Marks scored:

KATHMANDU UNIVERSITY
End Semester Examination [C]
July, 2017

Level : B. Sc.
Year : III
Course : PHYS 302
Semester : I

Exam Roll No. :
Time: 30 mins.
F. M. : 20

Registration No.:
Date : JUL 10 2017

SECTION "A"
[20 Q. × 1 = 20 marks]

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

1. In cylindrical coordinate, which one of the following relations between $\hat{\rho}$ and $\hat{\phi}$ is not correct?

[a] $\frac{\partial\hat{\phi}}{\partial\phi}=-\hat{\rho}$ [b] $\frac{\partial^2\hat{\phi}}{\partial\phi^2}=0$ [c] $\frac{\partial\hat{\rho}}{\partial\phi}=\hat{\phi}$ [d] $\frac{\partial^2\hat{\phi}}{\partial\phi^2}=-\hat{\phi}$

2. A quantity X is related with two tensors A^{λ} and Q^{ν}_{μ} as $A^{\lambda}X=Q_{\mu\nu}$. The quantity X is the

[a] covariant tensor of rank 3.
[b] contravariant tensor of rank 3.
[c] mixed tensor of rank 3
[d] mixed tensor of rank 2

3. The value of Christoffel's symbols [21,2] in cylindrical coordinate is

[a] $\rho cos\theta$
[b] ρ
[c] $-\rho$
[d] $-\rho cos\theta$

4. Which one of the following statements does not include in the Dirichlet's condition so that one can expand a function $f(x)$ as a Fourier series?

[a] The function must be periodic.
[b] The function must be single-valued.
[c] The function must be discontinuous within a period
[d] The integral over one period of $|f(x)|$ converges.

5. The three kets $|1\rangle$, $|2\rangle$ and $|3\rangle$ satisfy the linear combination $a_1|1\rangle+a_2|2\rangle+a_3|3\rangle=0$ These vectors are said to be linearly independent if

[a] $a_1=3,\ a_2=-5,\ a_3=2$
[b] $a_1=a_2=a_3=\frac{1}{3}$
[c] $a_1=1,\ a_2=1,\ a_3=-2$
[d] $a_1=a_2=a_3=0$

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

[a] anti-symmetric.
[b] symmetric.
[c] is 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 $z=3$ is

[a] -1 [b] 1 [c] 2π [d] 4π

8. The value of $\oint \frac{\sin 3z}{(z+\frac{\pi}{2})}$ if c is a circle of $|z|=5$ is equal to

[a] 0 [b] πi [c] $2\pi i$ [d] $-\pi i$

9. The generating function of Bessel's Differential equation is

[a] $f(x,t)=e^{\frac{x}{2t}[1-\frac{1}{t}]}$ [b] $f(x,t)=e^{\frac{x}{2}[t+\frac{1}{t}]}$

[c] $f(x,t)=e^{-\frac{x}{2}[t-\frac{1}{t}]}$ [d] $f(x,t)=e^{\frac{x}{2}[t-\frac{1}{t}]}$

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

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

11. A vector $\vec{A}$ in spherical polar coordinate is given as $\vec{A}=A_r\hat{r}+A_\theta\hat{\theta}+A_\phi\hat{\phi}$. Then $\nabla\cdot(A_r\hat{r})$ is equal to .....

12. Kronecker delta is a mixed tensor of rank.....

13. In tensor analysis, the expression ofdivergence of A^p is .....

14. The Fourier sine transform of $f(x)=|1|$in the interval $[-\pi,\pi]$is .....

15. The Laplace transform of t^3e^{3t} is .....

16. If A is Hermitian then e^{iA} is .....

17. The Green's function of ∇^2 in cylindrical coordinate is .....

18. A function which is analytic everywhere in a finite plane except at finite number of poles is called .....

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

20. If $J_n(x)$ is the Bessel function of first kind then $J_{n-1}(x)+J_{n+1}(x)$ equal to .....

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Time : 2 hrs. 30 mins.

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F. M. : 55

SECTION "B"
[5Q × 4 = 20 marks]

1. Prove $\frac{\partial g^{pq}}{\partial x^m} = -g^{pn}\begin{Bmatrix} q \\ mn \end{Bmatrix} - g^{qn}\begin{Bmatrix} p \\ mn \end{Bmatrix}$

2. If $\vec{a}$ and $\vec{b}$ are any two vectors in a linear vector space, prove the Cauchy's Schwartz inequality
$(\vec{a}.\vec{a})(\vec{b}.\vec{b}) \geq |\vec{a}.\vec{b}|^2$

OR

Show that any two eigen vector corresponding to two distinct eigen value of a unitary matrices are orthogonal.

3. Find the Fourier transform of the Gaussian distribution function $f(x) = Ne^{-\alpha x^2}$ where N and α are constants.

4. What is a delta function? State its properties and prove
$\delta(x - x') = \frac{1}{2\pi}\int_{-\infty}^{\infty} e^{ik(x-x')}\, dk$.

OR

Defining the generating function, establish the orthogonality condition of Laguerre polynomial.

5. Define the residue of a complex function $f(z)$ at $z = a$. Find the residue of $f(z) = \frac{1}{(z-3)^2(z-2)}$ at $z = 3$.

SECTION "C"
[5Q × 7 = 35 marks]

6. Integrate by the method of residue $\int_0^{2\pi} \frac{d\theta}{3 - 2\cos\theta + \sin\theta}$

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

OR

Obtaining the transformation laws of Christoffel's symbol of first and second kind, confirm whether they are tensors.

8. Write down the Hermite differential equation. Obtain the power series solution of it.

9. Find the Fourier series of $f(x) = x$ for $-\pi \le x \le \pi$ Also state and prove Parseval's relation.

OR

Define Laplace transform. Find the first and second order derivative of Laplace transform. Find the Laplace transform of $t \sin at$.

10. Solve for the Green's function

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