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Reg. No.....

Name.....

M.Sc. DEGREE [C.S.S.] (LAST AND FINAL SPECIAL MERCY) EXAMINATION, JANUARY 2025

First Semester

Faculty of Science

Branch : II—Physics-A–Pure Physics

Paper I/PH 101—MATHEMATICAL METHODS IN PHYSICS—I

(Common with Branch II B-Non-Conventional Energy)

(2004—2011 Admissions—Regular Study/2004—2013 Admissions—Private Study, Special Mercy Chance)

Time : Three Hours Maximum Marks : 75

Part A

Answer any **six** *questions.*
Each question carries 2 *marks.*

1. What is the physical interpretation of divergence ?
2. State Green's theorem.
3. Define orthogonality of two vectors.
4. List Pauli spin matrices and write its properties.
5. Define the Chi-square statistic for goodness of fit.
6. Write any *two* definitions of Gamma function.
7. Write geodesic equation.
8. What is a covariant tensor ?
9. What is the Dirac delta function ?

(6 × 2 = 12)

Turn over

Part B

Answer any **three** *questions.*
Each question carries 5 *marks.*

10. Explain spherical polar co-ordinate system.

11. Solve the following system of equations using the Gauss elimination method.

$$2x + y + 4z = 12$$
$$8x - 3y + 2z = 20$$
$$4x + 11y - z = 33.$$

12. Obtain the expression for metric tensor in spherical polar co-ordinate system.

13. Compare scalar potential, gravitational potential, and centrifugal potential in terms of their physical origin and mathematical form.

14. Define Neumann functions (Bessel functions of the second kind) and explain how they differ from Bessel functions of the first kind.

$(3 \times 5 = 15)$

Part C

Answer **all** *questions.*
Each question carries 12 *marks.*

15. (a) State and prove Stoke's theorem.

Or

(b) Explain Hermitian, unitary and projection operators with their properties.

16. (a) Explain diagonalization of matrices and its application.

Or

(b) Explain Gauss-Jordan inversion method of matrix.

17. (a) What is a Tensor ? What are different types of tensors ? Explain.

Or

(b) Define metric tensor and give its properties. Explain Riemann-Christoffel tensor.

18. (a) Find the solution of Bessel differential equation by Frobenious method.

Or

(b) Derive the Legendre differential equation and obtain the general solution in terms of Legendre polynomials.

(4 × 12 = 48)

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Reg. No.....

Name.....

M.Sc. DEGREE [C.S.S.] (LAST AND FINAL SPECIAL MERCY) EXAMINATION, JANUARY 2025

First Semester

Faculty of Science

Branch : II—Physics-A–Pure Physics

Paper IV/PH 104 - CLASSICAL ELECTRODYNAMICS

(2004—2011 Admissions—Regular Study/2004—2013 Admissions—Private Study, Special Mercy Chance)

Time : Three Hours

Maximum Marks : 75

Part A

Answer any **six** *questions.*
Each question carries 2 *marks.*

1. What is Lorentz force ? Write its mathematical expression.
2. What is a scalar potential in electrodynamics ?
3. Write d'Alembertian operator in tensor notations.
4. How is the momentum of an EM wave related to its energy ?
5. What is the four-potential in relativistic electrodynamics ?
6. What is a retarded potential in electrodynamics ?
7. What is magnetic dipole radiation ?
8. What is a Yagi-Uda antenna ?
9. Write the condition for TM mode propagation in a rectangular waveguide.

(6 × 2 = 12)

Turn over

Part B

Answer any **three** *questions.*
Each question carries 5 *marks.*

10. Find the energy of a uniformly spherical shell having radius 'R' and a charge 'q' on it.

11. Compare and contrast the Coulomb gauge and Lorenz gauge in electrodynamics.

12. Explain about electric dipole radiation.

13. Discuss about the radiation from a quarter wave monopole.

14. Distinguish between TE and TM modes in a rectangular waveguide.

(3 × 5 = 15)

Part C

Answer **all** *questions.*
Each question carries 12 *marks.*

15. (a) Discuss the boundary conditions of B and H across an interface.

Or

(b) Explain the concept of Gauge invariance in classical electrodynamics.

16. (a) Explain the transformation of the electromagnetic field tensor under a Lorentz transformation.

Or

(b) Reformulate Maxwell's equations and Lorentz force law using relativistic tensor notation.

17. (a) Obtain the expressions for Lienard-Wiechart's potentials for a moving point charge

Or

(b) Explain the concept of electromagnetic radiation from an arbitrary distribution of charges and currents.

18. (a) Write a detailed note on horn and parabolic reflector antennas.

Or

(b) Discuss the propagation of TE waves through a rectangular waveguide and obtain an expression for the cut-off frequency.

(4 × 12 = 48)

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Reg. No.....

Name.....

M.Sc. DEGREE (LAST AND FINAL SPECIAL MERCY) EXAMINATION, JANUARY 2025

Fourth Semester

Faculty of Science

Branch : II—Physics - A – Pure Physics

Paper XIII—ATOMIC AND MOLECULAR PHYSICS

(2004—2011 Admissions—Regular Study/2004—2013 Admissions—Private Study)

Time : Three Hours Maximum Marks : 75

Part A

Answer any **six** *questions.*
Each question carries 2 *marks.*

1. What do you understand by Larmor Procession ?
2. What is the Zeeman Effect ?
3. What is Born Oppenheimer approximation ?
4. Distinguish between Linear and Asymmetric top molecules.
5. State the conditions for a vibration to be Raman active.
6. What is g value in ESR spectroscopy ?
7. How is electron density related to chemical isomer shift ?
8. What is the difference between ESR and NMR ?
9. What is Predissociation ?

(6 × 2 = 12)

Turn over

Part B

Answer any **three** *questions.*
Each question carries 5 *marks.*

10. Explain the factors contributing to the intensity of rotational spectral lines.

11. Explain the Hyper Raman Effect.

12. How strong is LS coupling in Paschen back effect ?

13. Describe the working of an Electron Spin Resonance (ESR) spectrometer.

14. Write a short note on Fourier Transform spectroscopy and its advantages.

(3 × 5 = 15)

Part C

Answer **all** *questions.*
Each question carries 12 *marks.*

15. (a) Explain normal Zeeman effect using classical ideas. Get an expression for Zeeman shift.

Or

(b) What is JJ coupling ? Derive the expression for the interaction energy in JJ coupling scheme.

16. (a) Explain the working principle of a Stark modulation spectrometer.

Or

(b) Discuss the types of molecular vibrations in IR spectroscopy.

17. (a) What are non-linear Raman effects ? Explain the principles and mechanisms behind stimulated and inverse Raman scattering.

Or

(b) State and explain the Franck-Condon principle.

18. (a) What is the Mossbauer effect ? Explain its physical basis and conditions necessary for its observation

Or

(b) Explain the working principle of a CW NMR spectrometer. Describe its components and limitations.

(4 × 12 = 48)