NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–I, PAPER–I

(Mathematical Physics)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. Derive Hamilton's equations and use it to find the equation of motion of a compound pendulum.
2. Solve the differential equation $x(1-x)y'' - (6x+1)y' - 2y = 0$.
3. (a) If $\vec{A} = 3\hat{i} - \hat{j} + 2\hat{k}$, $\vec{B} = 2\hat{i} + \hat{j} - \hat{k}$ and $\vec{C} = \hat{i} - 2\hat{j} + 2\hat{k}$ then calculate $\vec{A} \times (\vec{B} \times \vec{C})$.
   (b) Show that $\vec{A} \times (\vec{B} \times \vec{C}) = (\vec{A} \cdot \vec{C})\vec{B} - (\vec{A} \cdot \vec{B})\vec{C}$.
4. Discuss the solution of the problem of Harmonic Oscillator by Hamilton-Jacobi method.
5. Write notes on skew-symmetric matrix and that its transpose, $A^T = -A$.
6. Write and solve the Legendre's differential equations.
7. Obtain expression for Laplace transform of integrals.
8. From Fourier integral, define Fourier integral transform in three different manners.
9. Write the law of transofrmation for the following tensors A_k^{ij} *and* B_{ijk}^{mn}.
10. Describe Bessel function and give its properties.

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Examination Programme, 2014

M.Sc. Physics, Part–I

Date	Paper	Time	Examination Centre
05.07.2014	Paper–I	3.30 PM to 6.30 PM	Nalanda Open University, Patna
07.07.2014	Paper–II	3.30 PM to 6.30 PM	Nalanda Open University, Patna
09.07.2014	Paper–III	3.30 PM to 6.30 PM	Nalanda Open University, Patna
11.07.2014	Paper–IV	3.30 PM to 6.30 PM	Nalanda Open University, Patna
15.07.2014	Paper–V	3.30 PM to 6.30 PM	Nalanda Open University, Patna
17.07.2014	Paper–VI	3.30 PM to 6.30 PM	Nalanda Open University, Patna
19.07.2014	Paper–VII	3.30 PM to 6.30 PM	Nalanda Open University, Patna
21.07.2014	Paper–VIII	3.30 PM to 6.30 PM	Nalanda Open University, Patna

NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–I, PAPER–II

(Quantum Mechanics)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. Give the physical interpretation of the wave function. Explain the normalization of the wave function. Argue that $\psi^*(x, t) \cdot \psi(x, t)$ must be real, and either positive or zero.

2. State the postulates of Schrödinger formulation of quantum mechanics.

3. A particle is incident from the left with energy E > 0 on a square potential well specified by $V(x) = -V_0,\ 0 < x < L$
$= 0 \quad ,\ x < 0 \ \text{and} \ x > L$. Calculate the reflection and transmission coefficients.

4. State and prove Heisenberg's uncertainty principle. What are its consequences.

5. The ladder operators are $L_+ = L_x + i L_y$ and $\underline{L} = L_x - i L_y$. Show that $[L_z, L_+] = i\hbar L_+$ and $[L_z, L_-] = i\hbar L_-$.

6. Give a brief account of the quantum mechanical theory of Stark effect for splitting of energy levels of hydrogen atom.

7. State and explain Fermi's golden rule. Explain adialiatic and sudden approximation.

8. State the hypothesis of de Broglie. Derive the de Broglie relation for a photon from the principle of mass-energy equivalence.

9. Give a brief account of Dirac delta function.

10. Write short notes on the following :—
    (a) Ehrenfest's theorem.
    (b) Symmetry of wave function.
    (c) Expectation value of a dynamical quantity.

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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–I, PAPER–III

(Electrodynamics and Plasma Physics)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer five questions in all, selecting at least Two Questions from each Group.
All questions carry equal marks.

Group–'A'

1. Explain contravariant and covariant tensors. Explain the rules of addition, subtraction, multiplication of tensors. Also write on contraction and quotient laws for them.

2. Find transformation equations of electric field $\left(\vec{E}\right)$ and magnetic field $\left(\vec{B}\right)$. Show that their product $\vec{E}\cdot\vec{B}$ is invariant.

