AFN-1182 MPH131

M.Sc. DEGREE EXAMINATION, NOVEMBER 2010

First Semester

Physics

MATHEMATICAL PHYSICS—I

(Non-CBCS—2004 onwards)

Time : 3 Hours Maximum : 60 Marks

Section - A (6 × 2 = 12)

Answer any **six** questions.

1. Linear vector spaces form the Mathematical basis of quantum mechanics—Justify.

2. Explain convolution theorem.

3. For positive value of arg (2), prove that org (2) – org (–2) = π .

4. State Cauchy-residue theorem.

5. Show that $\frac{d}{dx}\left\{x^n \mathrm{J}_n(x)\right\} = x^n \mathrm{J}_{n-1}(x)$

6. Show that $J_{-\frac{1}{2}}(x) = \sqrt{\frac{2}{\pi x}} \cos x$

7. Obtain Legendre differential equation from Rodrigues formula for $n = 2$.

8. Show that $\int_{-1}^{1} P_m(\mu) P_n(\mu) = 0 \; ; m \neq n$

Section - B (4 × 9 = 36)

Answer **all** questions.

9. (a) (i) State and prove Cayley-Hamilton theorem.

(ii) Find the characteristic equation of a matrix $\begin{bmatrix} 1 & 2 & 3 \\ 2 & -1 & 4 \\ 3 & 1 & 1 \end{bmatrix}$ and verify Cayley-Hamilton's theorem

(5 + 4 = 9)

(*Or*)

(b) (i) Obtain Finite Fourier sine and cosine transform.

(ii) Find the finite Fourier sine and cosine transform of $f(x) = x$ such that $0 < x < 2$.

10. (a) Evaluate the following integrals using Residue theorem.

(i) $\int_c \frac{dz}{\sinh 2z}$

(ii) $\int_0^{2\pi} \frac{\cos 3\theta}{5 - 4\cos\theta} d\theta$

(5 + 4 = 9)

(*Or*)

(b) Expand the following functions in Taylor series.

(i) $f(z) = \frac{1}{\sqrt{1+z}}$ around $z = 0$

(ii) $f(z) = 1/1-z$ around z = 0

(4 + 5 = 9)

11. (a) Show that $Y = \frac{1}{\pi}\int_{i}^{\pi} \cos(x\cos\phi)dy$ satisfies

(i) differential equation

$$\frac{d^2y}{dx^2} + \frac{1}{x}\frac{dy}{dx} + y = 0 \; ; y = J_o(x)$$

(ii) Prove that $J_{n+3} + J_{n+5} = \frac{2}{x}(n+4)\,J_{n+4}$

(6 + 3 = 9)

(*Or*)

(b) (i) $2J_n^{'}(x) = J_{n-1}(x) - J_{n+1}(x)$

(ii) $2nJ_n(x) = x\{j_{n+1}(x) + J_{n-1}(x)\}$

(5 + 4 = 9)

12. (a) (i) Show that $\int_{-1}^{1} P_m(\mu)P_n(\mu)d\mu = \frac{2}{2n+1}; m = n$

(ii) $\int_{-1}^{1} \left\{\frac{dPn(\mu)}{d\mu}\right\} d\mu = n(n+1)$

(4 + 5 = 9)

(*Or*)

(b) (i) Show that $\beta(m,n) = \frac{\lceil m \lceil n}{\lceil (m+n)}$

(ii) Prove that $H_n(x) = e^{x^2}(-1)^n \frac{d^n}{dx^n}(e^{-x^2})$

(4 + 5 = 9)

Section - C (2 × 6 = 12)

Answer any **two** questions.

13. Use finite Fourier transform to solve

$$\partial u/\partial t = \partial^2 u/\partial x^2 \quad \begin{matrix} u(0,t) = 0, & u(\pi,t) = 0 \\ u(x,0) = 2x, & 0 < x < \pi\ ; t > 0 \end{matrix}$$

14. Using calculus of residue prove that

$$\int_0^{2\pi} \frac{d\theta}{2+\cos\theta} = 2\pi/\sqrt{3}$$

15. Derive Bessels equation from Legendre differential equation.

16. The equation of motion of a particle moving from rest towards centre of a attraction point of a distance of "a' cms apart from if is given by $\frac{d^2x}{dt^2} + k/x = 0$, k- constant. Use gamma function to obtain a time to reach the centre of attraction $T = a\sqrt{\frac{\pi}{2k}}$.

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AFN-1183 MPH233

M.Sc. DEGREE EXAMINATION, NOVEMBER 2010

Second Semester

Physics

QUANTUM MECHANICS—II

(Non-CBCS—2004 onwards)

Time : 3 Hours Maximum : 60 Marks

Section - A (6 × 2 = 12)

Answer any **six** questions.

