F–1934

Sub. Code
7MPH1C1

M.Sc. DEGREE EXAMINATION, APRIL 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. Whether the set of vectors (3, 2, 4), (1, 0, 2) and (1, –1, –1) are linearly independent or dependent?

2. Suppose $\vec{F} = \vec{\nabla}\varphi$, where φ is single-valued and has continuous partial derivatives. Show that the work done in moving a particle from one point P to another point Q is independent of the path joining the two points.

3. What do you understand by indicial equation and indicial roots?

4. Write Hermite differential equation in Sturm-Liouville form.

5. Show that the function $u(x, y) = x^3 - 3xy^2 - 5y$ is harmonic in the entire complex plane.

6. Evaluate $\oint \frac{z^2 - 4z + 4}{z + i} dz$, where c is the circle $|z| = 2$.

7. What are Dirichlet's condition for a Fourier series expansion?

8. State any two applications of Fourier series.

9. State the scaling property of Fourier transform.

10. Explain the shifting property of Fourier transform.

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

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

11. (a) State and prove Green's theorem.

Or

(b) Verify Stokes' theorem for $\vec{A} = (2x - y)\hat{i} - yz^2\hat{j} + y^2z\hat{k}$, where S is the upper half surface of the sphere $x^2 + y^2 + z^2 = 1$ and C is its boundary.

12. (a) Demonstrate Cayley-Hamilton theorem for the matrix $\begin{pmatrix} 1 & 2 & 0 \\ 2 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$.

Or

(b) Find eigenvalues and eigenvectors of the matrix $\begin{pmatrix} 1 & 2 \\ 2 & 1 \end{pmatrix}$.

13. (a) Expand $f(z)=\dfrac{1}{1-z}$ in Taylor series with centre $z_0=2i$.

Or

(b) Using Residue theorem evaluate the integral $\int_0^{2\pi}\dfrac{\cos\theta}{3+\sin\theta}\,d\theta$.

14. (a) Find the Fourier half-range cosine series of the function $f(t)=\begin{cases}2t & 0<t<1\\ 2(2-t) & 1<t<2\end{cases}$.

Or

(b) Using Fourier sine series for $f(x)=1$ in $0<x<\pi$, show that $\dfrac{\pi^2}{8}=1+\dfrac{1}{3^2}+\dfrac{1}{5^2}+\dfrac{1}{7^2}+\cdots$.

15. (a) Find the Fourier sine transform of $f(x)=\dfrac{e^{-ax}}{x}$.

Or

(b) State and prove convolution theorem for Fourier transforms.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Use Gram-Schmidt orthogonalization process to determine an orthonormal basis in $\mathbb{R}^3$ for the given set of independent vectors. $X_1=(1,\,0,\,1)^T$, $X_2=(-1,\,1,\,0)^T$, $X_3=(-3,\,2,\,0)^T$.

17. Using Frobenius method obtain the general solution of the differential equation $3xy''+2y'+y=0$.

18. State and prove Cauchy's integral theorem.

19. Express the function $f(x) = x \sin x$ in the Fourier series in the interval $-\pi < x < \pi$.

20. Find the finite Fourier sine and cosine transform of $\frac{\partial^2 u}{\partial x^2}$, where u is a function of x and t for $0 < x < l$, $t > 0$.

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F–1935

Sub. Code
7MPH1C2

M.Sc. DEGREE EXAMINATION, APRIL 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? Mention its consequence.

2. Define

   (a) scleronomic and

   (b) holonomic constraints.

3. For the potential $V = 12\ kr^2$, what is the form of force?

4. Mention two examples where inverse square law of force is being considered.

5. Show by direct vector manipulation that the definition of moment of inertia that $I = m_i(\vec{r}_i \times \hat{n}) \,.\, (\vec{r}_i \times \hat{n})$ reduces to $I = m_i\left[r_i^2 - (\vec{r}_i, \hat{n})\right]$.

6. Define precessional and nutational motions of a top.

7. Using Poisson-bracket write the equations of motion for the Hamiltonian $H = \frac{1}{2m} p^2 + \frac{1}{2} kx^2$.

8. State any two properties of Poisson brackets.

9. What is meant by time dilation?

10. Prove that the momentum of a particle of velocity V and relativistic energy E is given by $\vec{p} = \frac{E\vec{V}}{c^2}$.

Part B (5 × 5 = 25)

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

11. (a) Set up Lagrangian and derive Euler Lagrange's equation of motion of a linear harmonic oscillator. Solve it to obtain the general solution of it.

Or

(b) Show that in the absence of the external torque, the total angular momentum of a system of particles is conserved.

12. (a) How will reduce the two-body problem into one-body problem?

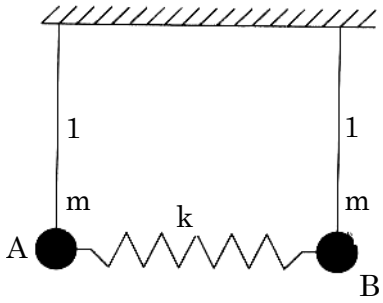
Or

(b) State and prove virial theorem.

13. (a) Obtain normal frequencies and normal modes of a linear triatomic molecule.

