KATHMANDU UNIVERSITY
End Semester Examination [C]
June, 2018

Marks Scored:

Level : B.Sc.
Year : III

Course : PHYS 302
Semester: I

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

Registration No.:
Date JUN 12 2018

SECTION "A"
[20Q.×1=20 marks]

I. *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 Kronecker delta is tensor of rank

   [a] 1 [b] 2 [c] 3 [d] zero

3. The value of Christoffel's symbols [33, 2] in spherical coordinate is

   [a] $-r\cos\theta$ [b] $-r\sin\theta\cos\theta$
   [c] $-r^2\sin\theta\cos\theta$ [d] $-\frac{1}{2}r^2\sin^2\theta$

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 eigen values of a Hermitian matrices are

   [a] real [b] zero [c] imaginary [d] both (a) and (c)

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 $w(z) = \frac{1}{(z-2)^2(z-1)}$ at $z = 2$ 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. If $P_n(x)$ is the Legendre's polynomial and, then $\int_{-1}^{+1}|P_n(x)|^2\,dx$ is equal to

[a] $n\cdot 2^{n+1}n!\sqrt{\pi}$
[b] $\frac{2}{2n+1}$
[c] $2^{n-1}(n-1)!\sqrt{\pi}$
[d] $2^n n!\sqrt{\pi}$

10. The recursion formula for the Hermite polynomial is

[a] $a_{r+2}=\frac{2(k+r-n)}{(k+r+1)(k+r+2)}a_r$
[b] $a_{r+2}=\frac{2(k+r-n)}{(k+r+1)(k+r+2)}a_r$
[c] $a_{r+2}=-\frac{2(k+r+n)}{(k+r+1)(k+r-2)}a_r$
[d] $a_{r+2}=\frac{2(k+r+n)}{(k+r-1)(k+r-2)}a_r$

II. *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. The covariant derivative of δ_k^j is.............................

13. In tensor analysis, the expression $\nabla^2\Phi$ is ....

14. The Fourier cosine transforms of $e^{-a^2x^2}$ is ....

15. The Laplace transform of $e^{ax}\sin bx$ 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 $\int_0^\infty \frac{dx}{1+x^4}=$ ....

20. The recurrence relation for the Hermite polynomial $H_n'(x)$ is equal to ....

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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

Find Spherical coordinate components of the velocity and acceleration of a moving particle.

3. Define Fourier transform and find out the first and second order derivative of Fourier transform.

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

Find the generating function of the Bessel's differential equation.

5. What is an analytic function? Obtain the Cauchy-Riemann condition for an analytic function.

SECTION "C"
[5Q.× 7 = 35 marks]

6. Evaluate by the method of residue $\int_0^{2\pi} \frac{d\theta}{(5-4cos\theta)^2}$

7. What do you mean by curvilinear coordinate system? Find the expression for gradient, divergence and curl in orthogonal curvilinear 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 Laguerre's differential equation. Obtain the power series solution of it.

9. Find the Fourier series expansion of $f(x) = x^2$ for $-\pi \leq x \leq \pi$. Also, state and prove Convolution theorem.

OR

What do you mean by Laplace transform? Use Laplace transformation to find the current in the series LCR circuit, connected across a source E_0. The circuit is switched on at $t = 0$.

10. Solve for the Green's function
$\frac{d^2G}{dx^2} + \omega^2 G = \delta(x - x_0)$ where G (0) = G(L) = 0.