19002636

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Reg. No.....

Name.....

M.Sc. DEGREE (C.S.S.) EXAMINATION, OCTOBER 2019

First Semester

Faculty of Science

Branch II—Physics (A)—Pure Physics

PH 1C 01—MATHEMATICAL METHODS IN PHYSICS–I

(2012 to 2018 Admissions)

Time : Three Hours

Maximum Weight : 30

Part A

Answer any **six** *questions.*
Each question carries 1 *weight.*

1. Show that surface area is a vector and volume a scalar.
2. Obtain unit vectors in spherical co-ordinates in terms of i, j and k.
3. Explain Schwartz inequality.
4. State Cayley-Hamilton theorem.
5. What are the characteristics of a binomial distribution ?
6. Explain Levi Cevitta tensor.
7. Define a β function. Prove that $\beta(a, b) = \beta(a+1, b) + \beta(a, b+1)$.
8. What is a unitary transformation ?
9. Prove $H_{2n}(0) = (-1)^n \frac{(2n)!}{n!}$.
10. Prove that $\left(-c\hbar\frac{\partial}{\partial x}\right)$ is Hermitian.

$(6 \times 1 = 6)$

Part B

Answer any **four** *questions.*
Each question carries 2 *weight.*

11. Show that $J_n^{\,1}(x) = \frac{1}{2}(J_{n-1}(x) - J_{n+1}(x))$ follows directly from $J_n(x) = \frac{1}{\pi}\int_0^{\pi}(\cos n\theta - x\sin\theta)\, d\theta$.
12. From Rodrigues formula, get Legendre polynomials of order 1, 2 and 3.

Turn over

13. Find the value of K for which the system of equations given below has a non-zero solution :

$$4x + 2y - 5z = 0,\ x + Ky + 2z = 0,\ 2x + y - z = 0.$$

14. The rank of a tensor is reduced by 2. Show that the transformation is a contraction.

15. Prove the recurrence relation $Y_{n-1}(x) + Y_{n+1}(x) = \frac{2n}{x} Y_n(x)$ for Neumann functions.

16. Prove that $\gamma\left(\frac{1}{2} - n\right) \gamma\left(\frac{1}{2} + n\right) = (-1)^n \pi$ where n is an integer.

$(4 \times 2 = 8)$

Part C

Answer **all** *questions.*
Each question carries 4 *weight.*

17. (a) Why do we need spherical polar co-ordinates ? Obtain the differential operators in both Cartesian and spherical polar co-ordinates.

Or

(b) Obtain the equation of continuity for fluid flow. Explain the physical significance of divergence and curl.

18. (a) Define orthogonal, Hermitian and Unitary matrices. Diagonalize $\begin{bmatrix} 1 & -2 \\ -5 & 4 \end{bmatrix}$ using similarity transformation.

Or

(b) If A + B are Hermitian matrices show that AB + BA and i (AB – BA) are also Hermitian. What are the properties of Hermitian matrices ?

19. (a) What is a tensor ? What are the different types of tensors ? Discuss elementary algebra of tensors.

Or

(b) Define Metric tensor and give its properties. Explain Riemann Christoffel tensor. How do you arrive at the Geodesic equation ?

20. (a) Establish the orthogonality of Bessel functions.

Or

(b) Obtain the Rodrigue's formula for Legendre polynomials.

Prove $(1 - x^2) P_n^1(x) = (n + 1)\, x\, P_n(x) - (n + 1) P_{n+1}(x)$.

$(4 \times 4 = 16)$