Or

(b) Two identical simple pendulums, each of length 0.5 m, are connected by a light spring as shown in the figure. The force constant of the spring is $2\ Nm^{-1}$ and the mass of each bob is 0.1 kg. If one pendulum is clamped, calculate the period of the other pendulum. When the clamp is removed, determine the periods of two normal modes of the system (g = 9.8 m sec^{-2}).



14. (a) Solve Hamilton-Jacobi equation and obtain an expression for Hamilton's principle function for the one dimensional harmonic oscillator.

Or

(b) Show that the transformation $q = \frac{P}{\sqrt{k}} \sin Q$, $p = \left(\frac{mP}{\sqrt{k}}\right)^{\frac{1}{2}} \cos Q$ is canonical and the generating function $F = \frac{1}{2}\sqrt{kq^2} \cot Q$.

15. (a) Obtain Einstein's formula for addition of velocities.

Or

(b) Show by direct application of Lorentz transformation that $x^2 + y^2 + z^2 - c^2t^2$ is invariant.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. State D'Alembert's principle and derive Lagrange's equation of motion from D'Alembert's principle.

17. Derive the differential equation for the orbit of a particle moving under central force.

18. Derive the equations of motion of a heavy symmetrical top in terms of Euler angles.

19. Solve the problem of harmonic oscillator by using action-angle variables.

20. Prove the relativistic formula $m = \frac{m_0}{\sqrt{1 - \frac{v_2}{c^2}}}$ and then $E = mc^2$.

F–1936

Sub. Code
7MPH1C3

M.Sc. DEGREE EXAMINATION, APRIL 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. Identify whether the operator $x\,d/dx$ is linear or not.

2. Write the wave equation for a wave function in momentum space.

3. Draw the first few energy eigen functions of a particle in a box potential.

4. State the quantum tunnel effect. Give an application of it.

5. Why should one study about angular momentum? State two reasons.

6. What are the significances of $[J^2, J_Z] = 0$?

7. Define non-degenerate and degenerate states.

8. State the variational theorem.

9. State the Pauli exclusion principle for a system of identical

   (a) fermions and

   (b) bosons.

10. Write the Slater determinant for a system of three identical particles.

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

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

11. (a) Explain the meaning of eigenvalues and eigen functions.

Or

(b) Calculate the expectation value of X if $\psi = \exp(-kx)$ for $x > 0$ and 0 for $x < 0$.

12. (a) What are the allowed energy eigen values of linear harmonic oscillator and rigid rotator? Also, determine the spacing between the successive energy levels in these two systems.

Or

(b) An electron of mass $m = 9.109 \times 10^{-31}$ kg is confined within a box with perfectly rigid walls, The width of the box is 2 nm. If the electron is in the ground state, compute the energy.

13. (a) Compute $[J_x, J_y]$.

Or

(b) Obtain the matrix representation of the components of J^2 for $j = 1/2$ and $l = 1$.

14. (a) Outline the basic principle of Born-Oppenheimer approximation.

Or

(b) Applying the WKB method, find the energy levels of linear harmonic oscillator.

15. (a) Setup the eigenfunctions for a system of two electrons.

Or

(b) Write the spin matrices for $s = 1/2$.

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

Answer any **three** questions.

16. State and prove Ehrenfest's theorem.

17. Determine the energy eigenvalues and eigenfunctions of a linear harmonic oscillator by solving the Schrödinger equation.

18. Compute the eigenvalues of J^2 and J_z using commutations relations.

19. Discuss the application of degenerate perturbation theory to account the Stark effect on a hydrogen atom.

20. Explain the basic idea of the Hartree-Fock approximation.

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F–1937

Sub. Code
7MPHE1B

M.Sc. DEGREE EXAMINATION, APRIL 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. What is solubility gradient?

2. List out the main disadvantages of low temperature solution growth.

3. Give the advantages of gel growth method.

4. What is meant by top solution in gel growth? Give an example.

5. List out the various melt growth techniques.

6. Name some of the heating sources with temperature range, used for melt growth techniques.

7. What are the typical conditions to achieve new phase in electrocrystallization?

8. What is over potential?

9. Explain the principle of SEM.

10. What is the role of indenter in Vicker's microhardness tester?

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

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

11. (a) What is supersaturation? Derive an expression for coefficient of supersaturation.

Or

(b) With a neat diagram explain the growth of crystals by slow cooling of solutions.

12. (a) Explain single and double diffusion gel method with suitable example.

Or

(b) Discuss about the structure of silica gel.

13. (a) Explain about the various advantages and disadvantages of Czochralski pulling method.

Or

(b) With a neat illustration, discuss about the role of crucible shapes and materials in Bridgman method.

14. (a) Briefly discuss about the principle, advantages and disadvantages of hydrothermal technique.

Or

(b) Write a short essay on electrocrystallization.

15. (a) Briefly explain the principle, advantages and disadvantages of atomic absorption spectrometer?

Or

(b) What is an interferometer? With a neat block diagram explain the working of FTIR spectrometer.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. (a) Explain the advantages and instrumentation of constant temperature bath. (5)

(b) Explain about the various criteria involved in the selection of crystallizer. (5)

17. (a) What is physical and chemical gel? Discuss the various important of gel techniques.

