

NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART-I, PAPER-I

(Mathematical Physics)

Annual Examination, 2013

Time : 3 Hours.

Full Marks : 80

Answer any Five Questions. All questions carry equal marks.

1. Prove that Poisson's brackets remain invariant with respect to canonical transformation.
2. (a) If \vec{A} is any vector, prove that $\vec{A} = (\vec{A} \cdot \hat{i})\hat{i} + (\vec{A} \cdot \hat{j})\hat{j} + (\vec{A} \cdot \hat{k})\hat{k}$.
(b) Determine a unit vector perpendicular to the plane $\vec{A} = 2\hat{i} - 6\hat{j} - 3\hat{k}$ and $\vec{B} = 4\hat{i} + 3\hat{j} - \hat{k}$.
(c) Show that the vectors $\vec{A} = 3\hat{i} - 2\hat{j} + \hat{k}$; $\vec{B} = \hat{i} - 3\hat{j} + 5\hat{k}$ and $\vec{C} = 2\hat{i} + \hat{j} - 4\hat{k}$ form a right angled triangle.
3. (a) Define orthogonal transformation.
(b) Show that the eigenvalues of a Hermitian matrix are real.
4. solve the differential equation :— $x(1 - 2x) y'' - (6x + 1)y' - 2y = 0$.
5. Prove the following relations for Legendre Polynomial :—
(a) $P'_{n+1}(x) - P'_{n-1}(x) = 2xP'_n(x) + P_n(x)$
(b) $nP_n(x) = x \frac{dP_n(x)}{dx} - \frac{dP_{n-1}(x)}{dx}$
6. Deduce generating function of Hermite Polynomials and thus show that $\frac{1}{e} \text{Cosh } 2x = \sum_{n=0}^{\infty} \frac{1}{(2n)!} H_{2n}(x)$.
7. (a) Derive the conditions for the existence of Laplace Transform.
(b) Solve the simple differential equation $\frac{dx}{dt} + ax = 0$, subject to initial condition :
 $x = x_0$ at $t = 0$.
8. State and prove (a) Modulation theorem & (b) Convolution theorem for Fourier transforms.
9. (a) Write the law of transformation for the tensors :- A_k^{ij} and B_{ijk}^{mn} .
(b) Prove that if the components of a tensor are zero in one coordinate system, they will be zero in all coordinate systems.
10. Write short note on any **Two** of the following :—
(a) Generalized coordinates.
(b) Triangular matrix and diagonal matrix.
(c) Values Bessel fn. $J_{+\frac{1}{2}}(x)$ & $J_{\pm\frac{3}{2}}(x)$
(d) Generating fn. for Laguerre Polynomial.

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Examination Programme, 2013

M.Sc. Physics, Part-I

Date	Paper	Time	Examination Centre
17.07.2013	Paper-I	3.30 PM to 6.30 PM	D.A.V. Public School Punaichak, Patna
19.07.2013	Paper-II	3.30 PM to 6.30 PM	D.A.V. Public School Punaichak, Patna
23.07.2013	Paper-III	3.30 PM to 6.30 PM	D.A.V. Public School Punaichak, Patna
25.07.2013	Paper-IV	3.30 PM to 6.30 PM	D.A.V. Public School Punaichak, Patna
27.07.2013	Paper-V	3.30 PM to 6.30 PM	D.A.V. Public School Punaichak, Patna
29.07.2013	Paper-VI	3.30 PM to 6.30 PM	D.A.V. Public School Punaichak, Patna
31.07.2013	Paper-VII	3.30 PM to 6.30 PM	D.A.V. Public School Punaichak, Patna
02.08.2013	Paper-VIII	3.30 PM to 6.30 PM	D.A.V. Public School Punaichak, Patna

NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART-I, PAPER-II

(Quantum Mechanics)

Annual Examination, 2013

Time : 3 Hours.

Full Marks : 80

Answer any Five Questions. All questions carry equal marks.

