

28. Write down Bernoulli's equation.

29. Enumerate the properties of Gamma function.

30. Plot the graph of $P_1(x)$.

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COURSE : MAJOR – CORE
PAPER : MATHEMATICAL PHYSICS
TIME : 2 ½ HOURS **MAX. MARKS : 70**

SECTION – B

ANSWER ANY FIVE QUESTIONS: **(5 x 5 = 25)**

1. A particle moves so that its position vector, is given by $\vec{r} = \vec{i}\cos wt + \vec{j}\sin wt$ where 'w' is a constant. If 'v' is the velocity of the particle, find $\vec{r} \times \vec{v}$.
2. If $\phi(x, y, z) = 3x^2 y - y^3 z^2$, find $\nabla\phi$ at the point $(1,-2,-1)$.
3. Find a unit normal to the surface $x^2 y + 2xz = 4$ at the point $(2,-2,3)$.
4. If $\vec{F} = \nabla\phi$, then show that the work done in moving a particle from $P_1 = (x_1, y_1, z_1)$ in this field to another point $P_2 = (x_2, y_2, z_2)$ is independent of the path joining the points.
5. Find the general solution of $(4x + xy^2)dx + (y + x^2 y)dy = 0$.
6. Solve: $2y'' - 5y' + 2y = 0$.
7. Prove that $\beta(m,n) = \dfrac{\lceil m \ \lceil n}{\lceil m+n}$.

SECTION – C

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

8. a) Show that the force field $\vec{F}$ defined by $\vec{F} = (y^2 z^3 - 6xz^2)\vec{i} + 2xyz^3\vec{j} + (3xy^2 z^2 - 6x^2 z)\vec{k}$ is a conservative force field.
   b) Find the work done by the force field $\vec{F}$ in moving a particle form the point $A(-2,1,3)$ to $B(1,-2,-1)$.

9. a) State and prove Gauss' Divergence theorem.
   b) Evaluate $\iint_s (\vec{r} \cdot \vec{n})ds$ where 's' is a closed surface and $\vec{r} = \vec{i}x + \vec{j}y + \vec{k}z$.

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10. a) Solve $\frac{d^2u}{dt^2} = 1 + \cos t$ where $u = 2$, $\frac{du}{dt} = 3$ at $t = 0$.

    b) A resistor of $R = 10$ ohms, an inductor of $L = 2H$ and a battery of E volt are connected in series with a switch 's'. At $t = 0$, the switch is closed and the current $I = 0$. Find I for $t > 0$ if $E = 40$ volt.

11. a) Derive Rodrigues' formula for $P_n(x)$.

    b) Express $f(x) = x + 3x^2 + 1$ in terms of Legendre polynomials.

12. a) Evaluate using Gamma function: $I = \int_0^\infty x^6 e^{-2x} dx$.

    b) Plot the graph of $\sqrt{(n)}$ for $0 \le n < 5$.

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