(b) Write a short essay on the growth of Cholesterol crystals by gel method.

18. Elaborately discuss about the principle, various components and growth procedure of Bridgman setup for single crystal growth.

19. Describe the various design aspects of autoclaves.

20. Describe the laue and Rotating crystal methods of crystal structure determination with neat diagrams.

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F–1938

Sub. Code
7MPH2C1

M.Sc. DEGREE EXAMINATION, APRIL 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 unit cell and lattice parameters.

2. What are the applications of Laue method of X-ray diffraction?

3. Define shearing strain.

4. Write any two properties of phonons.

5. Define Fermi energy for metals.

6. What is Bloch function?

7. Define Bohr magneton.

8. What is space-charge polarization?

9. What is hysteresis in magnetic materials?

10. Give any two applications of superconductor.

Part B (5 × 5 = 25)

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

11. (a) Describe structure of NaCl and Diamond with neat illustrations.

Or

(b) Explain the rotating crystal method of X-ray diffraction.

12. (a) Give a brief account on analysis of elastic strain.

Or

(b) Derive an expression for the frequency of the lattice vibrations of monoatomic one dimensional lattice.

13. (a) Derive an expression for the electrical conductivity of metal.

Or

(b) In the Hall effect measurement, a plate of width $d = 1.0\ cm$ and length $l = 5.0 cm$ made a p-type semiconductor was placed in the magnetic field $B = 0.5T$. A potential difference $V_a = 10.0V$ was applied across the edges of the plate. In this case the Hall voltage is $V_H = 0.05V$ and ρ is $= 2.5 \times 10^{-2}\ \Omega m$. Determine the Hall coefficient and concentration of holes and hole mobility.

14. (a) Derive Clausius-Mosotti equation from internal field equation.

Or

(b) State Hund's rule. Sm^{3+} has five electrons in the f-shell ($l = 3$). What are the values of L, S and J? Hence calculate P_{eff}.

15. (a) How does Heisenberg's exchange interaction explain ferromagnetism?

Or

(b) Write a short note on the high temperature superconductors.

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

Answer any **three** questions.

16. (a) State the properties of a reciprocal lattice. How is a reciprocal lattice constructed from a direct lattice? (5)

(b) Prove that *fcc* lattice is reciprocal to bcc lattice. (5)

17. (a) Express the laws of conservation of energy and momentum in case of inelastic scattering of neutrons by a phonon. (5)

(b) What are normal and Umklapp processes? Explain with the help of vector diagrams. (5)

18. Discuss the formation of allowed and forbidden energy bands on the basis of the Kronig-Penny model.

19. Explain quantum theory of paramagnetism and discuss the low and high temperature cases.

20. Write an essay on BCS theory by explaining the electron-lattice-electron interaction, Cooper pair and energy gap existence.

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F–1939

Sub. Code
7MPH2C2

M.Sc. DEGREE EXAMINATION, APRIL 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 the linearity property of Laplace transform.

2. What do you understand by the translation property of Laplace transform?

3. Write down two dimensional wave equation. How many arbitrary functions do appear in the general solution?

4. A second order linear partial differential equation is described by the following form $au_{xx} + bu_{xy} + cu_{yy} = 0$, where a, b and c are arbitrary constants. List out the condition for this equation to be (a) parabolic and (b) hyperbolic.

5. Show that the contraction of A_q^p is a scalar.

6. If A_{ij} is an antisymmetric tensor. What is the value of A_{11}?

7. Define the term coset.

8. What is meant by point groups? Give an example.

9. Show that Legendre equation is self-adjoint.

10. Show that $L_1(x) = L_1'(x) - \frac{1}{2} L_2'(x)$, where $L_n(x)$ is the Laguerre polynomial.

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

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

11. (a) An inductor of 3 henry is in series with a resistance of 30 ohms and an e.m.f of 150 volts. Assuming that the current is zero at $t = 0$, find the current at time $t > 0$.

Or

(b) Find the inverse Laplace transform of $l_n\left(\frac{s^2 + w^2}{s^2}\right)$.

12. (a) Derive the one dimensional wave equation.

Or

(b) With the help of separation of variables method find the solution of two dimensional Laplace equation.

13. (a) What do you mean by symmetric and anti-symmetric tensors?

Or

(b) If $a_{\alpha\beta} x^\alpha x^\beta = 0$ for all values of the variables $x^1, x^2, ..., x^n$ then show that $a_{\mu\gamma} + a_{\gamma\mu} = 0$.

14. (a) Prove that the covering operations of an equilateral triangle form a group homomorphic onto the group of elements $(1,-1)$.

Or

(b) Explain the reducible and irreducible representations and mention their main features.

15. (a) Prove that $\left(1 - 2xt + t^2\right)^{-\frac{1}{2}} = \sum_{n=0}^{\infty} P_n(x)t^n$.

Or

(b) Evaluate $\int_0^{\frac{\pi}{2}} \sin^5 \varphi \cos^5 \varphi \, d\varphi$.

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

Answer any **three** questions.

