F–2933

Sub. Code
7MPH1C1

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

First Semester

Physics

MATHEMATICAL PHYSICS I

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Find the value of $\lambda, \mu,$ and γ such that the vector $\vec{f} = (x + 2y + \lambda z)\hat{i} + (\mu x + 3y + 2z)\hat{j} + (3x + \gamma y + z)\hat{k}$ is irrotational.

2. Whether the vectors $X_1 = [1,-1,0]^T, X_2 = [0,1,-1]^T, X_3 = [0,0,1]^T$ and $X_4 = [1,2,3]^T$ are linearly dependent or independent? Demonstrate it explicitly.

3. Define a nonlinear second order ordinary differential equation with an example.

4. Rewrite the Hermite differential equation in Sturm-Liouville form.

5. Find the residue of $\dfrac{z^2}{(z-1)(z-2)(z-3)}$ at $z = 3$.

6. Define essential singularity. Give an example for it.

7. Explain the essential conditions to be satisfied for a function to be expanded in a Fourier series.

8. What are Dirichlet's conditions for a Fourier series expansion?

9. What is Fourier integral?

10. Write the complex form of a Fourier integral.

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) Suppose a force field is given by $\vec{F} = (2x - y + z)\hat{i} + (x + y - z^2)\hat{j} + (3x - 2y + 4z)\hat{k}$. Find the work done in moving a particle once around a circle C in the xy plane with its centre at origin and a radius of 3.

Or

(b) Evaluate $\iint \vec{A}.\vec{n}dS$, where $\vec{A} = 18z\hat{i} - 12\hat{j} + 3y\hat{k}$ and S is that part of the plane $2x + 3y + 6_z^S = 12$ which is located in the first octant.

12. (a) Verify Cayley-Hamilton theorem for the matrix $\begin{pmatrix} 1 & 2 & 3 \\ 2 & -1 & 4 \\ 3 & 1 & 1 \end{pmatrix}$

Or

(b) Find the eigenvalues and elgenvectors of the Sturm-Liouville problem $y'' + \lambda y = 0$.

13. (a) Find the Taylor series expansion of a function of the complex variable.

$$f(z) = \frac{1}{(z-1)(z-3)}$$

about the point z = 4. Find the region of convergence.

Or

(b) Find the Laurent's series expansion of the function $f(z) = \frac{1}{(1-z)(2-z)}$ valid for $0 < |z-1| < 1$.

14. (a) Find the Fourier series of the function $f(x) = x^2$ in the interval $-\pi < x < \pi$ and show that $\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + ... = \pi^2$.

Or

(b) Expand the function $f(x) = \sin x$ as a cosine series in the interval $(0, \pi)$.

15. (a) Using Fourier integral representation, show that

$$\int_0^\infty \frac{w + \cos x}{1 + w^2} = \frac{\pi}{2} e^{-x} \ (x > 0)$$

Or

(b) Find the Fourier sine integral for the function $f(x) = e^{-kx}$.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. State and prove Stokes' theorem.

17. Diagonalize the matrix $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 3 & -1 \\ 0 & -1 & 3 \end{bmatrix}$.

18. State and prove Cauchy residue theorem for a complex function.

19. Obtain a cosine series expansion of the function $f(x)$ $1 + x$ valid in the interval $0 \le x \le 2$ and hence deduce that $\frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} .... = \frac{\pi^2}{8}$.

20. Derive Fourier integral formula in complex form, that is $f(x) = \frac{1}{2\pi} \int_{-\infty}^{\infty} e^{iux}\, du \int_{-\infty}^{\infty} f(t) e^{iut} dt.$

F–2934

Sub. Code
7MPH1C2

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

First Semester

Physics

CLASSICAL DYNAMICS AND RELATIVITY

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. What are cyclic coordinates? How can they be used to find conserved quantities?

2. For a particle confined to move on the surface of a sphere, what are the generalized coordinates?

3. Show that Kepler's second law is valid for any system with central force.

4. Define rotational motion of a top.

5. Argue that the number of degrees of freedom for a rigid body in three dimensions is six.

6. For the force $F = -3ar^4$, what is the potential energy? For the potential $V = 12kr^2$, what is the force?

7. Show that the Poisson bracket is invariant under canonical transformation.

8. For the given $L = e^{c_1 t}\left(\frac{\dot{x}^2}{2} - \frac{c_2}{2}x^2\right)$, what is the corresponding Hamiltonian?

9. Show that $x^2 + y^2 + z^2 - c^2t^2$ is invariant under Lorentz transformation.

10. What is a four-space? What is a world line?

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) Show that if the external torque acting on a system is zero, the angular momentum is conserved.

Or

(b) Show that for a one-dimensional simple harmonic oscillator, Newton's equation of motion and Euler-Lagrange's equation of motion give the same expression. Integrate the equation and sketch the plots

(i) x versus t and

(ii) x versus x.

12. (a) In a central force motion, obtain the energy equation in the form

$$E = \frac{1}{2}\mu\dot{r}^2 + \frac{\mathbf{L}^2}{2\mu r^2} + V(r)$$

where L is the angular momentum and μ is the reduced mass.