1. State the hypothesis of de Broglie and derive the de Broglie relation for a photon from the principle of mass energy equivalence. Show that the group velocity of the de Broglie wave is equal to the velocity of the particle.
2. State and prove Ehrenfes's theorem in Quantum Mechanics. Explain the meaning of 'admissible wave function' and 'stationary states' in Quantum Mechanics.
3. Find the reflection and transmission coefficients in the case of a square potential barrier of width L and height V_0 . what is tunnel effect ?
4. What is an operator in quantum mechanics ? What is a wave function ? What is the physical significance of normalizing a wave function ?
5. Set up one dimensional harmonic oxillator Schrödinger's equation and solve it to find energy eigenvalues and eigenfunctions.
6. Prove the following angular momentum commutation reactions :—
(a) $[\hat{L}_x, \hat{L}_y] = i\hbar \hat{L}_z$ (b) $[\hat{L}_z, \hat{L}_\pm] = \hbar \hat{L}_\pm$ (c) $[\hat{L}^2, \hat{L}_z] = 0$
7. Using WKB method, calculate the transmission coefficient of the parabolic potential given by
 $V(x) = V_0 (1 - x^2/a^2)$, $-a \leq x \leq +a$
 $= 0$, $a \leq x \leq -a$
8. Use partial wave method to establish the relation : $\sigma = \frac{4\pi}{K^2} \sum_{l=0}^{\infty} (2l+1) \text{Sin}^2 \delta_l$ for the total scattering cross-section.
9. What are identical particles ? Give the significance of identical particles in Quantum Mechanics. Discuss the summetrization procedureds for 'bosons' and 'fermions'.
10. Write short note on any **Two** of the following :—
(a) Hesenberg's uncertainty relation.
(b) Dirac delta function.
(c) Expectation values.
(d) Stack effect.

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NALANDA OPEN UNIVERSITY
M.Sc. Physics
PART-I, PAPER-III
(Electrodynamics & Plasma Physics)
Annual Examination, 2013

Time : 3 Hours.

Full Marks : 80

Answer Five Questions in all, selecting atleast Two Questions from each Group.

All questions carry equal marks.

Group-'A'

1. State and prove Green's theorem. What are Green's first and second identify ? Apply this theorem to obtain the potential at a fixed point as a sum of volume & surface integrals.
2. Explain Biot-Savart law and deduce Ampere's circuital law for steady currents from this law. Define the magnetic vector potential for steady currents and show that it satisfies the Poisson's equation $\nabla^2 A = \frac{4\pi}{c} \vec{j}$.
3. Write down Maxwell's field equation and convert these equation into tensor form and this show the convenience of these equations under Lorentz transformation.
4. Show that the change is invariant under Lorentz transformation but volume and surface charge densities are not.
5. What do you mean by Lienard and Weichant potential ? Obtain expression for L-W potential for uniformly moving point charge.
6. What is adiabatic invariant ? Discuss, in detail, the first adiabatic invariant.

Group-'B'

7. Explain the following :—
 - (a) Debye length,
 - (b) Debye shielding &
 - (c) The plasma parameter.How can the plasma state of matter be subdivided into different groups.
8. Derive an expression for plasma frequency. What is the physical significance of lower and upper hybrid frequencies ?
9. Establish the equation $I = I_0 e^{-\beta v^2}$ with $I_0 = n_0 (\beta / \pi)^{1/2}$ giving Doppler's broadening in a spectral line. Hence, find the full width of the spectral line at half peak intensity.
10. Derive formulae for magneto-ionic refractive indices. Discuss their application to ionosphere.

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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART-I, PAPER-IV

(Statistical Physics)

Annual Examination, 2013

Time : 3 Hours.

Full Marks : 80

Answer any Five Questions. All questions carry equal marks.