16. Find the inverse Laplace transform of $f(s) = \frac{1}{s(s+2)^3}$.

17. Using Laplace transform, solve $u_t = 2u_{xx}$, where $u(0,t) = 0 = u(5,t)$ and $u(x,0) = 10\sin(4\pi x)$.

18. Define a metric tensor. Determine it in the case of spherical coordinates.

19. State and prove Schur's lemma.

20. Solve the Bessel differential equation $x^2y'' + xy' + \left(x^2 - \frac{1}{4}\right)y = 0$ and show that the solution can be written in terms of $\frac{\sin x}{\sqrt{x}}$ and $\frac{\cos x}{\sqrt{x}}$.

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F–1940

Sub. Code
7MPH2C3

M.Sc. DEGREE EXAMINATION, APRIL 2019

Second Semester

Physics

ELECTROMAGNETIC THEORY

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Define electric field.

2. Why the Gauss's law is not useful in calculating the field due to three equal charges located at the corners of an equilateral triangle?

3. Write an expression for the force acting on a moving charge in simultaneous electric and magnetic fields.

4. State Biot-Savart's law. Mention the significance of it.

5. Write Faraday's law in integral form.

6. Define Magnetic vector potentials.

7. Name different layers of ionosphere.

8. State law of reflection.

9. What is radiation?

10. Define scattering cross-section

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

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

11. (a) Establish the relation $\vec{E} = -\vec{\nabla} \vee$.

Or

(b) Discuss classic image problem with an illustration.

12. (a) Using Ampere's law, find the electric field inside a long solenoid.

Or

(b) Discuss the dynamics of a charged particle in the presence of an uniform magnetic field.

13. (a) Deduce Faraday's law of electromagnetic induction in differential form.

Or

(b) Establish the non-uniqueness of electromagnetic potentials and Gauge transformations.

14. (a) Show that the electromagnetic waves in free space are transverse.

Or

(b) Give an account of frequency dispersion characteristics of dielectrics.

15. (a) Discuss scattering by free electrons.

Or

(b) Derive Jefimenko's equation.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Using Gauss's law, find the electric field inside and outside a uniformly charged solid sphere of radius R and total charge q.

17. Derive an expression for multipole expansion of vector potential and show that the magnetic monopole term in this expression is zero.

18. Show that the energy radiated per unit area per second is represented by Poyting vector.

19. Derive the Fresnel's equations for reflection of light from dielectric surface.

20. Study the radiation produced by an oscillating magnetic dipoles.

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F–1941

Sub. Code
7MPH2C4

M.Sc. DEGREE EXAMINATION, APRIL 2019

Second Semester

Physics

QUANTUM MECHANICS – II

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** the questions.

1. Write any two differences between constant and harmonic perturbations on transition probability.
2. What is known as adiabatic approximation? Give an example of a perturbation that can be treated as an adiabatic.
3. State the aim of scattering theory in quantum mechanics. How do we achieve it?
4. What are partial waves?
5. What are called Einstein coefficients?
6. Define density matrix.
7. State two inadequacies of Klein--Gordon equation.
8. Write two properties of Dirac matrices.
9. Mention two reasons for necessity of quantum field theory.
10. Define number operator and write its equation of motion.

Part B (5 × 5 = 25)

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

11. (a) Starting from the expression for first-order transition probability arrive at the Fermi Golden rule.

Or

(b) Outline the theory of sudden approximation.

12. (a) The wave function of a scattering process is $\Psi = \exp(i\,k\,z) + [\cos\theta \exp(i\,k\,r)]/(5\,r)$. Calculate total scattering cross-section.

Or

(b) For the Yukawa potential obtain the scattering amplitude by Born approximation.

13. (a) Establish the relations between Einstein coefficients.

Or

(b) Explain an application of density matrix.

14. (a) Find the probability and current densities for a relativistic Dirac particle.

Or

(b) Enumerate the features of negative energy states.

15. (a) If the Lagrangian density of a system is $L = \frac{1}{2}(\partial q/\partial t)^2 - \frac{1}{2}(\partial q/\partial X)^2$ then find the wave equation using the Euler-Lagrange equation.

Or

(b) Explain the mode of setting quantum equations for fields.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Find the first-order transition probability for a system driven by a constant perturbation.

17. Through the partial wave analysis express scattering amplitude in terms of phase shift.

18. Discuss the interaction of incident radiation with atoms.

19. Show that for a Dirac particle orbital angular momentum is not conserved but the sum of orbital angular momentum and spin angular momentum is conserved.

20. Setup the Lagrangian and Hamiltonian densities associated with non relativistic Schrödinger equation and then show that the Schrödinger equation follows from the Hamiltonian formulation of field description.

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F–1942

Sub. Code
7MPH3C1

M.Sc. DEGREE EXAMINATION, APRIL 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. Write down the condition for Balmer and Paschen series in hydrogen spectrum.
2. State Pauli's Exclusion principle.
3. Give examples for covalent, ionic and Van der Waal's interaction.
4. In what way stimulated emission is different from spontaneous emission?
5. Why microwave spectroscopy is also called as rotational spectroscopy?
6. How do you classify molecules based on the moment of inertia?
7. Define polarizability ellipsoid.
8. "Franck Condon Principle is a direct consequence of Born-Oppenheimer approximation". Justify.
9. What is NMR?
10. Why electron spin resonance is also called as electron paramagnetic resonance?

