NALANDA OPEN UNIVERSITY

M.Sc. Physics, Part-I

PAPER–I

(Mathematical Physics)

Annual Examination, 2023

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

Answer any Five Questions.
All questions carry equal marks.

1. Find the equation of motion for a charged particle in an electromagnetic field using the Hamiltonian of the particle.

2. Show that the integral representation of Laguerre polynomials is given by

$$L_n(x) = \frac{e^x}{\underline{|n}} \int_0^\infty e^{-1}.\, t^n\ J_0\left[2(xt)^{\frac{1}{2}}\right]dt.$$

   Where J_o is the Bessel's functions of Zero order.

3. Show that (a) row-equivalent matrices have the same rank, (b) the row-space and the column-space of a matrix have the same dimension equal to rank A.

4. Find g and g^{jk} corresponding to $ds^2 = 5\,(dx^1)^2 + 3\,(dx^2)^2 + 4\,(dx^3)^2 - 6\,dx^1\,dx^2 + 4dx^2dx^3$.

5. Write notes on orthonormality of column and row vectors. Prove that eigenvectors of a symmetric matrix corresponding to different eigenvalues are orthogonal.

6. If ϕ is an invariant, determine whether $\frac{\partial^2\phi}{\partial x^p\,\partial x^q}$ is a tensor.

7. Starting with the series expansion, derive Rodrigues formula for Legendre polynomials.

8. State and prove (a) Parseval's theorem (b) Convolution theorem of Fourier-transforms.

9. Derive integral representation of $J_n(x)$, the Bessel's function of first kind of order n.

10. Find the Laplace's transform for (a) $3t^4 - 2t^3 + 4\,e^{3t} - 2Sin\,5t + 3\,Cos2t$.

* * *

EXAMINATION PROGRAMME-2023

M.Sc. Physics, Part-I

Date	Papers	Time	Examination Centre
04.07.2023	Paper–I	10.30 AM to 1.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
06.07.2023	Paper–II	10.30 AM to 1.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
08.07.2023	Paper–III	10.30 AM to 1.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
11.07.2023	Paper–IV	10.30 AM to 1.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
13.07.2023	Paper–V	10.30 AM to 1.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
15.07.2023	Paper–VI	10.30 AM to 1.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
18.07.2023	Paper–VII	10.30 AM to 1.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
20.07.2023	Paper–VIII	10.30 AM to 1.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna

NALANDA OPEN UNIVERSITY

M.Sc. Physics, Part-I

PAPER–II

(Quantum Mechanics)

Annual Examination, 2023

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

Answer any Five Questions.
All questions carry equal marks.

1. Obtain expressions for the group velocity and the phase velocity of a de-Broglie wave.
2. State Ehrenfest's theorem and show that classical mechanics agrees with quantum mechanics so far as the expectation values are concerned.
3. Find the energy levels and the energy eigenfunctions of a particle of mass m moving in a potential

$$V(x) = \tfrac{1}{2}kx^2, \quad x > 0$$
$$= \infty, \quad x < 0$$

.

4. Present the quantum mechanical theory of H-like atoms and discuss its energy level diagram in relation to potential.
5. Calculate the reflection and the refraction coefficients when a charged particle is incident from the left with energy $E > 0$, on a square well potential given by

$$V(x) = -V_0, \quad 0 < x < a$$
$$= 0, \quad x < 0 \text{ and } x > a$$

.

6. On the basis of WKB method, discuss the case of one dimensional harmonic oscillator and show that the theoretical results match with exact results.
7. (a) Prove that momentum operator is self adjoint.
   (b) Find the commutation relations of components of angular momentum.
8. Discuss the scattering of particles by a spherically symmetric potential. Explain partial wave and phase shift.
9. State and explain Fermi's golden rule. What do you understand by adiabatic and sudden approximation ?
10. Write short notes on any ***Two*** of the following :—
    (a) Degeneracy
    (b) $\Delta\phi \cdot \Delta\ell \geq \frac{\hbar}{2}$
    (c) Dirac δ-function.
    (d) $\Delta E \cdot \Delta t \geq \frac{\hbar}{2}$