Or

(b) A particle is moving in a circular orbit of diameter b in a central force field. If the centre of attraction is on the circumference itself, find the law of force.

13. (a) Explain normal coordinates and normal frequencies of a system.

Or

(b) If a rigid body with one point fixed rotates with an angular velocity $\vec{w}$ and has an angular momentum L, show that the kinetic energy is $\frac{1}{2}\vec{L}\cdot\vec{w}$.

14. (a) For the given Lagrangian $L=\frac{1}{2}\dot{x}^2-\frac{1}{2}x^2$, construct the Hamiltonian and its equation of motion. Integrate the equation of motion and obtain the general solution and discuss the associated phase-space trajectory.

Or

(b) Determine whether the transformation

$$Q_1 = q_1 q_2,\ P_1 = \frac{p_1 - p_2}{q_2 - q_1} + 1$$

$$Q_2 = q_1 + q_2,\ P_2 = \frac{q_2 p_2 - q_1 p_1}{q_2 - q_1} - (q_2 + q_1)$$

is canonical or not.

15. (a) In special theory of relativity mass and energy are equivalent. Discuss this statement with an example.

Or

(b) Show that under the Lorentz transformation, the wave equation

$$\nabla^2\phi = \frac{1}{c^2}\frac{\partial^2\phi}{\partial t^2} = 0$$

for the propagation of the electromagnetic potential remain invariant in form.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. What is Hamilton's principle? Derive Lagrange's equation of motion from it for a conservative system.

17. What are Kepler's law of planetary motion? Give the first of Kepler's laws of planetary motion and hence deduce that the areal velocity is constant.

18. Discuss the vibrations of a linear triatomic molecule.

19. Outline Hamilton-Jacobi theory and apply it to solve the problem of one dimensional harmonic oscillator.

20. Assuming the law of conservation of momentum to be correct in every inertial frame, show that by the use of transformation of energy and momentum, the relativistic energy is conserved.

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F–2935

Sub. Code
7MPH1C3

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

First Semester

Physics

QUANTUM MECHANICS – I

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. If x and px are the coordinate and momentum operators, prove that $\left[x, p_x^n\right] = ni\hbar p_x^{n-1}$.

2. Prove that we cannot measure the kinetic and potential energies of a particle simultaneously with arbitrary precision.

3. Explain why the quantum oscillator is found outside the parablolic potential barrier?

4. What do you understand by quantum mechanical tunneling?

5. What is the value of the uncertainity product $(\Delta L_x)(\Delta L_y)$ in a representation in which L^2 and Lz have simultaneously eigenfunctions?

6. What are ladder operators? Why are they called so?

7. Why the hydrogen atom in the ground state does not show a first order Stark effect?

8. Point out the validity of the WKB method.

9. What is symmetric and anti-symmetric wave function?

10. What do you understand by self consistent potential?

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) Obtain the equation of motion for a state function and for an operator in Heisenberg picture.

Or

(b) The wave function of a particle in a state is $\psi = \left(\frac{1}{\pi\alpha}\right)^{\frac{1}{4}} e^{\frac{-x^2}{2\alpha}}$.

12. (a) Formulate Schrödinger equation for a rigid rotator Find its eigenvalues and eigen- functions.

Or

(b) The energy eigenvalue and the corresponding eigenfunction for a particle of mass m in a one dimensional potential $V(x)$ are $E = 0, \psi = \frac{A}{x^2 + c^2}$. Deduce the potential $V(x)$.

13. (a) For a spin $-\frac{1}{2}$ system, state matrices for S_x, S_y, S_z. List their eigenvalues with the corresponding eigenvectors.

Or

(b) A particle is in an eigenstate of L_z . Prove that $\langle J_x \rangle = \langle J_y \rangle = 0$. Also find the values of $\langle J_x^2 \rangle$ and $\langle J_y^2 \rangle$.

14. (a) Outline the general theory of variational method. Point out the advantages of this method over other methods.

Or

(b) Obtain the energy values of harmonic oscillator by the WKB method.

15. (a) Find an expression for the electron density $n(r)$ in the Thomas-Fermi model in terms of the Thomas-Fermi function.

Or

(b) N noninteracting bosons are in an infinite potential well defined by $V(x) = 0$ for $0 =< x < a; V(x) = \infty$ for $x < 0$ and for $x > 0$. Find the ground state energy of the system. What would be the ground state energy if the particles are Fermions?

Part C (3 × 10 = 30)

Answer any **three** questions.

16. State and Prove Ehrenfest's theorem.

17. Set up Schrödinger equation for the one-dimensional linear harmonic oscillator and obtain eigenvalues and eigenfunctions of it. Sketch first three eigenfunctions.