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

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

11. (a) Write a note on various coupling schemes.

Or

(b) The following terms arise from a d^8 electron configuration: $^1S, ^1D, ^1G, ^3P, ^3F$. Use the first two of Hunds rules to properly order these terms according to energy. Then, determine the term symbols arising from each term, and use the third Hund's rule to complete the energy ordering

12. (a) State and explain Stark effect. Mention the condition for first-order and second-order Stark effect.

Or

(b) Elaborate Born-Oppenheimer approximation.

13. (a) Describe the rotational spectra of linear polyatomic molecules.

Or

(b) Mention the significance of characteristic and group frequencies.

14. (a) The first three Stokes lines in the rotational spectrum of $^{16}O_2$ are separated by $14.4cm^{-1}, 25.8cm^{-1}$ and $37.4cm^{-1}$ from the exciting radiation. Using the rigid rotator approximation obtain a value for r_0. [Given $= 1.328 \times 10^{-21} kg$]

Or

(b) With proper energy level diagram, elaborate dissociation energy and dissociation products.

15. (a) Outline the functioning of single coil method in NMR spectroscopy.

Or

(b) Draw and explain ESR spectrometer.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Based on vector atom model, explain the various quantum numbers available to define the quantum states of an electron.

17. With proper spectral diagram, explain the quantum mechanical description normal Zeeman effect for one electron system.

18. Describe the rotational spectra of a diatomic non-rigid rotator.

19. Discuss the rotational and vibrational Raman shifts of a diatomic molecule.

20. How is ESR used in free radical studies and biological applications?

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F–1943

Sub. Code
7MPH3C2

M.Sc. DEGREE EXAMINATION, APRIL 2019

Third Semester

Physics

NUCLEAR AND PARTICLE PHYSICS

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** the questions.

1. What is parity and isospin?
2. Comment on the spin dependence of nuclear forces.
3. Point out the three modes of beta radioactivity.
4. List the important characteristics a material should possess to behave as a semiconductor detector.
5. Justify the statement, *"synchro-cyclotron is frequency modulated cyclotron"*.
6. State Pinch effect.
7. Define nuclear cross section.
8. What are the major conclusions that can be arrived from the partial wave analysis?
9. In universe, which of the following total number of elementary particles is controlled by conservation of laws, Bosons or Fermions?
10. What are charge conjugations?

Part B (5 × 5 = 25)

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

11. (a) Draw and list out the important results arrived from the variation of binding energy per nucleon with the mass number.

Or

(b) Show that the nucleons in the deuteron spend only one-third of time within the nuclear force range and thus deuteron is loosely bound.

12. (a) Elaborate the concept of internal conversion.

Or

(b) Brief out the different process involved in scintillation counter.

13. (a) Draw the schematic diagram and describe the working of betatron.

Or

(b) Comment on the term controlled thermonuclear reactions.

14. (a) Based on product nuclei, how will you categories nuclear reactions.

Or

(b) Derive Breit-Wigner dispersion one level formula for spinless nuclei.

15. (a) List out the available elementary particles in Universe.

Or

(b) Write a note on space-inversion invariance.

Part C (3 × 10 = 30)

Answer any **Three** questions.

16. By writing the Semi-Empirical mass formula, discuss the various energies that contribute to the mass of a nucleus.

17. Show that the transmissivity of alpha particle through barrier is $T \sim e^{-2k} 2^{a}$.

18. Briefly explain solar fusion and cold fusion.

19. What is nuclear reaction kinematics? By deriving Q-equation, discuss the importance of general solutions.

20. Explain in detail the Quark theory.

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F–1944

Sub. Code
7MPH3C3

M.Sc. DEGREE EXAMINATION, APRIL 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 any two important properties of Semiconductor.

2. Give any two applications of diode.

3. Define CMRR.

4. Draw integrator circuit.

5. What is meant by RAM?

6. Mention uses of Flip-Flops.

7. State the function of RESET in 555 timer.

8. What is A/D.?

9. Define modulation factor.

10. What is phase modulation?

Part B (5 × 5 = 25)

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

11. (a) Distinguish between Intrinsic and Extrinsic semiconductors.

Or

(b) How does Zener diode maintain constant voltage across the load?

12. (a) Construct the characteristics of inverting Op-amp.

Or

(b) Explain how an op-amp works in integrator.

13. (a) Elucidate the verifying principle of the phase modulation.

Or

(b) Construct the ring counter and explain its function.

14. (a) Draw and explain the functional diagram of 555 timer.

Or

(b) Examine the operation of voltage controlled oscillators.

15. (a) Describe the theory of amplitude modulation.

Or

(b) Explain theory of frequency modulation.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Discuss the parameters and characteristics of MOSFET.

17. Construct with neat diagram in

    (a) Low pass filter

    (b) High pass filter.

18. Explain the following counters

    (a) Synchronous

    (b) Asynchronous

19. Describe the working of Successive approximation for ADC.

20. Explain the working principle of Klystron.

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F–1945

Sub. Code
7MPHE2A

M.Sc. DEGREE EXAMINATION, APRIL 2019

Third Semester

Physics

***Elective* — MICROPROCESSOR AND MICROCONTROLLERS**

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Section A (10 × 2 = 20)

Answer **all** questions.