1. Define : Specific heat of solids.

2. List any two admissibility conditions on the wave function of a system.

3. What is an operator ? State the principle of correspondence.

4. State the expansion postulate of quantum mechanics.

5. What do you mean by 'closure' ?

6. Give the Schrödringer equation with spherical polar coordinates.

7. Briefly mention the role of angular momentum operators.

8. What is a stark effect ?

Section - B $(4 \times 9 = 36)$

Answer **all** the questions.

9. (a) Deduce Planck's radiation law.

Or

(b) Define ψ and $|\psi|^2$, based on probability interpretation.

10. (a) Discuss the physical interpretation of formalism of Eigen-functions and Eigen-values.

Or

(b) Show how the degeneracy of states can be removed ?

11. (a) Obtain eigen functions for ψ_{100} and ψ_{101} of H-atom.

Or

(b) Enumerate the total angular momentum for the *p*-electron.

12. (a) Why the 'perturbation' is necessary for quantum systems ? Deduce first and second order perturbation equations (non-degenerate case).

Or

(b) Briefly discuss the WKB approximation.

Section - C (2 × 6 = 12)

Answer any **two** questions.

13. State and prove uncertainty principle.

14. Discuss both localized and non-localized states of a particle in a square well potential.

15. Show that $\langle P_x\, x\rangle - \langle x\ P_x\rangle = \frac{\hbar}{i}$

16. Discuss the properties with respective proofs, of self-adjoint operator.

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AFN-1184 MPH234

M.Sc. DEGREE EXAMINATION, NOVEMBER 2010

Second Semester

Physics

APPLIED ELECTRONICS

(Non-CBCS—2004 onwards)

Time : 3 Hours Maximum : 60 Marks

Section - A (6 × 2 = 12)

Answer any **six** questions.

1. How is an FET used as voltage variable resistance ?

2. What is the advantages of TRIAC over SCR ?

3. Define Modulation index.

4. What is the basic limitation of modulated transistor amplifiers ?

5. Why is it not practicable to use a reactance modulator in conjunction with a crystal oscillator ?

6. What is the function of the balanced modulator in the Armstrong modulation system ?

7. Why is storage time eliminated in a metal semiconductor diode ?

8. Give the principle of multicavity Klystron.

Section - B (4 × 9 = 36)

Answer **all** questions.

9. (a) Show the small signal model of an FET :

(i) at low frequencies and

(ii) at high frequencies

Or

(b) Draw the circuit of a UJT relaxation oscillator and explain it in detail.

10. (a) With a neat diagram, explain the principle of pulse code modulation and how PCM can generated and demodulated.

Or

(b) Explain with the aid of waveform, how a grid modulated class C amplifier generates AM.

11. (a) Derive the formula for the instantaneous value of an FM voltage and define the modulation index.

Or

(b) Draw and explain a typical preemphasis and deemphasis circuits.

12. (a) Describe briefly :

(i) Dielectric isolation.

(ii) Epitaxial growth

Or

(b) Explain the construction and working principle of Magnetron.

Section - C (2 × 6 = 12)

Answer any **two** questions.

13. A broadcst radio transmitter radiates 10 kW when the modulation percentage is 60. How much of this is carrier power ?

14. What is the bandwidth required for an FM signal in which the modulating frequency is 2kHz and maximum deviation is 10 kHz ?

15. Design a UJT relaxation oscillator to generate a sawtooth waveform at a frequency of 500 Hz. Assume the supply voltage V_{BB} = 20V, V_p = 9V, V_v = 1.118V, I_p = 1.6 mA and I_v = 3.5 mA.

16. Draw the popular structures of monolithic diodes and explain them.

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AFN-1185 MPH331

M.Sc. DEGREE EXAMINATION, NOVEMBER 2010

Third Semester

Physics

SOLID STATE PHYSICS—I

(Non-CBCS—2004 onwards)

Time : 3 Hours Maximum : 60 Marks

Part - A (6 × 2 = 12)

Answer any **six** questions.

1. Define :

   (i) Unit cell.

   (ii) Primitive cell

2. Why X-rays get diffracted by crystals ?

3. Distinguish between Ionic and Covalent bonds.

4. What are phonons ?

5. Define Fermi energy.

6. Write a note on Semimetals.

7. What are Brillouin zones ?

8. What is de Haas-Van Alphen effect ?

Part - B (4 × 9 = 36)

Answer **all** questions.

9. (a) Explain the concept of reciprocal lattice. Discuss its properties. What is its importance ?