18. Derive matrices for the operators J^2, J_z, J_x and J_y for $j = \frac{3}{2}$.

19. Discuss in detail time independent perturbation theory for non-degenrate states.

20. Discuss Hartee's self-consistent method for determing the potential energy $V(r)$ in central field approximation.

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F–2936

Sub. Code
7MPHE1A

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

First Semester

Physics

Elective – NUMERICAL METHODS

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Given that $a = 10.00 \pm 0.05$ and $b = 0.0356 \pm 0.0002$ Find the maximum value of the absolute error is

   (a) a + b

   (b) a + 5b

2. Define relative error.

3. Find the roots lies between the values of the equation $f(x) = x^3 - 2x - 5 = 0.$

4. Distinguish Gauss–Jordon and Gauss–seidal methods.

5. Give Newton's forward difference interpolation formula.

6. Why we need central difference interpolation formulae?

7. What is order of emergence for fourth under Runge – kutta method?

8. Write modified Euler method formula.

9. How Netwon's forward difference formula is used to compute derivative?

10. Write the order of error in the trapezoidal formula.

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) Fit a straight line of the form $Y = a_0 + a_1 x$ to the data.

x	1	2	3	4	6	8
y	2.4	3.1	3.5	4.2	5.0	6.0

Or

(b) The following table corresponding values of x and y. Obtain an equation of the form $y = a + bx$ using the method of average.

x	0	5	10	15	20	25
y	12	15	17	22	24	30

12. (a) Establish the formula $x_i + 1 = \frac{1}{2}\left(x_i + \frac{N}{x_i}\right)$ using Newton – Raphson method.

Or

(b) Write a C program for Gauss elimination method.

13. (a) Derive Lagrange interpolation formula.

Or

(b) Find out the value of y corresponding to x = 3.4 using Newton's interpolation for the following values.

x	0.5	1.2	2.1	2.9	3.6	4.5	5.7
y	3.2	5.2	9.3	14.6	20.5	30.1	45.2

14. (a) For the differential equation $\frac{dy}{dx} = \frac{x^2 - 1}{y^2 + 1}$ we have $y = 1$ at $x = 1$. Find out the value of y at x = 4 using Euler method.

Or

(b) Given that $\frac{dy}{dx} = y - x$, where $y(0) = 2$. Find $y(0.1)$ using Runge–Kutta second order method.

15. (a) Write a C program to evaluate given integral using Trapezoidal method.

Or

(b) Compute derivative using Newton's forward and backward difference formulae.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Derive the normal equation for evaluating the parameter 'a' and 'b' to fit data to power function model of the form $y = ax^b$ using principle of least squares.

17. Solve the following system of equations by the Gauss Elimination method

$10x + 2y + z = 9$

$2x + 20y - 2z = -44$

$-2x + 3y + 10z = 22$

18. The following table gives the viscosity of an oil as a function of temperature. Using Lagrange's interpolates formula. Find the viscosity of oil at temperature of 140°.

Temp. T°	110	130	160	190
Viscosity	10.8	8.1	5.5	4.8

19. Solve $\frac{dy}{dx} = 1 - y,\ \ y(0) = 0$ in the range using

(a) Euler method

(b) Improved Euler's method by choosing h = 0.1.

Compare the answers with exact solution.

Or

20. Evaluate $\int_0^{\pi/2} \sin x\, dx$ by

(a) Trapezoidal rule

(b) Simpson's rule using II ordinates. Also estimate the errors by finding the value of the integral.

F–2937

Sub. Code
7MPHE1B

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

First Semester

Physics

Elective: CRYSTAL GROWTH PROCESSES AND CHARACTERIZATION

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. List out advantages of low temperature solution growth techniques.

2. Mention some of the essential characteristics of solvents used to grow crystals from solution.

3. What are inner and outer reactants in gel growth?

4. What is synersis in gelling process?

5. Explain the principle of melt growth.

6. Write an expression to calculate the average growth rate of a crystal in pulling technique.

7. Explain the principle of chemical vapour transport method.

8. Mention any five important transporting agents.

9. Give the purpose and principle of recording single crystal X-ray diffraction.

10. State Beer-Lambert's law.

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) Explain the terms solution, solubility and supersolubility and discuss the importance of metastable zone width in low temperature solution growth method.

Or

(b) Discuss about the low temperature solution growth methods of crystallization.

12. (a) Describe single and double diffusion methods of crystallization.

Or

(b) Explain about chemical reduction and complex and decomplex methods of crystal growth.

13. (a) Describe the Bridgman method of crystal growth with neat diagram.

Or

(b) Explain the growth of bulk single crystal by Czochralski technique.

14. (a) Give an account on electrocrystallization.

Or

(b) Describe oscillating temperature profile method and list the advantages of chemical vapour transport method.

15. (a) Write a short essay on Vicker's microhardness tester.

Or

(b) With the help of a neat diagram, explain the working of Scanning Electron microscope (SEM).

Part C (3 × 10 = 30)

Answer any **three** questions.