3. Derive expressions for Lienard-Wiechart potentials due to a moving electric charge.

4. Deduce radiation fields due to slowly moving accelerated particle.

5. Discuss the motion of charged particles in oscillating electromagnetic fields.

6. What is adiabatic invariant ? Discuss the first adiabatic invariant $\left(\mu\right)$.

Group–'B'

7. Derive the Zeroth, first and second moments of Boltzmann's equation.

8. Discuss the theory of upper hybrid waves generated by the plasma in the presence of magnetic field.

9. Discuss the theory of Langmuir's double probe method of measuring plasma parameters.

10. What is a magnetic mirror-machine ? Explain loss cone and also the limitations under which it can work for confinement of charged particles.

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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–I, PAPER–IV

(Statistical Physics)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. What is partition function. Deduce partition function of an ideal monoatomic gas.
2. Derive Bose-Einstein distribution function. What is Bose-Einstein condensation.
3. What is entropy ? Show that, (i) $S = K \ln Z + U/T$, (ii) $U = -\frac{\partial}{\partial \beta}(\ln Z)$, where U = mean energy of the gas, Z = partition function and S= entropy.
4. Explain microcanonical and grand canonical ensembles. Derive Sackur-Tetrode equation for a perfect gas.
5. What is Gibbs' paradox and explain how is it resolved ?
6. Give fundamental assumptions of statistical mechanics. Explain phase space.
7. For a real gas obeying Van der Vaals equation of state evaluate ($C_p - C_v$).
8. Show how you can solve the one dimensional Ising model to obtain thermodynamic properties.
9. What are critical indices ? Explain the different kinds of critical indices.
10. Write notes on :—
    (a) Virial equation of state.
    (b) First order phase transition.

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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–I, PAPER–V

(Nuclear and Particle Physics)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. Give the theory of the force between the proton and the neutron in deuterium for the ground state.
2. Show that the nuclear force is spin dependent, Justify your answer with substantive experimental facts.
3. What is Majorana force ? Explain why neutron-proton pair form bound nucleus while a bi-neutron and a di-proton pair do not. How this exchange force gives rise to saturation in binding energy ?
4. Describe the basic ideas of Yukawa's meson exchange theory of the nuclear force.
5. Define total and differential cross section. Give the experimental determination of cross section.
6. Describe the compound nucleus theory of nuclear reactions. Give the experimental evidence in support of this theory.
7. Describe the shape of the β spectrum and give energy distribution and momentum distribution of β -particles.
8. Discuss the Fermi and Gamow-Teller selection rules in the Fermi's theory of β -disintegration.
9. Describe C.S. Wu's experiment on non conservation of parity in weak interaction.
10. Give an account of classification of hadrons Explain SU(3) symmetry and discuss octet and decuplet multiplets for hadrons.

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For Practical Counselling Class & Practical Examination Programme Please See on Back Page.

NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–I, PAPER–VI

(Atomic and Molecular Physics)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer five questions in all, selecting at least Two Questions from each Group.
All questions carry equal marks.

Group–'A'

1. State Bohr's postulates and deduce an expression for the transition between two energy levels of hydrogen atom.

2. Describe the general features of the spectra of alkali-like atoms. How are they explained ?

3. What are normal and anomalous Zeeman effects ? How are they explained ?

4. Outline the theory of Stark effect. Show that the splitting in stark effect increases with the increase of principal quantum no. *n*.

5. How does the nuclear spin affect the hyperfine structure of the emission spectrum of an atom ?

Group–'B'

6. Give the complete theory of vibrational-rotational spectrum of diatomic molecule.

7. State Franck-condon principle and give its wave mechanical interpretation. How does it help in understanding the intensity distribution in the vibrational structure of the electronic transitions of a diatomic molecule.

8. Discuss Raman spectra of diatomic molecule and point out the similarities and differences of this with infra-red Raman spectra.

9. Describe the principal features of the rotational band spectrum of a diatomic molecule. Estimate the energy difference between the rotational levels J = 0 and J = 1 of Hcl it its moment of inertia in 2.66×10^{-47} Kgm^2.

10. Write short notes on any ***Two*** of the following :—
    (a) LS and JJ coupling.
    (b) Broadening of spectral lines.
    (c) ESR spectroscopy.

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For Practical Counselling Class & Practical Examination Programme Please See on Back Page.

NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–I, PAPER–VII

(Condensed Matter Physcis)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. What do you understand by lattice, Bravais lattice, point group and space group ? Show that base centred and face centred tetragonal do not give any new Bravais lattice.

2. What are Miller indices ? How the orientation of a plane is specified by Miller indices ? Explain their importance. Write down the Miller indices for planes with intercepts (i) a, $\frac{b}{2}$, c.

3. What are Brillouin zones ? How are Brillouin zones constructed ? Give the sketches of the first Boillouin zones of bcc and fcc lattices.