Or

(b) Describe the crystal structure of diamond. Calculate the number of Carbon atoms per unit cell.

10. (a) Obtain the various vibrational modes of a linear monoatomic lattice. Discuss the important conclusions drawn.

Or

(b) Derive Debye's formula for the specific heat of solids. Compare it with Einstein's theory of specific heats.

11. (a) What is Hall effect ? Find an expression for the Hall co-efficient of a metal and describe an experimental set-up to measure it.

Or

(b) Deduce expressions for the densities of free electrons and holes in an intrinsic semiconductor. Show that the fermi level lies half way between conduction and valance bonds.

12. (a) Explain periodicity character for the potential incrystals. State and prove Block theorem in this reference.

Or

(b) Discuss what information does one obtain about the effective mass of electrons moving in a periodic potential

Part - C (2 × 6 = 12)

Answer any **two** questions.

13. Show that atomic packing factor for fcc and hcp metals are the same.

14. Discuss the propagation of elastic waves for a solid possessing cubic symmetry when the propagation direction is 100.

15. The Fermi temperature of potassium is 24600 k. Calcualte the Fermi velocity of electrons in potassium.

16. Discuss electron-phonon interaction

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AFN-1186 **MPH332**

M.Sc. DEGREE EXAMINATION, NOVEMBER 2010

Third Semester

Physics

NUCLEAR PHYSICS

(Non CBCS—2004 onwards)

Time : 3 Hours Maximum : 60 Marks

Section - A (6 × 2 = 12)

Answer any **six** questions.

1. Give an account of similarity between (nn) and (PP) forces.

2. What are exchange forces ?

3. Write a short note on Single Particle Model.

4. Give an example for stripping reaction.

5. What is meant by scattering length ?

6. List the different types of fission.

7. What is a nuclear reactor ?

8. Discuss the advantages of reflectors in reactors.

Section - B (4 × 9 = 36)

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

9. (a) Give a brief account of Neutron-Proton scattering below 10 MeV.

(*Or*)

(b) Write a short note on Meson theory of nuclear force.

10. (a) Write a short note on the liquid drop model of the nucleus.

(*Or*)

(b) Discuss the single particle levels on the basis of unified model.

11. (a) Discuss Bohr's model of a compound nucleus theory of nuclear reactions.

(*Or*)

(b) Discuss the optical model of a complex nuclear potential.

12. (a) Give an account of Bohr-Wheeler theory of Nuclear fission.

(*Or*)

(b) Discuss in detail about working of a Graphite Moderated Research Reactor.

Section - C (2 × 6 = 12)

Answer any **two** questions.

13. From meson theory of Nuclear forces, if a nucleon emits a virtual Pion of rest mass 270 m, calculate the range of nuclear force.

14. $^{10}_{5}B(\alpha, P)\ ^{13}_{6}C$ reaction shows among others a resonance for an excitation energy of compound nucleus to be 13.23 MeV. The width of this level as found experimentally is 130 keV. Calculate the mean life time of the nucleus for this excitation.

15. A deuterium reaction that occurs in experimental fusion reactor is

$$_1H^2 + {}_1H^2 \rightarrow {}_1H^3 + {}_1H^1 + Q_1$$

and then it follows

$$_1H^3 + {}_1H^2 \rightarrow {}_2He^4 + {}_0n^1 + Q_2$$

Calculate the energy released in each of these reactions.

16. Determine the harmonic Oscillator frequencies w appropriate to the nuclei O^{17} and Ni^{60}.

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AFN-1187 **MPH333**

M.Sc. DEGREE EXAMINATION, NOVEMBER 2010

Third Semester

Physics

QUANTUM MECHANICS—II

(Non CBCS—2004 onwards)

Time : 3 Hours Maximum : 60 Marks

Section - A (6 × 2 = 12)

Answer any **six** questions.

1. Distinguish between differential and total scattering cross-sections.

2. Write briefly about asymptotic behaviour of partial waves.

3. Write a note on Unitary transformations.

4. Explain the spin wave functions of half integral spin particles.

5. What is constant perturbation ?

6. Write down the condition of spontaneous emission using Einstein's coefficients.

7. Write down Klein Gordan equation and mention its importance.

8. Discuss the significance of negative energy states.

Section - B

$(4 \times 9 = 36)$

Answer **all** the questions.

9. (a) Explain the validity of Born approximation.

(*Or*)

(b) Discuss the problem of scattering by a square well potential.

10. (a) Write short notes on :

(i) Space inversion.

(ii) Time reversal.

(*Or*)

(b) Discuss the matrix representation of angular momentum operators.

11. (a) Explain the phenomenon of double scattering by two non-overlapping scatterers.