16. (a) With neat illustrations, explain about constant temperature bath and crystallizer. (6)

(b) Write a short note on seed preparation and seed mounting. (4)

17. Describe the principle, various types, structure, mechanism and importance of gel with suitable illustrations.

18. Describe physical and chemical vapour deposition methods and list out advantages and disadvantages.

19. Write an essay on design aspects of autoclave for hydrothermal growth.

20. Explain the principle, construction, working and applications of FTIR spectrometer.

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F–2938

Sub. Code
7MPH2C1

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

Second Semester

Physics

SOLID STATE PHYSICS

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Define a reciprocal lattice.

2. What are amorphous materials? Give an example of such material?

3. Define plastic deformation.

4. What are longitudinal and transverse modes of vibrations?

5. What is Matthiessen's rule?

6. Give the order of band gap for a metal, a semiconductor and an insulator.

7. What is ferroelectricity? Give an example of ferroelectric crystal.

8. State Hund's rule.

9. State Curie-Weiss law of ferromagnetism.

10. What is coherence length?

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) What are point group and space group. Discuss all the point groups in a two dimensional lattice.

Or

(b) (i) A unit cell has the dimensions a =b = 4.0Å, c = 8.0Å, and $\alpha = \beta = 90^0$ and $y = 120^0$. Find the spacing between the (210) planes. (3)

(ii) The distance between adjacent atomic planes in $CaCO_3$ is 3.0 Å. Find the smallest angle Bragg scattering for 0.3 Å X-rays. (2)

12. (a) Derive an expression of velocity of transverse wave in [100] direction of cubic crystal.

Or

(b) Distinguish between the group velocity and phase velocity of a wave and establish a relation between them. In which case, these two velocities are equal?

13. (a) Write a short note on effective mass of electron.

Or

(b) Give a brief account on tight-binding approximation of electron in a crystal.

14. (a) Explain the different types of polarization mechanisms with neat diagram.

Or

(b) Discuss the theory of paramagnetism for conduction electrons.

15. (a) What are magnetic domains? Explain ferromagnetism on the basis of domain theory.

Or

(b) Derive first and second London equations.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Describe the Rotating crystal method for diffraction of X-rays. How do layer line form.

17. Discuss the lattice vibrations of diatomic one dimensional lattice and describe optical and acoustical modes of vibrations.

18. (a) What is Hall effect? How can you determine whether the given semiconductor is n-type or p-type?

    (b) State and prove Bloch theorem. (4+6)

19. Derive an equation for the internal field and hence deduce the Clausius and Mosotti equation.

20. (a) Show that perfect diamagnetism and zero resistivity are independent and essential properties of superconductor.

    (b) Describe the Josephson effect underlying a SQUID. (5+5)

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F–2939

Sub. Code
7MPH2C2

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

Second Semester

Physics

MATHEMATICAL PHYSICS - II

CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. State any two properties of inverse Laplace transform.

2. Explain the linearity property of Laplace transform.

3. Write down heat flow equation.

4. Consider a second order linear partial differential equation with constant coefficients and classify the types.

5. Show that $\frac{\partial x^m}{\partial \overline{x}^p}, \frac{\partial \overline{x}^p}{\partial x^n} = \delta_n^m$.

6. Write all possible equations of transformation for a mixed tensor of rank four.

7. Distinguish between isomorphism and homomorphism.

8. Show that $(1, i, -1, -i)$ form a cyclic group under multiplication.

9. Show that $\beta(m,n) = \beta(n,m)$.

10. Find the value of $\beta(1,2)$.

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) Obtain Laplace transform of the function $f(t) = \sinh at \sin at$.

Or

(b) Find Laplace transform of $\frac{\sin at}{t}$.

12. (a) Write Laplace equation in cylindrical coordinates. Solve it completely by the method of separation of variable.

Or

(b) Write a short note on boundary conditions that are being used to solve partial differential equations.

13. (a) Define

(i) symmetric and

(ii) anti-symmetric tensor. Give one example for each.

Or

(b) Prove that Kronecker delta is a mixed tensor of rank two.

14. (a) Define a cyclic group and show that a group of order four may or may not be a cyclic group.

Or

(b) State the symmetry elements of a square. Construct the group multiplication table of it.

15. (a) Show that $\left(1-2xz+z^2\right)^{-\frac{1}{2}}=\sum P_n(x)z^n$.

Or

(b) Prove that $L_n(x)=\frac{e^n}{n!}\frac{d^n}{dx^n}\left(x^n e^{-x}\right)$.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Using Laplace transform solve the differential equation $y'''(t)-2y''(t)+5y'(t)=0$ with $y(0)=0, y'(0)=1, y''\left(\frac{\pi}{8}\right)=1$.

17. Using Laplace transform method solve the one dimensional heat equation.

18. Define metric tensor. How are the contravariant components of a metric tensor related? Express a metric tensor in the case of spherical coordiantes.

