

(7 pages)

Reg. No. :

Code No. : 7388

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M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2024.

First Semester

Physics – Core

MATHEMATICAL PHYSICS – I

(For those who joined in July 2021 & 2022 only)

Time : Three hours

Maximum : 75 marks

PART A — ($10 \times 1 = 10$ marks)

Answer ALL questions.

Choose the correct answer :

1. If a set of vectors spans a vector space and is linearly independent, what is it called?
 - (a) Subspace
 - (b) Basis
 - (c) Orthogonal set
 - (d) Linear transformation

2. Which of the following statements about linear independence is true?

- (a) A set of vectors is linearly independent if one vector is a scalar multiple of another
- (b) A set of vectors is linearly independent if the only linear combination that equals the zero vector is the trivial one
- (c) A set of vectors is linearly independent if they are all orthogonal to each other
- (d) A set of vectors is linearly independent if their sum is the zero vector

3. Which of the following statements about Legendre's differential equation is true?

- (a) It is a linear ordinary differential equation
- (b) It has no singularities within its domain
- (c) Its solutions are always convergent for all x
- (d) It is a second-order differential equation

4. The solutions to Legendre's differential equation are commonly referred to as:

- (a) Bessel functions
- (b) Hermite polynomials
- (c) Legendre polynomials
- (d) Laguerre functions

5. Which physical principle governs the Heat Flow Equation?
 - (a) Conservation of mass
 - (b) Conservation of energy
 - (c) Conservation of momentum
 - (d) Conservation of charge
6. Which method is commonly used to solve the Heat Flow Equation numerically?
 - (a) Finite difference method
 - (b) Laplace transform method
 - (c) Finite element method
 - (d) Fourier transform method
7. What does the rank of a tensor represent?
 - (a) The number of indices in the tensor
 - (b) The number of components in the tensor
 - (c) The number of dimensions in the space the tensor acts upon
 - (d) The order of the tensor

8. What is the contraction of a tensor?
 - (a) The operation of raising the indices of a tensor
 - (b) The operation of lowering the indices of a tensor
 - (c) The operation of summing over repeated indices in a tensor product
 - (d) The operation of multiplying two tensors together
9. What is the mean of a binomial distribution?
 - (a) np
 - (b) nq
 - (c) p/q
 - (d) $p+q$
10. Which of the following statements is true regarding the shape of the binomial distribution?
 - (a) It is always symmetric
 - (b) It is always positively skewed
 - (c) It is always negatively skewed
 - (d) Its skewness depends on the values of n and p

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).
Each answer should not exceed 250 words.

11. (a) State and prove expansion theorem.
Or
(b) Show that the vectors $(1, 2, -3)$, $(1, 3, -2)$ and $(2, -1, 5)$ are linearly independent.

12. (a) Prove that $x L_n'(x) = n L_n(x) - n L_{n-1}(x)$.

Or

- (b) Prove that $P_n(x) = \frac{1}{2^n n!} \frac{d^n}{dx^n} (x^2 - 1)^n$.

13. (a) Obtain the solution of Laplace's equation in Cartesian coordinates.

Or

- (b) Explain 'D' Alembert's solution in partial differential equation.

14. (a) Define contravariant, covariant and mixed tensors. Give examples.

Or

- (b) Explain the addition and subtraction of tensors.

15. (a) Find the correlation coefficient from the following data.

x	1	2	3	4	5
y	2	5	3	8	7

Or

- (b) The following data are the number of seeds germinating out of 10 on damp filter for 80 sets of seeds. Fit a Binomial distribution to these data.

x	0	1	2	3	4	5	6	7	8	9	10
f	6	20	23	12	8	6	0	0	0	0	0

PART C — (5 × 8 = 40 marks)

Answer ALL the questions, choosing either (a) or (b).
Each answer should not exceed 600 words.

16. (a) State and explain Gram Schmidt's orthogonalization process.

Or

- (b) State and prove Stokes theorem in vector analysis.

17. (a) Obtain the series solution of Laguerre's differential equation $xy'' + (1-x)y' + \lambda y = 0$.

Or

- (b) Show that $\int_{-1}^1 P_n(x) P_m(x) dx = \frac{2}{2n+1} \delta_{mn}$.

18. (a) Obtain the Fourier series solution using method of separation of variables.

Or

- (b) Derive the equation of motion for the vibrating string.

19. (a) Discuss the applications of tensor analysis for invariance of Maxwell's equations.

Or

- (b) Discuss the applications of tensor analysis in electro magnetic theory.

20. (a) Ten students got the following percentage of marks in Economics and statistics.

Roll. no	1	2	3	4	5	6	7	8	9
Marks in Economics	78	36	98	25	75	82	90	62	65
Marks in Statistics	84	51	91	60	68	62	86	58	53

Calculate the coefficient of correlation.

Or

- (b) Find the first four moments of the Binomial distribution.
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