1. Use Boltzmann theory of entropy to find the entropy of a monoatomic gas. Also, show that the mean energy of a gas is given by $U = -\left(\frac{\partial \ln Z}{\partial \beta}\right)$ where Z is the partition function.
2. (a) Show that the partition function of a monoatomic gas is given by $Z = \frac{V}{h^3}(2\pi m k T)^{3/2}$.
(b) Find the change in entropy of one mol of gas contained in volume V_1 when it is expanded is other usually to volume $(V_1 + V_2)$.
3. State and prove Liouville theorem. How is it analogous to the equation of continuity of an incompressible fluid ?
4. (a) Suppose that the energy of a molecule is the sum of independent contributions arising from translation, rotation, vibration etc. Prove that the total partition function can be written as the product of separate partition functions : $Z = Z_{translation} \cdot Z_{rotation} \cdot Z_{vibration}$.
(b) Discuss briefly how statistical physics gives a physical picture of entropy.
5. Compare and contrast the Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics.
6. Helium has two isotopes viz. ^3He and ^4He . Classify these as fermions and bosons. Justify your conclusion.
7. Prove that the one dimensional Ising model does not explain the spontaneous magnetization. How does the solution of the two-dimensional Ising Model overcome this difficulty ?
8. What do you mean by cluster expansion ? Discuss the classical approach towards the theory of cluster expansion.
9. What is phase transition ? Differentiate between the 1st order and 2nd order phase transition. Discuss the Landau theory of phase transition.
10. Write short notes on any **Two** of the following :—
 - (a) Spontaneous transformation in phase transition.
 - (b) Fermi Dirac distribution law.
 - (c) Phase space, trajectory and density of states.

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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART-I, PAPER-V

(Nuclear and Particle Physics)

Annual Examination, 2013

Time : 3 Hours.

Full Marks : 80

Answer any Five Questions. All questions carry equal marks.

1. Outline the theory of neutron-proton scattering at energies below 10 Mev. Can you determine the shape of neutron-proton potential from the data at these energies ? Explain.
2. State clearly the definition of nuclear quadrupole moment and discuss the ground state of the deuteron in the light of the fact that it has small but finite quadrupole moment.
3. Give the properties of the π -meson. How does it account for the charge independence of nuclear forces ?
4. What is the Q-value of a nuclear reaction ? Establish the Q-equation of a nuclear reaction and find its solution.
5. Give the simple Breit-Wigner one level formula for the cross-section of neutron reaction in nuclei. Explain how the width of the resonance level can be obtained from this formula.
6. What are stripping and pick up reactions ? Obtain an expression for reaction amplitude using Born approximation for stripping and pick-up reaction (also called Butler theory).
7. Give a brief account of Fermi's theory of β -decay and show how it was necessary to postulate the existence of neutrino. What is Kurie plot ?
8. Describe the phenomenon of internal conversion. Obtain an expression for internal conversion coefficient for K-shell conversion in parity favoured transition.
9. Write a detailed note on the classification of elementary particles.
10. What are quarks ? Build up the structure of Mesons on quark model.

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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART-I, PAPER-VI

(Atomic and Molecular Physics)

Annual Examination, 2013

Time : 3 Hours.

Full Marks : 80

Answer Fine Questions in all, selecting at least Two Questions from each Group.

All questions carry equal marks.

Group-'A'

1. Deduce an expression for the series spectra of a hydrogen-like atom, taking into account the finite mass of the nucleus. Calculate the energy required to remove the electron from singly-ionized helium atom.
2. State, explain and deduce Pauli's exclusion principle. What is its physical significance ? How is it connected with the symmetry of the wave function.
3. Calculate the spin-orbit interaction energy for a single non-penetrating valence electron. if the doublet splitting of ISP excited state $^2P_{3/2} - 2P_{1/2}$ of He^+ is 5.84 Cm^{-1} , then find the corresponding separation for Li^{++} .
4. Describe the main features of the observed Stark effect. What is its theoretical explanation ? Use energy level diagrams to explain this effect.
5. Discuss the hyperfine structure of spectral lines. What light does this throw on the spin and magnetic moment of atomic nuclei ?

Group-'B'

6. Discuss the intensities of rotational lines produced by a non-rigid rotator. How is J_{max} related to the absolute temperature T of the molecule ?
7. Give the complete theory of vibrational-rotational spectrum of diatomic molecule.
8. What is Raman effect ? Explain theoretically the observed characteristics of the Raman spectrum of a diatomic molecule. How is it used to obtain the molecular constant.
9. Discuss the principal features of the electronic spectrum of a diatomic molecule.
10. What do you mean by (i) ESR and (ii) NMR ? Explain the basic principles of Interaction of spin and applied magnetic field giving specific examples.