19. State and prove great orthogonality theorem.

20. Prove that $\int_{-\infty}^{\infty} c^{-x}H_n(x)H_m(x)dx=\sqrt{\pi 2^n \bullet n!\delta_m,n.}$.

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F–2940

Sub. Code
7MPH2C3

M.Sc DEGREE EXAMINATION, NOVEMBER 2019

Second Semester

Physics

ELECTROMAGNETIC THEORY

(CBCS 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. State Gauss's law.
2. Justify the statement "Curl of E is zero".
3. How will you define magnetic vector potential?
4. Distinguish paramagnetism and diamagnetism.
5. Write down Maxwell's equation in linear isotropic media.
6. Define Poynting vector.
7. State Snell's law of refraction.
8. What is a waveguide?
9. Compare coherent and incoherent waves.
10. Write about retarded potential.

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) Deduce Laplace and Poisson's equation.

Or

(b) Describe the equation of continuity that express the conservation of charge.

12. (a) State Biot-Savart law and relate it to ampere's law.

Or

(b) Find the relation between magnetic susceptibility and relative permeability.

13. (a) Elaborate the differential form of Faraday's law's.

Or

(b) Discuss about the Lorentz gauge and invariance.

14. (a) Obtain an equation for Poynting vector of a plane electromagnetic waves in free space.

Or

(b) Derive an expression for Group velocity.

15. (a) Write a short note on magnetic dipole radiation.

Or

(b) Give an account on normal and anomalous dispersion.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Explain multipole expansion of potential of charge distribution.

17. State Ampere's theorem. Discuss the applications of Ampere's law.

18. Elaborate Poynting theorem for the conservation of energy in an electromagnetic field.

19. Discuss the reflection and refraction of electromagnetic waves at a plane interface between dielectrics.

20. Derive the total scattering cross section on the basis of theory of scattering of electromagnetic waves.

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F–2941

Sub. Code
7MPH2C4

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

Second Semester

Physics

QUANTUM MECHANICS – II

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Define the term transition probability.

2. Write down any two differences between constant and harmonic perturbation.

3. State any two importance of scattering experiments.

4. The wave function of a scattering process is given by $\Psi = e^{ikx} + \frac{\cos\theta}{5}\frac{e^{i\vec{k}.r}}{r}$. Calculate total scattering cross-section.

5. What is spontanous emission?

6. Define Einstein's B-coefficient.

7. What are the inadequacies one observes in Klein-Gordon equation?

8. State any two unusual features of the negative energy states.

9. Write down the classical field equation for the Lagrangian $L(t, \Psi, \Psi_x, \Psi_t)$.

10. What is meant by second quantization?

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) Derive Fermi Golden rule for the transition rate from a given initial state to a final state of continuum.

Or

(b) A linear harmonic oscillator is subjected to the time varying field described by $-e \in xe^{-i\Omega t}$ during the time t = 0 to T. If the system is initially in its ground state calculate the probability of finding the system in the first excited state for t > T. Find the probability if $H^{(1)} = -e \in x \sin \Omega t$.

12. (a) Obtain an expression for differential scattering cross section of particles by a coulomb potential.

Or

(b) Discuss in-detail the validity condition for Born approximation.

13. (a) Calculate the electric dipole transition probability for an atom placed in a radiation field.

Or

(b) Discuss in-detail the physical significance of the phase-shift in scattering theory.

14. (a) Show that Dirac's equation automatically endows the spining motion of an electron.

Or

(b) Find four linearly independent solutions of the Dirac equation for a free particle moving in the z-direction.

15. (a) Quantize the electromagnetic field in the absence of charge and currents. Hence obtain the Hamiltonian density of the field.

Or

(b) Write a short note on creation, annihilation and number operators.

Part C $(3 \times 10 = 30)$

Answer any **three** questions.

16. Using perturbation theory of non-degenerate levels explain the first order Stark effect in hydrogen.

17. Construct Green's function for an outgoing wave in scattering problem and use it to calculate the amplitude in first approximation.

18. What are Einstein transition probabilities? Outline the ways in which absorption and emission of radiation explained in quantum mechanics.

19. Derive Schrodinger's relativistic wave equation for a free particle and show that a plane wave solution of this equation gives both positive and negative energy solutions.

20. Discuss the quantization of Schrödinger equation.

F–2942

Sub. Code
7MPH3C1

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

Third Semester

Physics

ATOMIC AND MOLECULAR PHYSICS

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. List the various quantum numbers in Vector atom model.
2. Comment on the influence of electron spin in vector atom model.
3. Point out the fundamental postulates of Born-Oppenheimer Approximation.
4. Draw and define stimulated emission.
5. Based on moment of inertia, classify molecules in rotational spectra.
6. Differentiate microwave and IR spectroscopy.
7. State Raman Effect.
8. What is dissociation energy?
9. Write the basic principles of NMR.
10. Define 'g' factor.

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) Explain LS and JJ coupling.

Or

(b) State and explain Pauli's exclusion principle as applied to arrangement of electrons in an atom.

12. (a) Elaborate anomalous Zeeman effect.

Or

(b) Mention the significance of bonding and anti-bonding of MOs.

13. (a) Describe the effect of isotopic substitution in microwave spectroscopy.

Or

(b) The harmonic vibrational frequency of HCl lies at 2989.6 cm^{-1}. Calculate the energy (in terms of Joules) associated with the ground state and first excited state of HCl.

