STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2004-05 & thereafter)

SUBJECT CODE : **PH/MC/MP34**

B.Sc. DEGREE EXAMINATION NOVEMBER 2008
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. The vector defined by $V = 2xyzi + (x^2z + 2y)j + x^2yk$ is
   a) rotational b) irrotational c) solenoidal d) a sink

2. The value of λ so that the vector $u = (x+3y)i + (y-2z)j + (x+\lambda z)k$ is a solenoidal vector is
   a) -2 b) 3 c) 1 d) 0

3. A necessary and sufficient condition that the integral $\int_c A.dr = 0$ for every closed curve C is that
   a) div A = 0 b) curl A = 0 c) div A $\neq$ 0 d) curl A $\neq$ 0

4. Laplace's equation is given by
   a) $\nabla.\nabla\phi = 0$ b) $\nabla \times \nabla\phi = 0$ c) $\nabla.\nabla \times A = 0$ d) $\nabla \times \nabla \times A = 0$
   where ϕ is a scalar and A is a vector function.

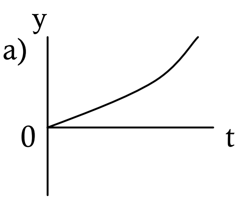
5. The poles of a function $f(z) = \int \frac{z+4}{z^2+2z+5} dz$ are
   a) $1 \pm 2i$ b) $-1 \pm 2i$ c) $2 \pm 2i$ d) $-2 \pm 2i$

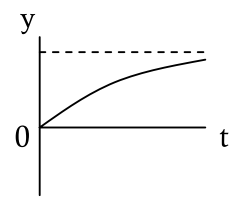
6. Cauchy – Riemann differential equation for an analytic function f(z)=u(x,y)+iv(x,y) are
   a) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}; \frac{\partial u}{\partial y} = \frac{-\partial v}{\partial x}$ b) $\frac{\partial u}{\partial x} = \frac{-\partial v}{\partial y}; \frac{\partial u}{\partial y} = \frac{-\partial v}{\partial x}$
   c) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial x}; \frac{\partial u}{\partial y} = \frac{-\partial v}{\partial y}$ d) $\frac{\partial u}{\partial x} = \frac{-\partial v}{\partial x}; \frac{\partial u}{\partial y} = \frac{-\partial v}{\partial y}$

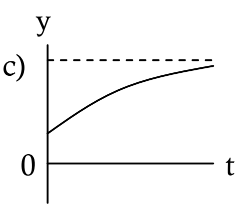
7. In conformal mapping straight lines are mapped into
   a) straight lines b) hyperbolas c) circles d) ellipse

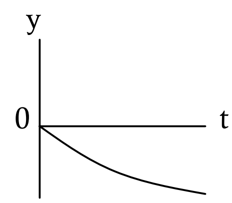
8. The constants c_1 and c_2 of the differential equation $y(x) = c_1 e^{2x} + c_2 e^x + 2\sin x$ satisfying the conditions $y(0) = 0$; $y^1(0) = 1$ are
   a) $c_1=1$; $c_2=1$ b) $c_1= -1, c_2=1$ c) $c_1= -1$; $c_2= -1$ d) $c_1=1$; $c_2= -1$

9. The graph for diffusion problem given by $\frac{dy}{dt} = k(a - y)$ where 'y' is the concentration at any time 't' and 'a' is greater than the initial concentration is

a) 

b) 

c) 

d) 

10. 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
   d) resistance due to air but no external force

11. An RL circuit represented by $E=RI+L\frac{dI}{dt}$ where I is the current at any time 't', the transient part of the current as 't' tends to ∞
   a) approaches zero b) approaches a steady value
   c) tends to ∞ d) remains the same independent of 't'

12. The Rodrigue's formula for $P_n(x)$, the Legendre polynomial of degree 'n' is
   $P_n(x) = k\frac{d^n}{dx^n}\left[(x^2 - 1)^n\right]$ where 'k' is given by
   a) $\frac{n!}{2^n}$ b) $\frac{2^n}{n!}$ c) $\frac{1}{2^n n!}$ d) $\frac{1}{2^n (n!)^2}$

13. $\beta(x+1, y)$ is given by
   a) $\frac{x+y}{x}\beta(x, y)$ b) $\frac{y}{x+y}\beta(x, y)$ c) $\frac{x+y}{y}\beta(x, y)$ d) $\frac{x}{x+y}\beta(x, y)$

14. $\Gamma(1)$ is given by
    a) 0 b) ∞ c) $\sqrt{\Pi}$ d) 1

15. $\beta(1,2)$ is equal to
    a) ½ b) 2 c) - ½ d) -2

II FILL IN THE BLANKS:

16. The value of the lines integral $\int_c y^2 dx + x^2 dy$ where c is the boundary of the square $- \leq x^2 < 1, -1 \leq y < 1$ is ___________________.

