STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2011-2012 and thereafter)

SUBJECT CODE : 11PH/MC/MP34

B.Sc. DEGREE EXAMINATION NOVEMBER 2015
BRANCH III - PHYSICS
THIRD SEMESTER

REG. No.________________

COURSE : MAJOR - CORE
PAPER : MATHEMATICAL PHYSICS
TIME : 30 MINUTES **MAX. MARKS : 30**

SECTION – A
TO BE ANSWERED IN THE QUESTION PAPER ITSELF

ANSWER ALL QUESTIONS: **(30x1=30)**
Choose the correct answer:

1. A conservative force field can be written as
   a) curl of a vector function b) divergence of a vector function
   c) gradient of a scalar function d) none of these

2. div $r = \nabla . r$ is equal to
   a) zero b) 3 c) -3 d) +1

3. A vector $\vec{F}$ is said to be solenoidal if
   a) div $\vec{F}$ =0 b) Curl $\vec{F}$ =0 c) div Curl $\vec{F}$ =0 d) none

4. Gauss's law in electrostatics in differential form is given by
   a) div $E = \rho / \varepsilon_0$ b) div $E = \rho$ c) $E.ds = \rho / \varepsilon_0$ d) $E.ds = \rho$
   where ρ is the charge density, E the electrostatic field and ε_0 the permittivity of free space.

5. The value of $\iint_s \vec{r}.\overrightarrow{ds}$ where S is the surface of the sphere $x^2 + y^2 + z^2 x = a^2$ is
   a) $\frac{4}{3}\Pi a^3$ b) $4\Pi a^3$ c) Πa^3 d) a^3

6. For a surface ϕ(x,y,z)=c, where 'c' is a constant, $\hat{\nabla}\phi$ is
   a) a null vector b) unit vector
   c) a vector parallel to the surface d) a vector perpendicular to the surface

7. Solution of $\frac{dy}{dx} + y \sin x = 0$ is
   a) $y = ce^{\sin x}$ b) $y = ce^{\cos x}$ c) $y = ce^{-\sin x}$ d) $y = ce^{\tan x}$

8. The differential equation $Mdx + Ndy = 0$ is exact if
   a) $\partial M / \partial x = \partial N / \partial y$ b) $\partial M / \partial y = \partial N / \partial x$ c) $\partial M / \partial y = -\partial N / \partial x$

9. 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) $R = \frac{4}{3 - t^3}$

10. The complementary function of differential equation $\frac{d^2 y}{dx^2} - 9y = e^{3x}$ is

    a) $A\, sin\, 3x + B\, cos\, 3x$ b) $A\, cos\, (3x + 4)$
    c) $Ae^{3x} + B\, e^{-3x}$ d) $A\, sin\, (3x + 4)$

11. Solution for the differential equation $y'' + 4y' = 0$ under the initial condition $y(0) = 0$ and $y(0) = 1$ is

    a) $y = sin\, 2x$ b) $y = 2x\frac{dy}{dx}$ c) $y = ½\, (sin\, 2x)$ d) $\frac{d^2 y}{dx^2} + \frac{dy}{dx} = 2$

12. Free undamped motion of a spring has
    a) no air resistance and no external force b) no air resistance but external force acts
    c) both air resistance and external force acts d) air resistance and no external force

13. As $P_n(x)$ and $Q_n(x)$ are two independent solutions of Legendre's equation most general solution of Legendre equation is given by
    a) $y = AP_n(x) - BQ_n(x)$ b) $BP_n(x) – AQ_n(x)$
    c) $y = AP_n(x) + BQ_n(x)$ d) $BP_n(x) – AQ_n(x)$

14. In Gamma function Gamma (n) is equal to
    a) 0 b) 1 c) (n-1)! d) ∞

15. The value of $\overline{)\,{}^{3}\!/_{2}}$ is

    a) 1.45 b) 3.14 c) 0.886 d) 1.571

Fill in the blanks;

16. Laplace's equation in Electrostatics is given by ____________________.

17. The volume of a parallel-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 _____________________.

18. The order and degree respectively of the following differential equation $\frac{d^2}{dx^2} y - 4\sqrt{\frac{dy}{dx}} = 0$ are _____________________.

19. In an LCR circuit as $t \to \infty$ the transient component of current tends to __________________________.

20. Beta and Gamma functions are related by _________________________.

State whether the following statements are true or false:

21. Work done in moving an object around any closed path in a constant force field is zero.

22. n is a unit positive vector parallel to dS.

23. Free living dividing cells have positive exponential growth.

24. An example of Exact Differential equation is $\left(4x^3 + 6xy + y^2\right)\left({dx}/{dy}\right) = -\left[3x^2 + 2xy + 2\right]$.

25. The Legendre polynomial $P_o(x) = 1$.

Answer briefly:

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

27. State Stokes theorem.

28. What is a partial differential equation?

29. What is an integration factor?

30. Prove that $\Gamma\left({1}/{2}\right) = \sqrt{\Pi}$.

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COURSE	**:**	**MAJOR - CORE**
PAPER	**:**	**MATHEMATICAL PHYSICS**
TIME	**:**	**2½ HOURS**

MAX. MARKS : 70

SECTION – B

Answer any Five Questions: **5x5=25**

1. Find the unit vector $\perp r$ to the surface $x^2 + y^2 - z^2 = 11$ at the point $(4, 2, 3)$.
2. If $\phi(x,y,z) = 3x^2y - y^3z^2$, find $\nabla\phi$ at the point $(1,-2,-1)$.
3. Verify Stoke's theorem for $A = (2x-y)i - yz^2j - y^2zk$. where S is the upper half surface of the sphere $x^2 + y^2 + z^2 = 1$ and C is its boundary.
4. A man plans to place a certain sum in a N.S.S. certificate with a guaranteed compound interest at the rate of 11% p.a. for eight years. How much should be deposit so that he can claim the 50,000/- at the end of Eight years.
5. Derive the expression for charge in an RC circuit.
6. Show that $2^n \overline{\big)(n+\tfrac{1}{2}} = 1.3.5\ldots.(2n-1)\sqrt{\Pi}$.
7. Using Rodrigue's formula prove that $\int_{-1}^{+1} Po(x)dx = 2$

SECTION – C

Answer any Three Questions: **3x15=45**

8. a) Show that $div(\phi\vec{A}) = (grad\phi).\vec{A} + \phi(div\vec{A})$

   b) $Curl(curl\vec{A}) = grad(div.\vec{A}) - \nabla^2\vec{A}$.

9. a) State and prove Gauss' divergence theorem.
   b) Use the above theorem to solve $\iint_s A.ds$ where $A = x^2i + y^2j + z^2k$ taken over the cube $0 \le x, y, z \le 1$.

10. A body at a temperature of 50 ^{0} C is placed outdoors where the temperature is 100 ^{0} C . If after 5 minutes the temperature of the body is 60 ^{0} C, then find
    i) how long it will take the body to reach a temperature of 75 ^{0} C
    ii) the temperature after 20 minutes.

11. a. Solve $y'' - 2y' + y = 3ex$

b. A 10 kg mass is attached to a spring having a spring constant of 140 N/m .the mass is started in motion from the stationary position with an initial velocity 1 m/s in the upward direction and with an applied force F(t) = 4 sin t . Find the subsequent motion of the mass .

12. From Legendre differential equation deduce the series solution hence obtain the values for a_2 , a_4 and a_6 when $k = n$.

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