1. Define opcode.

2. List out any four arithmetic instructions.

3. What are advantages of serial data transfer?

4. Name any two applications of 8253.

5. Write format of 8051 PSW.

6. Why microcontrollers are often called single-chip computers?

7. What is need for bit addressing?

8. When is the instruction DJNZ useful?

9. What is the need of 8255 in a microcontroller system?

10. Why stepper motor is called as DC motor?

Section B (5 × 5 = 25)

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

11. (a) Discuss the pin configuration of 8085 with suitable diagram.

Or

(b) Explain the time delay calculation using the register.

12. (a) Explain with a block diagram of programmable Peripheral interface (8255 A).

Or

(b) Give the functions of DMA controller.

13. (a) Differentiate between microprocessors and microcontrollers.

Or

(b) Explain stack operation in 8051.

14. (a) Write an ALP of 8051 for biggest number from a given list.

Or

(b) List out and explain Arithmetic instructions of the 8051.

15. (a) Discuss the interfacing of seven segment display in 8051.

Or

(b) How to interface a DAC in the 8051?

Section C (3 × 10 = 30)

Answer any **three** questions.

16. Discuss the different addressing modes of 8085 with suitable examples.

17. (a) Give the detail about the USART (8215 A).

    (b) Examine the 8259 A programmable interrupt controller.

18. Explain architecture of 8051 in detail.

19. Give one-byte, two-byte, and three bytes instructions of 8051 and explain them with examples.

20. Explain the interfacing of Stepper motor with 8051.

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F–1946

Sub. Code
7MPHE2B

M.Sc. DEGREE EXAMINATION, APRIL 2019

Third Semester

Physics

Elective — MODERN OPTICS AND LASER PHYSICS

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Comment on the speed of light.

2. Compare circular and elliptical polarization.

3. Define coherence time.

4. What is spatial coherence?

5. Say True or False with reason "In Fraunhofer diffraction, the shape and intensity of a pattern remain constant".

6. Who is called as Father of holography? Justify your answer.

7. In what way parametric amplifier works?

8. How does self-focusing occur?

9. Differentiate spontaneous and stimulated emission.

10. Point out the major applications of laser in medicine.

Part B (5 × 5 = 25)

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

11. (a) Write a note on plane harmonic waves.

Or

(b) Mention the significance of Brewster's angle.

12. (a) Looking into the Michelson interferometer, one can see a dark central disk surrounded by concentric light and dark rings. One mirror is 2 cm farther from the beam splitter than the other, and λ = 500 nm. What is the order of the central disk and the 6^{th} dark ring?

Or

(b) How will you demonstrate the occurrence of interference with multi beam?

13. (a) List out some of the examples for Fraunhofer diffraction patterns.

Or

(b) (i) Suppose a 1.0-mm-thick CD can store 1.0 gigabyte of information in the top 1.0-micrometer-thick layer. How much information can this CD store if it can record over its entire volume at the same information density?

(ii) Why does the image of a reflection hologram made with red laser light when illuminated with white light appear yellow, or even green?

14. (a) Demonstrate the first experiment to evidence the existence of second harmonic generation.

Or

(b) Elaborate the concept of phase matching.

15. (a) What is population inversion? List out the possible pumping schemes available to achieve population inversion.

Or

(b) How does a He-Ne laser work?

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

Answer any **three** questions.

16. Briefly describe the formation and significance of Evanescent waves in total internal reflection.

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

18. Describe in detail the Leith- Upatniek"s hologram.

19. What is nonlinear polarization? Arrive at an expression to prove the existence of second and third harmonic generation.

20. Derive Einstein's coefficients that are used to explain the interaction of light with matter and obtain the relation between them.

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F–1947

Sub. Code
7MPHE3A

M.Sc. DEGREE EXAMINATION, APRIL 2019

Fourth Semester

Physics

Elective : NANOSCIENCE

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. What are the different dimensions of nanomaterials? Give examples.

2. Distinguish between metals, semiconductors and insulators.

3. Write down any four synthesis methods of nanomaterial preparation.

4. Define the principle of chemical vapour deposition.

5. What is CNT?

6. What do you mean by photonics?

7. Write any four biological applications of nanotechnology.

8. Give any four example of nano-biometrics.

9. In TEM, the accelerating voltage is 100 kV. What is the wavelength of incident electron?

10. Define catalysis.

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

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

Draw the diagram wherever it is necessary in neat.

11. (a) Write a short note on surfaces and dimensional phases.

Or

(b) Discuss about the concept of molecular and atomic size.

12. (a) Explain the technique of plasma arcing.

Or

(b) Outline the working of Ball Milling.

13. (a) Describe the different types of carbon nanotube.

Or

(b) Why Carbon nanotube is used as a hydrogen storage material?

14. (a) What are the different techniques for producing optical devices?

Or

(b) Write a short note on nano holes and photons.

15. (a) Explain briefly the optical lithography.