14. (a) Brief out the quantum theory of Raman effect.

Or

(b) Write a short note on Franck-Condon Principle.

15. (a) Describe the Bloch equations in NMR Spectroscopy.

Or

(b) Give an account on the nuclear interaction and hyperfine structure of H_2 atom.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Validate the existence of vector atom model by Stern-Gerlah experiment. Also compare fine and hyperfine structure.

17. Explain the experimental arrangement and theory of normal Zeeman Effect.

18. Give an account on the rotational spectra of linear, symmetric top and asymmetric top molecules in microwave spectroscopy.

19. Discuss in detail the rotational fine structure of electronic vibration transitions.

20. Describe the experimental techniques of ESR Spectrometer with its biological applications.

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F–2943

Sub. Code
7MPH3C2

M.Sc.DEGREE EXAMINATION, NOVEMBER 2019

Third Semester

Physics

NUCLEAR AND PARTICLE PHYSICS

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Define binding energy.

2. Is nuclear force spin independent?

3. Give the non-conservation of parity in beta decay.

4. Point the uses of detectors.

5. List out the limitations of cyclotron.

6. What is chain reaction?

7. Why theoretical formula of cross section is also called as dispersion formula?

8. Write about the conservation of energy.

9. Classify the major types of elementary particles.

10. Draw Su(2) symmetry.

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) How is shell model of a nucleus accounts for the existence of magic numbers?

Or

(b) Explain Yukawa's meson theory of nuclear forces.

12. (a) State and explain Geiger and Nuttal law.

Or

(b) Brief out the construction and working of scintillation counter.

13. (a) With diagram, describe the power reactor.

Or

(b) Comment on the controlled thermounclear reactions.

14. (a) List out the types of nuclear reaction with example.

Or

(b) Write short notes on Stripping and Pick-up reactions.

15. (a) Elaborate Gellmann Nishijima formula.

Or

(b) Give an account on space-inversion invariance principle.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Explain the properties of ground state of deuteron and show that it is a loosely bounded system.

17. With necessary diagram, describe the construction and working of ionization chamber.

18. Using liquid drop model, explain the Bohr-Wheelers theory of nuclear fission.

19. Derive Q-equation in nuclear reaction. and give a brief note on compound nucleus.

20. Describe the various types of interactions in elementary particles.

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F–2944

Sub. Code
7MPH3C3

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

Third Semester

Physics

ADVANCED ELECTRONICS

(CBCS 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

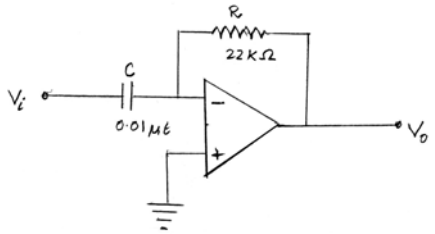
Part A (10 × 2 = 20)

Answer **all** questions.

1. Give two applications of photo-diodes.

2. Distinguish between a JFET and tripolar transistor.

3. Refer to the given figure. What is the name of the circuit?



4. Sketch the output waveforms from a differentiating circuit when the input is square wave.

5. What is primary disadvantage of a synchronous counter?

6. How does ROM retain information?

7. Give applications of Schmitt trigger.

8. Write the principle of a sample and hold circuit.

9. Give major areas of application of FM transmission.

10. Compare Gun and IMPATT diodes.

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) Explain construction, operation and application of SCR.

Or

(b) With neat diagram give the working principle of LASER diode.

12. (a) Draw the circuit diagram of differentiator and derive an expression for the output interms of the input.

Or

(b) Derive the gain of inverting and non-inverting op-amp.

13. (a) Explain the operation of MOD-6 counter.

Or

(b) Write a note on charged coupled device.

14. (a) Describe the working principle of voltage controlled oscillator.

Or

(b) With a neat diagram explain the action of phase shift oscillator.

15. (a) With neat diagram explain pulse width modulation scheme.

Or

(b) Write short notes on Klystron and Reflex Klystron.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Enumerate the input and output characteristics of a transistor in common-Emitter configuration.

17. Draw the block diagram of op-amp and explain it in detail.

18. Explain the operation of J-K flipflop with neat diagram.

19. Write the help of circuit diagram describe the working of basic triangular and square wave generators.

20. Explain amplitude modulations. Derive voltage equation of AM wave.

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F–2945

Sub. Code
7MPHE2A

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

Third Semester

Physics

Elective: MICROPROCESSOR AND MICROCONTROLLERS

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** the questions.

1. Define Fetch operation.

2. What are flags available in 8085?

3. What is interrupt?

4. Depict the sketch of control word bits for Intel 8255.

5. What is function of ALE pin?

6. How many byte does the internal RAM memory of the 8051 have?

7. What is DAA?

8. What will be output of the following instruments MOV A, RI?

9. Give the use of transducer.

10. What is DAC 0808?

Part B (5 × 5 = 25)

Answer **all** the questions, choosing either (a) or (b).

11. (a) Explain the Bus architecture of 8085.