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NALANDA OPEN UNIVERSITY
M.Sc. Physics
PART-I, PAPER-VII
(Condensed Matter Physics)
Annual Examination, 2013

Time : 3 Hours.

Full Marks: 80

Answer any Five Questions. All questions carry equal marks.

1. Define unit cell, primitive cell and Wigner-Seitz cell. How is Wigner-Seitz cell constructed? Platinum (at wt. = 195) crystallizes in the fcc form and has the density $21.4 \times 10^3 \text{ Kg/m}^3$. Calculate the size of a side of the unit cell.
2. Describe a hexagonal close packed structure (hcp) and calculate its atomic fraction. Show that the c/a ratio for an ideal hcp structure is $\sqrt{8/3}$.
3. Derive the Laue equations for diffraction of x-ray by a crystalline solid. Show that the Bragg's equation is a special case of the Laue equations.
Calculate the wavelength and the speed of neutrons when reflected by a crystal ($d = 3.84 \text{ \AA}$) at glancing angle of 30° in 1st order.
4. What is atomic scattering factor? Derive the general expression for this quantity using spherical polar coordinate. How is it related to geometrical structure factor?
5. Explain the Schottky and the Frenkel defects. Calculate the equilibrium concentration of each defect and indicate the order of their magnitude.
6. Write an essay on the observation of imperfections in crystals by x-ray topographic technique. Mention the principle behind Electron Microscope Technique. What are its applications?
7. Explain how the band theory of solids lead to the classification of solids into conductors, semiconductors and insulators.
8. What is a Fermi surface? What are its main characteristics? Discuss the effect of electric field and magnetic field on FS.
9. Give the qualitative description of the BCS theory. How does it account for the superconducting state?
10. Give an account of "de Hass-van Alphen effect". How does it provide a powerful method for the study of Fermi Surface?

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NALANDA OPEN UNIVERSITY

M.Sc. Physics PART-I, PAPER-VIII (Electronic Devices) Annual Examination, 2013

Time : 3 Hours.

Full Marks: 80

Answer any Five Questions. All questions carry equal marks.

1. Describe the mechanism of current flow in a properly biased BJT. Define various BJT parameters.
2. Describe the design and operating characteristics of Tunnel Diode. What is meant by Tunneling ?
3. Distinguish between RAM and ROM. What are static and dynamic RAMs ? How can these be obtained ?
4. Describe the theory of (a) DC Kerr effect & (b) AC Kerr effect.
5. What is the basic principle behind Raman-Nath diffraction ? How can it be observed ? Give its theory.
6. What are ferroelectric materials ? Discuss its classification. What are the important properties these materials ?
7. What is Surface Acoustic Wave (SAW) ? Discuss the use of SAW in sensors.
8. State and explain (a) Electrostrictive effect (b) Magnetostrictive effect & (c) Villari effect.
9. What is Pockels effect ? What is a Pockels cell ? Explain the dynamics within the cell. Also, discuss the applications of Pockels cells.
10. Write notes on any **Two** of the following :—
 - (a) Charge Coupled Derive (CCD)
 - (b) Gunn effect
 - (c) MOSFET
 - (d) Acoustooptic deflectors.

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NALANDA OPEN UNIVERSITY
M.Sc. Physics
PART-II, PAPER-IX
(Computational Mathematics)
Annual Examination, 2013

Time : 3 Hours.

Full Marks: 80

Answer any Five Questions. All questions carry equal marks.

1. Find the roots of the equation : $x \sin x + \cos x = 0$ by making use of Newton-Raphson formula.
2. Solve the following set of algebraic equations :—
 $3x + y + 2z = 3$; $2x - 3y - z = -3$ & $x + 2y + z = 4$.
3. Derive Newton's forward interpolation formula and its error.
4. Determine the constants a and b by the least squares method such that $y = ae^{bx}$ fits the following data :—

