KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2019

Marks Scored:

Level : B.Sc.
Year : III

Course : PHYS 302
Semester: I

Exam. Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date FEB 2 7 2019

SECTION "A"
[20Q.×1=20 marks]

I. *Choose and tick the most appropriate answer. The symbols, unless mentioned otherwise, have their usual meanings.*

1. The value of scale factor h_r, h_θ, h_ϕ in spherical polar coordinate system are given by

   [a] $1, r\sin\theta, r$ [b] $1, r, r\sin\theta$ [c] $r\sin\theta, 1, r$ [d] $r, r\sin\theta, 1$

2. Metric tensor is a tensor of rank

   [a] three [b] scalar [c] two [d] 0

3. A real matrix is Unitary if and only if it is

   [a] Hermitian [b] Orthogonal
   [c] Unitary [d] None of the above

4. Laplace transform of Cosh at is

   [a] $\frac{a}{s^2-a^2}$ [b] $\frac{a}{(s^2+a^2)^2}$ [c] $\frac{s}{(s^2-a^2)^2}$ [d] $\frac{s}{s^2-a^2}$.

5. Among the following, the pair of vectors orthogonal to each other is

   [a] $[3,4,7],[3,4,7]$ [b] $[1,0,0],[1,1,0]$
   [c] $[1,0,2],[0,5,0]$ [d] $[1,1,1],[-1,-1,-1]$

6. The Green's function, $G(\vec{r},\vec{r}')$, is

   [a] anti-symmetric. [b] symmetric.
   [c] discontinuous everywhere. [d] such that $\nabla G(\vec{r},\vec{r}')$ is continuous at $\vec{r}=\vec{r}'$

7. The residue of $w(z)=\frac{1}{(z-2)(z-1)^3}$ at $z=1$ is

   [a] 0 [b] 1 [c] -1 [d] 4π

8. A complex function $f(z)=u(x,y)+iv(x,y)$ is analytic. If $u(x,y)=x^3-3xy^2$ then $v(x,y)$ is equal to ....

   [a] $3x^2-y^2$ [b] $3xy-y^3$ [c] $3x^2y^2-y^3$ [d] $3x^2y-y^3$

9. If $e^{2xt-t^2}=\sum_{n=0}^{\infty}H_n(x)\frac{t^n}{n!}$, then $H_3(x)$ is equal to

   [a] $4x^2-2$ [b] $8x^3-12x$ [c] 1 [d] 0

10. The recursion formula for the Legendre polynomial is

[a] $a_{r+2} = \frac{(k+r)(k+r+1)-\lambda}{(k+r+2)(k+r+1)} a_r$

[b] $a_{r+2} = \frac{(k+r)(k+r+1)+\lambda}{(k+r+2)(k+r+1)} a_r$

[c] $a_{r+2} = \frac{(k+r)(k+r-1)+\lambda}{(k+r+2)(k+r-1)} a_r$

[d] $a_{r+2} = \frac{(k+r)(k+r-1)+\lambda}{(k+r-2)(k+r+1)} a_r$

II. *Fill in the following blanks with appropriate answer. The symbols, unless mentioned otherwise, have their usual meanings*

11. The square of arc length in Spherical polar coordinate system is ....

12. The value of Christoffel's symbols $[12,2]$ in cylindrical coordinate is ....

13. The Fourier transform of Gaussian distribution function is ....

14. The inverse Laplace transform of $\frac{1}{S^{n+1}}$ is ....

15. The derivative of step function is ....

16. If $\delta(x)$ is the delta function, then $\int_{-\infty}^{\infty} \delta(x)dx =$ ....

17. Eigen value of a real skew- symmetric matrices is ....

18. The Cauchy Riemann conditions are given by ....

19. The value of $\int_0^{\infty} \frac{dx}{1+x^6} =$ ....

20. If $J_n(x)$ is the Bessel function of first kind then the value of $\left(J_{\frac{1}{2}}(x)\right)^2 + \left(J_{-\frac{1}{2}}(x)\right)^2$ equals to

....

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SECTION "B"
[5Q.×4=20 marks]

1. Show that $\nabla^2\phi = \frac{1}{\sqrt{g}}\frac{\partial}{\partial x^k}\left\{\sqrt{g}\, g^{kr}\frac{\partial\phi}{\partial x^k}\right\}$

2. Show that any two eigen vectors corresponding to two distinct eigen value of a Unitary matrix are orthogonal.

OR

Define Fourier sine and cosine transform and find out the first and second order derivative of sine function.

3. What do you mean by Laplace transform? Find the first and second order derivatives of Laplace transform.

4. Prove the Dirac- delta function $\delta(r-r') = \frac{1}{(2\pi)^3}\int_{-\infty}^{\infty} e^{ik(\mathrm{r}-r')} d^3k$

OR

Defining the generating function, establish the orthogonality condition for Bessel function.

5. Derive Cauchy- Riemann conditions in polar form.

SECTION "C"
[5Q × 7 = 35 marks]

6. Evaluate by the method of residue $\int_0^{\infty}\frac{dx}{1+x^4}$.

7. What do you mean by curvilinear coordinate system? Find the expression for divergence, curl and Laplacian in cylindrical coordinate system.

OR

If A^j and $\overline{A}^p$ represents the same contravariant vector in unprimed and primed frame of reference respectively, show that $\overline{A}^p = \frac{\partial \overline{x}^p}{\partial \overline{x}^j} A^j$.

8. Write down the Hermite differential equation and obtain its power series solution.

9. The one- dimensional wave equation for a transverse wave in a string is

$$v^2 \frac{\partial^2 \phi(x,t)}{\partial x^2} = \frac{\partial^2 \phi(x,t)}{\partial t^2}$$

Solve this by Fourier transform method where,

$$\phi(x,t) \to 0 \text{ and } \frac{\partial \phi}{\partial x} \to 0 \text{ as } (x \to \pm\infty). \ \phi(x,0) = f(x) \text{ and } \frac{\partial \phi}{\partial t}\Big|_{t=0} = 0.$$

OR

Express Fourier series in Complex form. Find the Fourier series expansion of $f(x) = e^x$ in the interval $[-\pi, \pi]$.

10. What do you understand by Green's function? Solve the Green's function

$$\frac{d^2 y}{dx^2} + \omega^2 y = \delta(x - \xi) \text{ where } y(0) = y(L) = 0.$$