Or

(b) Write an assembly language program to sum of the given series of data.

12. (a) What is asynchronous data transfer? Describe it with relevant diagrams.

Or

(b) Explicate about interrupts in 8085.

13. (a) Explain the MOV instruction with examples.

Or

(b) Draw and mention the pin configuration of 8051.

14. (a) Write a program to add 16-bit numbers. Place the sum in R7 and R6.

Or

(b) Explain jump instruction with examples.

15. (a) What is seven segment display? Member how does it connect to 8051?

Or

(b) Which IC is used in traffic control system for all the input and output? Explain its operations.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. With neat diagram, Explain the architecture of Intel 8085.

17. Describe the architecture of programmable peripheral Interface 8255.

18. Explicate is detail the serial communication interrupt and interrupt priority.

19. Write a 8051 program to find the smallest and largest numbers in an array.

20. Explain with a neat sketch how microcontroller 8051 is used for stepper motor control application.

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F–2946

Sub. Code
7MPHE2B

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

Third Semester

Physics

Elective – MODERN OPTICS AND LASER PHYSICS

(2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** the questions.

1. State Doppler Effect.
2. Write down the condition for circular and elliptical polarization.
3. Compare partial and spatial coherence.
4. How is Fabry-Perot interferometer used in laser generation?
5. What is Fresnel diffraction?
6. In what way holograms differ from conventional images?
7. Why conventional light sources do not induce nonlinearity in optics?
8. List out the advantages of Laser Raman spectroscopy.
9. Why stimulated emission is also called as negative absorption?
10. Point out the major applications of laser in communication.

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) Explain about phase velocity using plane harmonic waves.

Or

(b) What are Evanescent waves? Mention its significance.

12. (a) Define and explain coherence time and coherence length.

Or

(b) How does a Michelson interferometer works?

13. (a) What is Fraunhofer diffraction? List out the examples of Fraunhofer diffraction patterns.

Or

(b) Describe reflection hologram.

14. (a) Prove that the condition of phase matching is $\eta_{\omega} = \eta 2_{\omega}$.

Or

(b) Elucidate the theory of stimulated Raman scattering.

15. (a) Brief out the possible pumping schemes available to achieve population inversion.

Or

(b) How does a ruby laser work?

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Discuss the phenomenon of reflection at plane boundary.

17. Explain the construction and working of Fabry-Perot interferometer.

18. Describe in detail the Gabor hologram.

19. Why does nonlinearity in optics originate under high intense laser excitation? Derive an expression for nonlinear polarization and elaborate the possible phenomenon associated with it.

20. List out the various interaction of light with matter. And derive Einstein's coefficients.

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F–2948

Sub. Code
7MPHE3B

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

Fourth Semester

Physics

Elective — ANALYTICAL INSTRUMENTATION

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. List out the basic components of an emission spectrometer.

2. Define Rayleigh's scattering.

3. The wavelength of mercury green light is 546.1 nm. Calculate the frequency in Hz.

4. What is the information's derived from vibrational frequencies?

5. Draw the schematic diagram of IR spectrometer.

6. Mention any two sample preparation techniques in IR spectroscopy.

7. Why stokes lines are more intense than anti-stokes lines?

8. Distinguish between spin lattice and spin-spin interactions.

9. What is the magic angle spinning NMR?

10. Define ESR.

Part B (5 × 5 = 25)

Answer **all** questions choosing either (a) or (b).

(Draw the diagram wherever it is necessary in need)

11. (a) Explain the concept of Absorption photometry.

Or

(b) Explain the working of Photo-conductive cell.

12. (a) Discuss about the principle and working of Atomic emission spectrometer.

Or

(b) Write a short note on IR spectrometer.

13. (a) Explain the sample handling technique of Laser Raman spectrometer.

Or

(b) Outline the principle of Raman spectroscopy.

14. (a) Calculate the difference in the energies of protons oriented with and against a magnetic field of strength 1.5 T. What is the frequency of radiation that has photons with this energy? (g_N = 5.5857).

Or

(b) Write a short note on ESR spectrometer.

15. (a) Write a brief note on Flame Emission Spectrometry.

Or

(b) Describe the construction of Atomic Absorption Spectrometry.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Describe the construction and working of Ultraviolet Absorption Photospectrometry with neat block diagrams.

17. Discuss in detail about the working of Photo-Graphic and Photo-Electric detection.

18. Outline the principle, construction and working of X-Ray Florescence Spectrometer.

19. Explain the principle of SEM and ESCA.

20. (a) Write a short essay on Atomic Florescence Spectrometers.

(b) Distinguish between FES and AAS.

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F–2949

Sub. Code
7MPHE4A

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

Fourth Semester

Physics

Elective — THERMODYNAMICS AND STATISTICAL PHYSICS

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. State the first law of thermodynamics and what conservation law it is based.

2. Define Entropy. What is its S.I. unit?

3. Define mean free path.

4. Define the term distribution function.

5. Explain the term most probable macrostate.

6. Prove that the probability of a composite event is equal to the product of probability of the individual and independent events.