x	1.0	1.2	1.4	1.6
y	40.170	73.196	133.372	243.02

5. What is Monte Carlo Method ? Describe various areas where this method is applied. Explain 'Monte Carlo Simulation' and 'Monte Carlo Integration'.
6. Enumerate the various uses of sampling. Describe the various sampling techniques.
7. Use the Runge-Kutta method to solve the differential equation $10 \frac{dy}{dx} = x^2 + y^2$ with $y(0) = 1$ for the interval $0 < x \leq 0.4$ with $h = 0.1$.
8. Using Newton's forward difference formula, derive a general formula for numerical integration and hence establish Simpson's one-third rule.
9. Describe "the Crank-Nicholson" method to solve the parabolic differential equations. Give a suitable example.
10. Write short notes on any **Two** of the following :—
 - (a) Transcendental equations.
 - (b) Eigenvalues and eigenvectors of matrices.
 - (c) Iterative method of solution of algebraic equations.
 - (d) Newton-Cotes formula.

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NALANDA OPEN UNIVERSITY
M.Sc. Physics
PART-II, PAPER-X
(Programming with Fortran & C++)
Annual Examination, 2013

Time : 3 Hours.

Full Marks: 80

Answer any Five Questions. All questions carry equal marks.

1. Write down the characteristics of a digital computer. How are these classified ? What do you mean by machine language and assembly language.
2. A deck of cards is given. Each card contains four numbers representing student ID and the scores of three tests. Write a Fortran program with the flow-chart to compute the average of the three tests for each card.
3. (a) Write a subroutine to plot a graph between specified limit with its argument range of 161.
(b) Write a Fortran programme which counts the number of positive numbers and the number of negative numbers.
4. Write a programme in Fortran to calculate the (a) mean and (b) variance and standard deviation of N data X.
5. What are special operators used in the C++ language to perform particular type of operation ? Discuss all such operators in detail.
6. (a) What are the different types of statements used in C++ ?
(b) Write a program in C++ to solve a quadratic equation ?
7. (a) Write a program in C++ to find the sum of the even numbers using "do-while loop".
(b) Write a program in C++ to display the first 100 odd numbers using the "while loop".
8. What is a function ? List out the advantages and disadvantages of using functions in C++. What do you mean by local and global variables ?
9. Write a program to initialize the members of a union and to display the contents of the union.
10. Explain the various functions involved in opening and closing a sequential file in C++.

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NALANDA OPEN UNIVERSITY
M.Sc. Physics
PART-II, PAPER-XI
(Physics of Nano-Materials)
Annual Examination, 2013

Time : 3 Hours.

Full Marks: 80

Answer any Five Questions. All questions carry equal marks.

1. Derive an expression for the electrical conductivity of a free electron gas using the collision time concept. Does this result explain the experimental value of resistivity of a metal ?
2. Explain the bond formation in the hydrogen molecule. What do you understand by energy bands in crystals ?
3. (a) Explain the concept of effective mass of charge carriers.
(b) Classify crystalline solids into metals, semiconductors and insulators on the basis of band theory.
4. Discuss the motion of electrons in two dimensional potential well and obtain expression for its density of states.
5. Describe the Hartree-Fock approximation of the coulomb interaction between 3D confined electrons. Mention the application of Hund's rules in quantum dots.
6. What is a quantum wire ? Discuss its optical properties.
7. Write short notes on the following :—
 - (a) Electron Microscopy.
 - (b) Positron annihilation spectroscopy.
8. What is Raman effect ? Discuss the variations in Raman spectra of nano-materials.
9. Name the six widely known methods to produce nano-materials. Describe, briefly, at least three of these.
10. Write short notes on any **Two** of the following :—
 - (a) Biological Nanoparticles.
 - (b) Multiferroic Magnetoelectric Materials.
 - (c) Quantum Dots.
 - (d) Super lattice.

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NALANDA OPEN UNIVERSITY
M.Sc. Physics
PART-II, PAPER-XII
(Science and Technology of Renewable Energy)
Annual Examination, 2013

Time : 3 Hours.

Full Marks: 80

Answer any Five Questions. All questions carry equal marks.

