KATHMANDU UNIVERSITY
End Semester Examination [C]
May/June, 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 : 02 JUN 2019

SECTION "A"

[20Q. × 1 = 20 marks]

I. Choose and the most appropriate answer among the given options and **encircle** the letter of your choice. The symbols, unless mentioned otherwise, have their usual meanings.

1. The value of scale factor h_ρ, h_ϕ, h_z in cylindrical coordinate system are given by

[a] 1,1,1 [b] $1, \rho, 1$ [c] $\rho, 1, 1$ [d] $1, 1, \rho$

2. In contraction operation of tensor, the rank is

[a] invariant [b] reduced by 1 [c] reduced by 2 [d] increased by 1

3. If A is a real skew-symmetric matrix such that $A^2 + I = 0$, then A is

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

4. Laplace transform of $t^3 e^t$ is

[a] $\left(\frac{6}{s-3}\right)^4$ [b] $\frac{6}{(s-1)^4}$ [c] $\frac{6}{(s+1)^4}$ [d] $\frac{6}{(s-1)^3}$.

5. Eigen value of a unitary matrix is

[a] $|1|$ [b] 1 [c] 0 [d] All of the above

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 $f(z) = \frac{z^5 + z_0^5}{(z - z_0)^5}$ at $z = z_0$ is

[a] $\frac{1}{120} z_0$ [b] z_0 [c] $120 z_0$ [d] $5 z_0$

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] $3x^2 y^2 - y^3$ [d] $3x^2 y - y^3$

9. Recurrence relation of Hermite polynomial is

[a] $H_n'(x) = 2nH_{n-1}(x)$
[b] $H_n'(x) = 2xH_n(x) - H_{n+1}(x)$
[c] Both a and b
[d] $H_n'(x) = \frac{2x}{n} H_n(x) - H_{n+1}(x)$

10. The degree of polynomial $f(x)$ so that $\int_{-1}^{1} f(x)P_n(x)dx = 0$ will be

[a] 0 [b] n [c] less than n [d] none of these

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

11. Arc length in general curvilinear co-ordinate system is ....

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

13. The Fourier series contains only sine series if the function is ....

14. The inverse Laplace transform of $\frac{1}{s^2(s^2+1)}$ is ....

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

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

17. Parseval's relation in Fourier transform is ....

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

19. The value of $\int_{0}^{\infty} \frac{\sin x}{x} dx$ is ....

20. If $J_n(x)$ is the Bessel function of first kind then the value of $J_{-\frac{3}{2}}(x)$ equals to ....

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0 2 JUN 2019

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Year : III
Time : 2 hrs. 30 mins.

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Semester : I
F.M. : 55

SECTION "B"
[5Q. × 4 = 20 marks]

Attempt *ALL* questions.

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

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 the trace and determinant of a matrix remains invariant under similarity transformation.

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

4. What is Green's function? Show that the Green's function of ∇^2 in cylindrical coordinate is $G(\rho,\rho') = \frac{1}{2\pi}\ln|\rho-\rho'|$.

OR

Defining the generating function, establish the orthogonality condition for Legendre polynomial.

5. Prove that the necessary and sufficient condition that $w = f(z) = u(x,y) + iv(x,y)$ be analytic in a region $\Re$ is that the Cauchy-Riemann equations $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}, \frac{\partial u}{\partial y} = -\left|\frac{\partial v}{\partial x}\right|$ are satisfied in $\Re$ where it is supposed that the partial derivative are continuous in $\Re$.

SECTION "C"
[5Q. × 7 = 35 marks]

Attempt *ALL* questions.

6. Evaluate $\int e^{ax}\sin bx dx$ and $\int e^{ax}\cos bx dx$.

7. What do you mean by curvilinear coordinate system? Find the expression for gradient, divergence and curl orthogonal curvilinear coordinate system.

OR

Show that the equation of geodesic in tensor form is $\frac{d^2x^k}{ds^2} + \begin{Bmatrix} k \\ pq \end{Bmatrix}\frac{dx^p}{ds}\frac{dx^q}{ds} = 0$

8. Write down the Laguerre differential equation. Obtain its power series solution.

9. The one- dimensional wave equation for a transverse wave in a string is $\frac{\partial^2\phi(x,t)}{\partial x^2}=\frac{1}{v^2}\frac{\partial^2\phi(x,t)}{\partial t^2}$

Solve by Fourier transform method where,

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

OR

Find the Fourier series expansion of $f(x)=\begin{cases}-\sin x; -\pi\leq x<0\\ \sin x; 0\leq x\leq\pi\end{cases}$ and also sketch it.

10. What do you understand by Green's function? Solve for the Green's function $\frac{d^2G(x,x_0)}{dx^2}+k^2G(x,x_0)=\delta(x-x_0)$ under the boundary condition

$$\left.\frac{dG(x,x_0)}{dx}\right|_{x=0}=\left.\frac{dG(x,x_0)}{dx}\right|_{x=2}=0$$