4. What is crystal defect ? Describe different types of point defects. Derive an equation relating to the no. of vacancies found under equilibrium in a monoatomic crystal at a constant temp, to the average energy required to create one vacancy.

5. Discuss the Kronig-Penny model for a linear lattice. How does it lead to the formation of energy bands in solids ?

6. Describe the cellular method for studying the band structure of solids. What are the problems encountered in this method.

7. Discuss the quantisation of electron orbits in a magnetic field.

8. What is quantum hall effect ? Give an account of its relevant theory.

9. What is a superconductor ? How do their properties differ from those of normal conductors ? Give some applications of superconductors.

10. Show that the intensity of x-rays passing through a material decreases as given below $I_{(x)} = I_{(0)^0}\ e^{-\mu x}$. Where μ = absorption coefficient and x is the thick of material travelled by x-rays.

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For Practical Counselling Class & Practical Examination Programme Please See on Back Page.

NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–I, PAPER–VIII

(Electronic Devices)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. What in Gunn effect ? Describe the design of Gunn diode and discuss its operating characteristics.

2. Describe the design and operating characteristics of UJT. How are they explained ?

3. What is meant by Pinch off ? How does it take place in JFET.

4. What do you understand by electrogyration ? Explain it on the basis of symmetry approach.

5. Explain the basic design and working of Change Coupled Device (C.C.D.).

6. Explain large Bragg angle diffraction with special reference to codirectional and contradirectional coupling.

7. What do you mean by piezoelectricity ? Discuss the application of piezoelectric material in sensors and actuators.

8. What is Raman-Nath diffraction ? How can it be observed ? Give the theory of this diffraction.

9. Give an account of the theoretical treatment of liquid crystals.

10. What is meant by magneto optic effect ? Explain it with special reference to Faraday effect and magneto optic-Kerr effect.

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For Practical Counselling Class & Practical Examination Programme Please See on Back Page.

NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–II, PAPER–IX

(Computational Mathematics)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. Using Lin-Bairstow's method obtain quadratic factor of the polynomial given by $f(x) = x^3 - 2x^2 + 5x - 2$.

2. Find the eigenvalues and eigenvectors of the following matrix $\begin{bmatrix} -5 & 2 \\ 2 & -2 \end{bmatrix}$.

3. State and prove Stirling's formula for interpolation.

4. What is Euler-Maclaurin formula for numerical integration ? Evaluate $I = \int_0^{\pi/2} Cosx\, dx$ using this formula.

5. From the Taylor series for *y(x)*, find *y(0, 1)* correct to three decimal places if *y(x)* satisfies $y' = x - y^2$ and $y(0) = 1$.

6. Using finite difference method, solve the following differential equation $\frac{d^2y}{dx^2} = y$ with $y(0) = 0,\ y(2) = 3.627$.

7. Solve the equation $y'' + y + 1 = 0$, with boundary conditions, $y = 0$ when $x = 0$ and $y = 0$ when $x = 1$.

8. Solve the equation $\frac{dy}{dx} + x + y,\ y(0) = 0$ by Euler's methods. Choose $\lambda = 0.2$ and compute $y(0.4)$ and $y(0.6)$.

9. Use the Spline method to solve initial value problem $y'' + 2y' + y = 0,\ y(0) = 0$ and $y(1) = 0$.

10. From the following table of values of *x* and *y*, obtain $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ for *x = 1.2*

x	1.0	1.2	1.4	1.6	1.8	2.0	2.2
y	2.7183	3.3201	4.0552	4.9530	6.0496	7.3891	9.0250

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Examination Programme, 2014

M.Sc. Physics, Part–II

Date	***Paper***	***Time***	***Examination Centre***
13.08.2014	Paper–IX	3.30 PM to 6.30 PM	D.A.V. Public School, Punaichak, Patna
19.08.2014	Paper–X	3.30 PM to 6.30 PM	D.A.V. Public School, Punaichak, Patna
21.08.2014	Paper–XI	3.30 PM to 6.30 PM	D.A.V. Public School, Punaichak, Patna
23.08.2014	Paper–XII	3.30 PM to 6.30 PM	D.A.V. Public School, Punaichak, Patna
25.08.2014	Paper–XIII	3.30 PM to 6.30 PM	D.A.V. Public School, Punaichak, Patna
27.08.2014	Paper–XIV	3.30 PM to 6.30 PM	D.A.V. Public School, Punaichak, Patna
29.08.2014	Paper–XV	3.30 PM to 6.30 PM	D.A.V. Public School, Punaichak, Patna
02.09.2014	Paper–XVI	3.30 PM to 6.30 PM	D.A.V. Public School, Punaichak, Patna

NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–II, PAPER–X

(Programming with Fortran and C^{++})

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. What are excutable and nonexcutable statements and what is the difference between them.
2. Discuss the following three ways of writing ×2 in Fortran; (a) ×*×, (b) ×**2, (c) ×**2.0.
3. Write a Fortran program which counts the number of positive numbers and the number of negative numbers.
4. Write a SUBROUTINE subprogram which does not have any, (a) argument, (b) RETURN statement.
5. Write a program segment or subroutine to plot a graph between specified limit with its argument range of 101.
6. Discuss the characteristics of OPEN, READ END FILE and CLOSE FILE used in file format of Fortran.
7. Write a function in C^{++} to generate a Fibonacci series of n numbers, where n is defined by a program.
8. Write a program in C^{++} to perform the following, (a) Area of a triangle, (b) Area of a rectangle.
9. What is a function ? List out the advantages and disadvantages of using functions in C^{++}.
10. What is a relationship between a pointer and an array ? How is a pointer variable declared in C^{++} ?

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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–II, PAPER–XI

(Physics of Nanomaterials)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. What are nanoparticles ? What are quantum dots ? Give short notes on their applications.
2. Write one dimensional time-independent Schrödinger's wave equation and discuss the motion of a charged particle in an one-dimensional infinite potential well.
3. Explain density of states in a metal. Derive an expression for the density of states of electrons in metals.
4. Write notes on, (i) Quantum Well and (ii) Superlattice.
5. What is quantum wire ? Discuss their optical properties. Describe the various quantum wire devices.
6. Enumerate the basic steps involved in construction of electron microscope. Give brief notes on Transmission Electron Microscope (TEM) and Scanning Electron Microscope (SEM)
7. Explain the phenomena of photoluminescence, phosphorescence and chemiluminescence. How do you account for the shift in peaks of PL-spectra ?
8. What is the difference between the 'Bottom Up' and 'Bottom Down' methods of producing nanoparticles ? Describe in detail the 'Sol-Gel method' of preparation of nanoparticles.
9. What is multiferroic magnetoelectric material ? Discuss the applications of such materials.
10. Write notes on, (i) Plasma Arcing and (ii) Biological Nanomaterials.

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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–II, PAPER–XII

(Science and Technology of Renewable Energy)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. Derive expression for Radiant Power Density.
2. Explain Minority Carrier life time and diffusion length in simple semiconductor crystal.
3. State and explain the Diode equation for no-ideal and ideal Diodes. Graphically, illustrate the Diode law and explain the importance of dark current. Explain Depletion approximation.
4. Explain 'quantum efficiency' and 'spectral response'. How will you calculate quantum efficiency from spectral response.
5. What do you understand by first, second and third generation of solar cells ? What efficiency they can achieve ?
6. Explain series and shunt resistances and their effects on 'Fill Factor' (FF) in solar cells. Distinguish between characteristics and parasitic resistances.
7. Compare hydroelectric generation with others sources of energy and discuss its positive and negative aspects. What are its limitations ?
8. What are advantage and disadvantages of hydrogen energy applications ?
9. Can solar energy be used for cooling ? How ?
10. Explain the physics behind wave energy generation and harnessing.

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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–II, PAPER–XIII

(Environmental Physics)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. What is 'Atmospheric Stratification' ? Explain its importance. What do you mean by 'The Froude Number ?
2. Explain Einstein's A and B coefficients of absorption, stimulated emission and spontaneous emission. Hence deduce Lambert-Beer's law.
3. What is LIDAR ? Explain its principle, physical and technical aspects with applications.
4. (a) Explain the zero dimensional green house gas model.
   (b) Discuss weather and climatic effect on Earth is nuclear explosion occurs and the sun becomes cold.
5. Discuss the equations of motion for a fluid and hence obtain the Navier-Stokes equation for fluids.
6. Derive Fick's law and explain its analogy with heat transfer equation.
7. Show that the efficiency (η) of a real heat engine is always smaller than that of the ideal Carnot engine (η_C) by the factor of $1+\sqrt{\frac{T_C}{T_H}}$. The smaller efficiency implies that the entropy Δs is produced while operating the engine show that $\Delta s = (\eta_c - \eta)\frac{Q_H}{T_C}$.
8. What do you mean by renewable energy ? Discuss in detail various types of renewable energy.
9. Explain the principle of solar collectors which absorb solar radiation. Find the expression for the net heat flux entering the collector.
10. Write notes on the following :—
    (a) Photovoltaic effect.
    (b) Solar pond.
    (c) Nuclear fission.