Or

(b) How does a quantum computer work? Write a short note on idealized atomic quantum computer.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Discuss about the following :

    (a) Atomic Structure,

    (b) Molecules and Phases, and

    (c) Energy.

17. Discuss in detail about the sol – gel process.

18. Describe the different formation methods of nanotubes.

19. Write a brief note on new low cost energy efficient windows and solar absorbers based on nanoparticles.

20. Explain the functions of Electron Beam Epitaxy and Molecular Beam Lithography.

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F–1948

Sub. Code
7MPHE3B

M.Sc. DEGREE EXAMINATION, APRIL 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. Define the resolving power of spectrometer.
2. State Rayleigh criterion.
3. What are the lights sources used in UV-Vis spectrophotometer?
4. What is the wavelength range of visible spectrum?
5. Define photometry.
6. What do you mean by Raman effect? Define stokes and anti-stokes line.
7. What is the short wavelength limit for X-Ray generated in a copper anode operated at 20 kV?
8. Define chemical shift. Distinguish between δ and τ chemical shifts.
9. What are the basic requirements of ESR spectrometer?
10. Distinguish between FES and AAS.

Part B (5 × 5 = 25)

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

(Draw the diagram wherever it is necessary in neat)

11. (a) Write a short note on Photo-Multiplier Tube.

Or

(b) Explain the functioning of Photo-emissive cell.

12. (a) Explain the working of Photo-electric detection.

Or

(b) Outline briefly the FTIR spectroscopy.

13. (a) Discuss about the X-Ray fluorescence spectrometer.

Or

(b) If the bond length of H_2 is 0.07417 nm, what would be the Positions of the first three rotational Raman lines in the spectrum?

14. (a) Write a brief note on NMR spectrometer.

Or

(b) Explain the principle of Scanning electron microscopy.

15. (a) Describe the construction of Atomic fluorescence spectrometry.

Or

(b) A free electron is placed in a magnetic field of strength 1.3 T. calculate the resonance frequency if g = 2.0023.

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 IR spectrometer with sample preparation technique.

18. Explain the principle and working of laser Raman spectrometer with suitable figures.

19. Outline the principle and basic component of ESR spectrometer.

20. Write a short note on (a) Flame Emission and (b) Atomic Absorption Spectrometry.

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F–1949

Sub. Code
7MPHE4A

M.Sc. DEGREE EXAMINATION, APRIL 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 third law of thermodynamics.

2. Distinguish between reversible and irreversible process.

3. State any two conservation laws that can be identified from the Boltzmann transport equation.

4. Define mean free path.

5. What are micro-states and macro-states? Give one example for each.

6. How do you connect micro-states and macro-states in the micro-canonical ensemble picture?

7. Suppose there are single particle energy eigenvalues of 0, $\in$, $2\in$ and $3\in$ which are non-degenerate. A total of $6\in$ is to be shared between four particles. List the configuration of the particles if they are Fermi particles.

8. Mention any four particles that obey Bose-Einstein statistics.

9. State any two properties of liquid Helium.

10. What is the minimum energy that has to be supplied to the electron for its emission in the metal?

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

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

11. (a) State the second law of thermodynamics in atleast two distinctly different ways. Comment on the relation between these statements.

Or

(b) Calculate the change in entropy in an irreversible process.

12. (a) Derive Maxwell-Boltzmann distribution from Boltzmann transport equation.

Or

(b) Explain Brownian motion. Give Einstein's theory of Brownian movement.

13. (a) State and prove Liouville theorem.

Or

(b) Calculate the mean energy of one dimensional linear harmonic oscillator.

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

Or

(b) Consider two identical particles which are to be placed in four single-particle states. Two of these states have energy 0, and has energy E, the last has energy $2E$. Calculate the partition function given that the particles are (i) fermions and (ii) bosons.

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

Or

(b) What is a Fermi gas? Deduce an expression for energy of a Fermi gas at absolute zero.

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

Answer any **three** questions.

16. Derive van der Waals equation of state.

17. Obtain Boltzmann transport equation and discuss about its validity.

18. State and prove equipartition theorem using canonical ensemble.

19. What is Bose-Einstein condensation? Calculate the critical temperature at which Bose-Einstein condensation will start.

20. Derive Planck's formula for the black body radiation. Hence deduce Stefan's fourth power law of temperature.

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F–1950

Sub. Code
7MPHE5A

M.Sc. DEGREE EXAMINATION, APRIL 2019

Fourth Semester

Physics

Elective — ENERGY AND ENVIRONMENTAL PHYSICS

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Comment on transport of energy.
2. Write about hydrostatic equilibrium.
3. What is Pyroheliometer?
4. Define Transmissivity – absorptivity product.
5. Differentiate biomass and biogas.
6. Point out the advantages of focusing collector.
7. Mention some of the fuels that are used in fuel cells.
8. Write any two advantages of fuel cell.
9. List out the factors that governs noise pollution.
10. State heat island effect.

Part B (5 × 5 = 25)

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

11. (a) Point out the major causes of greenhouse effect.

Or

(b) Write a short note on general circulation of the tropics.

12. (a) How will you measure solar radiation using pyranometer?

Or

(b) Give the energy balance equation to describe the performance of solar collector.