(*Or*)

(b) Discuss the perturbation theory for a time evolution problem.

12. (a) Discuss in detail the Dirac's relativistic Hamiltonian.

(*Or*)

(b) Discuss the plane wave solutions of Dirac equation. How it can be used to explain a particle in electromagnetic field ?

Section - C (2 × 6 = 12)

Answer any **two** questions.

13. Find an expression for the scattering amplitude in terms of phase shifts.

14. Discuss the spin wave functions for a system of two spin - ½ particles.

15. Explain the concept of harmonic perturbation.

16. Apply Klein-Gordan equation to solve hydrogen atom.

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AFN-1189 MPH431

M.Sc. DEGREE EXAMINATION, NOVEMBER 2010

Fourth Semester

Physics

SOLID STATE PHYSICS – II

(Non-CBCS—2004 onwards)

Time : 3 Hours Maximum : 60 Marks

Section - A (6 × 2 = 12)

Answer any **six** questions.

1. Define Penetration depth.

2. What are the types of Polarizability ?

3. Distinguish between Dia and Para magnetic materials.

4. What are magnons ?

5. What are excitons ?

6. Mention two basic requirements for maser action.

7. Define : Schottky defect.

8. What is Kondo effect ?

Section - B (4 × 9 = 36)

Answer **all** questions.

9. (a) What is Meissner effect ? Explain it on the basis of London equations.

(*Or*)

(b) What are ferroelectric materials ? Give the theory of ferroelasticity. Mention its applications.

10. (a) "All substances should exhibit diamagnetism". Comment in this statement. Discuss the quantum theory of diamagnetism.

(*Or*)

(b) Describe briefly the domain theory of ferromagnetism. Derive Curie-Weiss law for their susceptibility.

11. (a) Discuss Kramers-Kronig relations.

(*Or*)

(b) Explain the principle of MASER. Describe the operation of multilevel maser

12. (a) Explain edge dislocation. Calculate the stress field for it.

(*Or*)

(b) What is a grain boundary ? Explain low angle grain boundary Burger's model.

Section - C (2 × 6 = 12)

Answer any **two** questions.

13. The relative permittivity of argon at 0°C and one atmosphere is 1.000435. Calculate the polarizability of the atom.

14. A paramagnetic material is subjected to a homogeneous field of 10^6 ampere/metre at 37°C. Calculate the average magnetic moment along the field direction per spin in Bohr magneton.

15. Discuss the motional effects on the line width in NMR.

16. How Frenkel defect is formed ? Explain the necessary theory involved in it.

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AFN-1191 **MPH433**

M.Sc. DEGREE EXAMINATION, NOVEMBER 2010

Fourth Semester

Physics

MOLECULAR SPECTROSCOPY

(Non-CBCS—2004 onwards)

Time : 3 Hours Maximum : 60 Marks

Section - A (6 × 2 = 12)

Answer any **six** questions.

1. How many rotational lines will be observed in the microwave spectrum of HCl gas ?

2. How many normal vibrational modes are possible in the non-linear molecule C_5H_6 ?

3. What is Raman effect ?

4. What are the differences between Raman Spectra and Infrared Spectra ?

5. What is predissociation ?

6. State Frank - Condon principle.

7. Define 'Coupling Constant'.

8. Which of the following systems will show ESR Spectrum ?

   (a) H.

   (b) H_2.

Section - B (4 × 9 = 36)

Answer **all** questions.

9. (a) Describe the rotational spectra of symmetric top molecules.

(*Or*)

(b) Discuss the vibration - rotation spectrum of carbon monoxide molecule.

10. (a) (i) Write short notes on Quantum theory of Raman Effect

(ii) Explain briefly, how the structure can be determined by Raman and IR spectroscopy.

(*Or*)

(b) Discuss some of the applications of Raman spectroscopy.

11. (a) Write short notes on :

(i) Dissociation.

(ii) Predissociation.

(*Or*)

(b) Derive the frequencies of rotational fine structure of electronic vibration transition for a diatomic molecule.

12. (a) Explain the basic principles of NMR Spectroscopy and discuss the interaction between Nuclear Spin and Magnetic field.

(*Or*)

(b) Explain the basic principle of ESR Spectroscopy and hence write a note on the instrumentation involved.

Section - C (2 × 6 = 12)

Answer any **two** questions.

13. Compare the rotational energy levels of a diatomic molecule on the basis of Rigid rotator and Non rigid rotator.

14. Explain the selection rule in rotational Raman spectroscopy and the criterion for getting Raman Spectrum.

15. Describe a Fortrat Diagram.

16. Write a short note on Chemical Shift.

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