7. Point out the reasons for the need of quantum statistics.

8. What are symmetric and anti-symmetric wavefunctions. Give one example for each.

9. Mention four unusual properties of liquid helium II.

10. The velocities of longitudinal and transverse waves in metal aluminium are 6374 and 3111 ms^{-1} respectively. Calculate the Debye frequency and the Debye temperature for aluminium. Assume that there are 6.02×10^{28} atoms per m^3 in aluminium.

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) Define thermodynamic potentials *U*, *F*, *H* and *G*.

Or

(b) Deduce Clausius-Clapeyron's latent heat function. Can latent heat becomes zero?

12. (a) What is Brownian motion? Derive Einstein's relation for Brownian motion.

Or

(b) Deduce the equation of continuity of hydrodynamics from Boltzmann transport equation.

13. (a) State and prove Liouville theorem.

Or

(b) With the help of microcanonical ensemble, calculate the entropy of an ideal gas.

14. (a) Derive Bose-Einstein distribution law.

Or

(b) Discuss the postulates of quantum statistics.

15. (a) Calculate the value of Fermi-energy at absolute zero temperature.

Or

(b) Discuss the Pauli's theory of paramagnetism of an ideal Fermi gas and derive expression for the magnetic susceptibility.

Part C $(3 \times 10 = 30)$

Answer any **three** questions.

16. Distinguish between a perfect gas and a real gas. Derive van der Waals equation of state and use it to obtain the expression for the critical constants in terms of the constants of the van der Waal's functions.

17. State and prove Bolltzmann's H-theorem.

18. Obtain the equation of state of an ideal gas in the canonical ensemble picture.

19. What is Bose-Einstein condensation? Derive thermodynamic quantities for a Bose-Einstein gas at a temperature below the Bose temperature.

20. Describe Debye's theory of specific heat of solids.

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F–2950

Sub. Code
7MPHE4B

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

Fourth Semester

Physics

Elective : COMMUNICATION ELECTRONICS

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Define Modulation index.

2. What is noise?

3. What are the most commonly used digital modulation techniques?

4. Draw Ask signal to transmit data stream – 1111000111.

5. Give important use of CW radar.

6. What is transit time in klystron?

7. Give the advantages of optical fibers.

8. What may limit the top speed of fiber communication?

9. Why is a satellite link prove to eclipses?

10. Give the disadvantages of geosynchronous satellites.

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) Discuss the effect of noise in AM and FM signals.

Or

(b) Explain the power gains of an antenna. In what form is it usually expressed?

12. (a) Describe the generation and demodulation of Pulse Position Modulation (PPM).

Or

(b) Define Pulse Amplitude Modulation (PAM). Explain distortion in PAM.

13. (a) Draw the block diagram of MTI radar system and explain its working.

Or

(b) Explain the working principle of Gunn diode for detection of microwaves.

14. (a) Discuss different types of fiber.

Or

(b) Explain salient features of optical sources and detectors.

15. (a) What are communications satellite? List out the reasons for their increasing popularity.

Or

(b) What is GSM? Explain it.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Give the theory of frequency modulation.

17. Describe multiplex transmission techniques.

18. Give the working principle of a basic radar system. Also device radar range equation in free space.

19. Draw the block diagram of optical fiber communication and explain each block.

20. Explain different domestic satellites including Intelsat, Marisat satellites.

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F–2951

Sub. Code
7MPHE5A

M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

Fourth Semester

Physics

***Elective*-ENERGY AND ENVIRONMENTAL PHYSICS**

(CBCS – 2017 onwards)

Time: Three Hours Maximum: 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Write down the composition of air.
2. How will define hydrostatic equilibrium?
3. Define collector efficiency.
4. Give any two reasons for variation in solar radiation reaching the earth than outside the atmosphere.
5. List out the factors that affect bio-digestion.
6. Point out the conditions that are necessary for photosynthesis.
7. Comment on the adverse effects of depletion of fossil fuels.
8. What are hybride batteries?
9. Tabulate any four potentially hazardous air pollutants and their sources.
10. Mention the significance of heat island effect.

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) State and explain Raynolda's transport theorem.

Or

(b) Write short notes on stratification and stability of atmosphere.

12. (a) Describe the solar radiation at the earth's surface.

Or

(b) Elaborate the physical principles of flat plate solar collector.

13. (a) Explain the wet processes in biomass conversion.

Or

(b) Brief out the advantages and disadvantages of floating drum plant.

14. (a) How will you use hydrogen for electricity generation?

Or

(b) Figure out the working of hydride batteries work.

15. (a) What are the factors that governing water and noise pollution?

Or

(b) Differentiate land breeze and sea breeze.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Explain the following

    (a) Variation of temperature, pressure and density with height

    (b) Greenhouse effect.

17. Give a detailed explanation in measuring solar radiation using pyrheliometer and pyranometer?

18. Explain the classification of Biogas plants.

19. Discuss the application of fuel cell.

20. Describe the sources and purification of air pollution. How will you control air pollution?

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