1. (a) Explain "Green House Effect" and correlation of the rise in atmosphere carbon dioxide concentration with the rise in average temperature.
(b) Explain the following :—Photon Flux, Spectral Irradiance, Radiant power density.
2. What do you understand by Band Gap ? Describe the formation of intrinsic carriers and their concentration variation with temperature.
3. Explain the importance of Fill Factor (FF) in a solar cell and derive its expression. What do you understand by Efficiency of a solar cell ? Calculate FF of the solar cell $V_{oc} = 0.6$ V; Ideality factor $n = 1$; Temperature $T = 300$ K and normalized $V_{oc} = 23.188$ V.
4. (a) Explain how light collection efficiency affects overall efficiency of the cell. How will you minimize optical losses in solar cells.
(b) Explain Lambertian Rear Reflectors and its application.
5. Explain the impact of optical and recombination losses on quantum efficiency of an ideal and actual solar cell. How can the front and rear surface recombination be minimized in solar cells ?
6. What do you understand by 1st, 2nd and 3rd generation of solar cells ? What are the efficiencies which these cells can achieve ?
7. Derive Betz's law and show that the maximum efficiency of the rotors can't exceed 60%. What are the factors that limit the use of Wind energy ?
8. Explain methodologies of hydrogen production. How are there energies stored ?
9. What are the environmental impacts of harnessing geothermal, wave and tidal energy ? What are the methods employed in harnessing tidal energy ?
10. Explain Diode equation for Non-ideal and Ideal Diodes. Illustrate diode law graphically and explain the importance of dark current.

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<p>For Practical Counselling Class & Practical Examination Programme Please See on Back Page.</p>
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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART-II, PAPER-XIII

(Environmental Physics)

Annual Examination, 2013

Time : 3 Hours.

Full Marks: 80

Answer any Five Questions. All questions carry equal marks.

1. Explain the mechanism of Heat transfer in environment. How does transfer behave as Electric Resistance ? What is the heat equation ? How does temperature vary between Day and Night ?
2. Enumerate the basic atmospheric forces to study laws of motion in atmosphere. Explain what you mean by 'Baroclinic Model' & 'Reynolds number Re'.
3. What are the elements of Weather and Climate ? What is common between General Circulation Model (GCM) and Numerical Weather Prediction (NWP) model ?
4. Explain Raman, Rayleigh & Mie Scatterings. Distinguish between Raman and Mie Scattering. Explain Resonance Raman Scattering.
5. (a) Discuss the diffusion of guest particles in a host medium.
(b) Derive the turbulent diffusion equation. What is its application ?
6. Discuss the improvement in diffusion equations to predict the transport of pollutants to fair accuracy. What is Dupuit Approximation ? Discuss.
7. (a) Calculate the efficiency of a Real Heat Engine and show that it is less than Carnot engine.
(b) Show that for hydrocarbon fuels one will lose some 30% of energy in the combustion process.
8. Compare hydroelectric energy generation with other sources of energy and discuss its positive and negative aspects.
9. Why Biofuels are called renewable energy source ? Explain, briefly, the four generations of biofuels.
10. Write short notes on any **Three** of the following :—
 - (a) Black body radiation
 - (b) Greenhouse gas model
 - (c) Nuclear fission
 - (d) Nuclear fusion
 - (e) Solar Pond
 - (f) Solar Architecture

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**For Practical Counselling Class & Practical Examination Programme
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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART-II, PAPER-XIV

(Photonics)

Annual Examination, 2013

Time : 3 Hours.

Full Marks: 80

Answer any Five Questions. All questions carry equal marks.

1. Describe the p-n junction diode. What are barrier potential and depletion layer and how are they affected by the application of external biasing potentials ?
2. Describe the three generation development of solar cell. What is a solar module ? Describe the natural limits of efficiency of a solar cell. What is the latest trend in Solar Cell development ?
3. Explain the origin of spiking in laser emission. Describe the principles of Nd-YAG laser. What are its applications ?
4. Describe He-Ne laser with a diagram. Why is this laser not so powerful ? How many energy levels are involved in this laser emission ?
5. Explain the operating principle of a double Heterojunction laser with suitable diagrams for layer structure and refractive index profile. Explain the role of such structure in confining charge carriers and optical power. What are quantum well lasers ?
6. Explain the difference between analog and digital communication. Why digital communication is more suitable with modern day requirements ?
7. Describe briefly with suitable diagrams the difference between the paths of a meridional rays and the skew rays in a step index fibre. Derive an expression for the acceptance angle for a skew ray which changes direction by an angle 2γ at each reflection.
8. Explain the detection process in a p-n junction photodiode. Compare the device with p-i-n photodiode. What is 'Quantum Efficiency' and 'Responsivity' of p-n photodiode ?
9. Describe the role played by diffraction in deciding the focussed spot size of a laser beam using a lens. A laser beam has a cross-sectional area whose radius is 10mm, its wavelength being $0.53 \mu\text{m}$, find the minimum size of the focussed spot using a lens of focal length 10cm.
10. What is mode locking operation in laser ? Prove that the output of a mode locked laser is n times the power of the same laser with modes uncoupled. Describe a technique developed for achieving mode locking. What is passive mode locking ?