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NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–II, PAPER–XIV

(Photonics)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. Describe a double heterojunction LED. Why this system has better light emitting efficiency than p-n junction LED.
2. What do you mean by 'stimulated emission' and 'population inversion' ? How is the population inversion accomplished in semiconductor and non-semiconductor laser ?
3. Derive relation between Einstein's A and B coefficients what are the weak points of Einstein's theory ?
4. Describe with a neat diagram the operation of Ruby laser. Explain the origin of spiking in laser emission.
5. Describe an injection laser. What is double heterjunction injection laser ? Explain the origin of the term 'injection'.
6. What do you mean by Core and Cladding ? Describe the structures of different types of optical fibres with ray paths.
7. Describe Avalanche Photodiode (APD). Illustrate its advantage.
8. How plasma screen is different from LCD screen ? What is the future of LCD screen ?
9. Give the principles of photo-detection. Explain the photo-detection process in a p-n junction photodiode. Compare this device with p-i-n photodiode.
10. Write notes on the following :—
    (a) Optical transmitters and receivers.
    (b) Ultrafast laser and its uses.
    (c) Holography.

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For Practical Counselling Class & Practical Examination Programme Please See on Back Page.

NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–II, PAPER–XV

(Advanced Condensed Matter Physics)

Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

Answer any Five Questions. All questions carry equal marks.

1. (a) Describe the covalent bonding process between a pair of hydrogen atoms. What is the driving energy for the formation of a diatomic molecule ?
   (b) What is Madelung constant ? Show that the madelung constant for an infinite linear chain of ions of alternating unit charge at an equilibrium separation in *2ln2.*
2. Establish the Lydden-Sachs-Teller relation between the static dielectric constant and that at optical frequencies.
3. (a) What is a phonon ? Enumerate its salient features.
   (b) What are the normal and Umkalpp processes ?
4. Derive an expression for the thermal conductivity of a crystal. Discuss its variation with temperature and the size of the crystal.
5. What is Debye-Waller factor ? Discuss the temperature dependence of the Bragg reflection lines pointing out the origin of Debye-Waller factor.
6. What do you understand by direct transition and indirect transition ? Calculate the absorption coefficient in case of direct transition.
7. What do you mean by optical properties of metal ? Obtain expression for each of them giving the relevant theory.
8. Give the theory of interaction of electron with acoustic phonons.
9. Give a quantitative treatment of BCS ground state. Obtain an expression for the energy gap at ok.
10. Derive an expression for electrical conductivity of metal on Drode Model. Explain the effect on conductivity if an alternating electric field is applied to the system.

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For Practical Counselling Class & Practical Examination Programme Please See on Back Page.

NALANDA OPEN UNIVERSITY

M.Sc. Physics

PART–II, PAPER–XVI

(Advanced Electronics)

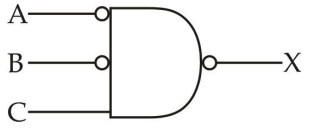
Annual Examination, 2014

Time : 3 Hours. **Full Marks : 80**

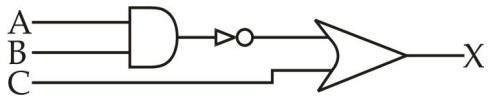
Answer any Five Questions. All questions carry equal marks.

1. What is a level transistor circuit ? Why is it used with the cascaded differential amplifier ?
2. What is an op-amp ? What are the characteristics of an ideal op-amp ? Draw the block diagram of an op-amp.
3. Explain the working of inverting and noninverting amplifiers. Derive the expression for the output voltage.
4. Derive an expression for frequency of oscillation of phase shift oscillator.
5. What is a comparator ? Explain the working of a comparator. What are its important characteristics ?
6. Develop the truth table for each of the combinational logic circuits given below :—

(a)



(b)



7. What is a flip-flop ? Explain functioning of NOR and NAND latch.
8. What is ROM ? Distinguish between PROM and FPROM. Give some of the important applications of ROM.
9. What are the five basic hardware blocks of a digital computer ? Draw the block diagram of a digital computer and explain the working of each block.
10. What is a decoder ? Describe seven-segment displays for an LED circuit.

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For Practical Counselling Class & Practical Examination Programme Please See on Back Page.