13. (a) What are the factors that affect bio–digestion? Explain any two of them.

Or

(b) Describe the continuous and batch type biogas plant.

14. (a) Write the applications of fuel cells.

Or

(b) Explain the various factors relevant to safety use of hydrogen as fuel.

15. (a) Describe the causes of global warming.

Or

(b) Compare land breeze and sea breeze.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. (a) State and explain Raynold's transport theorem.

    (b) Write a note on stratification and stability of atmosphere.

17. Discuss the flat–plate solar collector in detail with its advantages.

18. Classify and explain the types of biomass conversion technologies.

19. Elaborate the fossil fuel cells.

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

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F–1951

Sub. Code
7MPHE5B

M.Sc. DEGREE EXAMINATION, APRIL 2019

Fourth Semester

Physics

Elective – MEDICAL PHYSICS

(CBCS – 2017 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** the questions.

1. Write the function of lymphocyte.

2. Write briefly the function of breathing.

3. Give briefly the properties of ultrasound.

4. Write the use of stethoscope.

5. Indicate two applications of infrared light.

6. What is meant by chromatic aberration?

7. Give three properties of X – radiation.

8. Define Gray and how it is related to rad?

9. Mention the major components of cardiovasculary system.

10. What are biopotential electrodes?

Part B (5 × 5 = 25)

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

(Draw the diagram wherever it is necessary in neat)

11. (a) Discuss the function of electroencephalogram.

Or

(b) Explain the function of magnetocardiogram.

12. (a) How do you use ultra Sound to measure motion?

Or

(b) Discuss different types of hearing test.

13. (a) Write the applications of microscope in the field of medicine.

Or

(b) Write different parts of the eye and discuss their function.

14. (a) Discuss about brachy therapy and its applications.

Or

(b) Give an account of principle of radiation therapy.

15. (a) Discuss briefly about cardiovascular diseases.

Or

(b) Write a short note on pacemaker.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Explain with necessary diagram the recording of electric signals from the heart using electrocardiograph.

17. Elaborate the function of outer ear, middle ear and inner ear.

18. Explain the defective vision of eye and the correction method.

19. Discuss radiotherapy planning and megavoltage therapy.

20. State Bernoulli's principle and explain its use in blood flow measurements.

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F–2133

Sub. Code
7MPHE1A

M.Sc. DEGREE EXAMINATION, APRIL 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. How does a truncation error occur?
2. State the principle of linear regression.
3. State Newton's – Raphson method formula.
4. What is pivoting?
5. What is major pitfall of using Lagrange polynomial?
6. State Gauss's backward interpolation formula.
7. State Runge – Kutta algorithm of the third order.
8. Give Euler's improved formula.
9. Write Simpson's 1/3 rule.
10. Why is the Trapezoidal rule so called?

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

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

11. (a) Find the absolute error in the product uv if $u = 56.54 \pm 0.005$ and $v = 12.4 \pm 0.05$.

Or

(b) Find the curve $y = ae^{bx}$ to the following date

X :	0	2	4
Y :	5.1	10	3.1

12. (a) Write down *C* program for Newton Raphson method.

Or

(b) Write down C program to solve the following equation using Gauss – Elimination method

$$2x + y + z = 10, 3x + 2y + 3z = 18, x + 4y + 9z = 16$$

13. (a) Find the forward interpolation which, take the following values $y(1) = 24, y(3) = 120$, $y(5) = 336$ and $y(7) = 720$. Hence obtain the values of $y(8)$.

Or

(b) Using Lagrange Interpolation method, find $y(x)$ using *C* program.

x	0	1	3	4
y	–12	0	12	24

14. (a) Using Euler's method, to solve the differential equation $\frac{dy}{dx} = -y,\ y(0) = 1$.

Or

(b) Using RK-4 method to solve the differential equation $y' = 1 + y^2$ where $y = 0$ when $x = 0$ find $y(0.2)$ and $y(0.4)$.

15. (a) Derive Simpson's 1/3-rule using the method of undetermined coefficients.

Or

(b) Write a C program to evaluate integrals using Simpson's 1/3 rule.

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

Answer any **three** questions.

16. Find the least square parabola $y = a + bx + cx^2$ to the data

x	0	1	2	3	4	5	6
y	71	89	67	43	31	18	9

17. State the condition of convergence of Gauss Seidel Iterative method. Apply this method, upto six iterations, to solve the system defined by

$$28x + 4y - z = 32$$
$$2x + 17y + 4z = 35$$
$$x + 3y + 10z = 24$$

18. Using Newton's divided difference formula find $f(2)$, $f(5)$, $f(15)$ and $f(12)$ from the given table

x	4	5	7	10	11	13
$y = f(x)$	48	100	294	900	1210	2028

19. Write an algorithm to implement Runge – Kutta fourth order formula for solving an initial value problem. Find $y(0.1)$, $y(0.2)$ and $y(0.3)$ given that

$$y' = 1 + \frac{2xy}{1+x^2},\ y(0) = 0$$

20. Compute the value of $I = \int_0^1 \frac{1}{1+x}dx$, obtain both trapezoidal and Simpson's rule with h = 0.5, 0.25, 0.125 respectively.