17. The directional derivative of a scalar ϕ in the direction of a vector is __________

18. If a function is analytic at all points inside a circle it can be expanded by ______________ series.

19. Mdx + Ndy is an exact differential equation if ___________________.

20. $\int_{-1}^{+1} P_0(x)dx =$ _______________ where $P_0(x)$ is Legendre polynomial of degree n.

III STATE WHETHER TRUE OR FALSE:

21. For every vector field V, div curl V = 0.

22. $\int_c \frac{dz}{z^2 - 1}$ where c is a circle $x^2 + y^2 = 4$ is $2\pi i$

23. The method of carbon dating makes use of first order differential equation.

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

25. As 'x' increases the Legendre polynomial $P_1(x)$ also increases.

IV ANSWER BRIEFLY:

26. State Stoke's theorem.

27. What is Cauchy's integral formula?

28. Define order and degree of a differential equation.

29. Apply Kirchoff's voltage law to form the differential equation for an inductance – Resistance (LR) series circuit with the voltage source 'E' at any time 't'.

30. State gamma and beta functions.

✕✕✕✕✕✕✕

STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2004-05 & thereafter)

SUBJECT CODE : **PH/MC/MP34**

B.Sc. DEGREE EXAMINATION NOVEMBER 2008
BRANCH III - PHYSICS
THIRD SEMESTER

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

SECTION – B

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

1. Find the directional derivative of the scalar function $\phi = 4e^{(2x-y+z)}$ at the point (1,1,-1) in a direction towards the point (-3,5,6).

2. Evaluate $\iiint_v \left(x^2 + y^2 + z^2\right)$dxdydz where v is a sphere having center at the origin and radius equal to 'a'.

3. Determine the analytic function f(z)=u+iv where v=6xy-5x+3 using Cauchy Reimann equation. Express the result as a function of 'z'.

4. An RC circuit has an emf of 5volts, a resistance of 10 ohms, a capacitance of 10^{-2} Farad and initially a charge of 5 coulombs on the capacitor. Find (a) the transient Current and (b) the steady state current.

5. A tank contains 100 litres of brine solution containing 20gms of salt. At t=0 fresh water is poured into the tank at the rate of 5 litres/min while the well stirred mixture leaves the tank at the same rate. Find the amount of salt in the tank at any time 't'.

6. Express $1+x – x^2$ in terms of Legendre polynomial.

7. Evaluate the integral $\int_0^\infty x^{5/4} e^{-\sqrt{x}}\, dx$.

SECTION – C

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

8. 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 $0 \le x, y, z \le 1$.

9. a) Find a unit vector perpendicular to the surface $x^2 + y^2 - z^2 = 1$ at the point (4, 2, 3).

   b) If $A = 5t^2 i + tj - t^2 k$ and $B = \sin t i - \cos t j$ find $\frac{d}{dt}(AxB)$.

10. a) Determine whether the differential equation $(x + \sin y)dx + (x \cos y - 2y)dy = 0$ is exact. Hence solve the equation.

    b) Assume Newton's law of cooling to solve the following problem: A body cools from 60°C to 50°C in 15 minutes in air which is maintained at 30°C. How long will it take this body to cool from 100°C to 80°C in air which is maintained at 50°C?

11. a) Solve $y'' - 2y' + y = 3e^x$.

    b) A 10 kg mass is attached to a spring, stretching it 0.7m from its natural length. The mass is started in motion from the equilibrium position with an initial velocity of 1m/sec in the upward direction. Find the subsequent motion, if the force due to air resistance is $90\dot{x}$ Newtons.

12. a) Derive the relation between beta and gamma function.

    b) Solve $\int_{-1}^{+1} \frac{(1+x)^{1/2}}{(1-x)^{1/2}} dx$.

✕✕✕✕✕✕✕