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**For Practical Counselling Class & Practical Examination Programme
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NALANDA OPEN UNIVERSITY
M.Sc. Physics
PART-II, PAPER-XV
(Advanced Condensed Matter Physics)
Annual Examination, 2013

Time : 3 Hours.

Full Marks: 80

Answer any Five Questions. All questions carry equal marks.

1. What are ionic crystals ? Explain the formation of an ionic crystal and obtain an expression for its cohesive energy.
2. Discuss the normal modes of a monatomic three dimensional Bravais lattice and that of a lattice with a basis.
3. Discuss the dependence of dielectric constant of frequency. Explain the concept of longitudinal and transverse dielectric constants. Show that $n^2 = \epsilon_r$ where n is the refractive index and ϵ_r the dielectric constant of a medium.
4. Describe the inelastic scattering of neutrons. What are the two methods used for defining and measuring neutron energies ?
5. What is Mössbauer effect ? Give an account of the quantum theory of Mössbauer effect.
6. (a) Discuss briefly the factors influencing the phonon mean free path in insulators.
(b) Explain the two phonon processes. N-process and U-process.
7. What is polariton ? Obtain polariton dispersion relation. How does it stand the experimental test ?
8. What is skin effect ? What do you understand by surface impedance ? Give the mathematical theory of Normal Skin effect.
9. Discuss the theory of interaction of electron with optical phonons in case of polar lattice.
10. Give an account of Ginzberg-Landau theory of the phenomenology of the super conducting state. How do you get coherence length.

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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART-II, PAPER-XVI

(Advanced Electronics)

Annual Examination, 2013

Time : 3 Hours.

Full Marks: 80

Answer any Five Questions. All questions carry equal marks.

1. (a) What is a differential amplifier ? What are the four types of its configurations ? Define each of these configuration.
(b) What is cascaded differential amplifier ? What is the use of level translator circuit ?
2. What is an op-amp ? What are the important characteristics of an ideal op-amp ? Define the following electrical parameters :- Input offset voltage V_{io} and current I_{io} , Differential input Resistance R_i , $CMRR$, $SVRR$ & SR .
3. Draw the circuit diagrams and derive the expressions for output voltage of summing, scaling and averaging amplifiers in inverting configurations.
4. Derive an expression for frequency of oscillation of Wien bridge oscillator. Show that the gain of Wien bridge oscillator is 3 to make the loop gain unity and sustain oscillation.
5. Draw the schematic diagram of a triangular wave generator using a square wave generator and an integrator. Also draw the input and output wave forms. Calculate the frequency of oscillation of the square wave generator if $R_1 = 12k\Omega$, $R_2 = 13.92k\Omega$, $R = 100k\Omega$ and $C = 0.01\mu F$.
6. (a) What is combinational logic ? Give at least 3 common combinational logic circuits considered as gates. How do you create Boolean expression from combinational logic ?
(b) What are the laws of Boolean Algebra ? What is DeMorgan's theorem ? What is the meaning of SOP & POS format of Boolean Expression ?
7. Explain the advantage of Edge triggered Flip-Flops over simple latch type flip-flops. Explain the working of Edge Triggered RS Flip-Flop giving logic symbols and truth tables of both positive & negative type RS flip-flops.
8. What is shift register counter ? Discuss the working of any one shift register counter.
9. What is an adder circuit ? Explain the implementation of a half-adder and a full-adder circuits. Also, explain the difference between these.
10. Give the internal architecture and working principle of 8086 CPU.

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