• • •

परीक्षाफल प्रकाशन से सम्बन्धित आवश्यक सूचना

सम्बन्धित सभी विद्यार्थियों को सूचित किया जाता कि वे अपने विषय के रिजल्ट से सम्बन्धित जानकारी हेतु समय–समय पर (time to time) विश्वविद्यालय के वेबसाईट (www.nou.ac.in) का संदर्भ करेंगे ।

- परीक्षाफल प्रकाशित हो जाने के उपरान्त सभी विद्यार्थियों का e-marksheet उनके Student Login पर मौजूद रहेगा, जिसे वे नालन्दा खुला विश्वविद्यालय में किसी प्रयोजनार्थ व्यवहार में ला सकते हैं ।
- परीक्षा में उत्तीर्ण विद्यार्थी अपने Student Login से निर्धारित तिथियों (जो कि रिजल्ट नोटिस पर मौजूद रहेगा) के अन्तर्गत अगले सत्र में Online Admission लेना सुनिश्चित करेंगे ।

• • •

NALANDA OPEN UNIVERSITY

M.Sc. Physics, Part-I

PAPER–III

(Electrodynamics and Plasma Physics)

Annual Examination, 2023

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

Answer any Five Questions.
All questions carry equal marks.

1. Calculate vector potential of a current loop.
2. What is Plasma ? Give the key difference between plasma and normal gas. Derive an expression for Debye length.
3. Show that D' Alembertian operator $\Box^2$ is invariant under Lorentz transformation.
4. Derive the zeroth, first and second moments of Boltzmann's equation.
5. Explain advanced and retarded potential. Obtain an expression for angular distribution of power for uniformly moving point charge.
6. Derive expression for plasma frequency. Explain the significance of lower and upper hybrid frequencies.
7. Write notes on (a) Synchrotron radiation (b) Cerenkov radiation.
8. While discussing the behaviour of plasma particles in static magnetic field, deduce and discuss Larmour frequency.
9. Discuss the motion of a charged particle in oscillating magnetic fields.
10. Explain the following terms :-
    (a) Match number (b) Reynold's number
    (c) Stuart number (d) Hartmann number.

* * *

परीक्षाफल प्रकाशन से सम्बन्धित आवश्यक सूचना

सम्बन्धित सभी विद्यार्थियों को सूचित किया जाता कि वे अपने विषय के रिजल्ट से सम्बन्धित जानकारी हेतु समय–समय पर (time to time) विश्वविद्यालय के वेबसाईट (www.nou.ac.in) का संदर्भ करेंगे ।

- परीक्षाफल प्रकाशित हो जाने के उपरान्त सभी विद्यार्थियों का e-marksheet उनके Student Login पर मौजूद रहेगा, जिसे वे नालन्दा खुला विश्वविद्यालय में किसी प्रयोजनार्थ व्यवहार में ला सकते हैं ।
- परीक्षा में उत्तीर्ण विद्यार्थी अपने Student Login से निर्धारित तिथियों (जो कि रिजल्ट नोटिस पर मौजूद रहेगा) के अन्तर्गत अगले सत्र में Online Admission लेना सुनिश्चित करेंगे ।

• • •

NALANDA OPEN UNIVERSITY

M.Sc. Physics, Part-I

PAPER–IV

(Statistical Mechanics)

Annual Examination, 2023

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

Answer any Five Questions.
All questions carry equal marks.

1. State and prove Boltzmann theorem of entropy. Obtain expression for the entropy of a monatomic gas.
2. Derive Virial equation of state and evaluate the Virial coefficients.
3. What do you mean by partition function ? Show that partition function of a monatomic gas is given by $Z = \frac{V}{h^3}(2\pi m k T)^{3/2}$.
4. What are critical indices ? Explain the different scaling relations and the critical indices.
5. State and explain the fundamental assumptions of statistical mechanics. Explain phase space and density of states.
6. Describe two dimensional *Ising* model and show how does it explain the phenomenon of spontaneous magnetization.
7. Explain microcanonical and grand canonical ensembles. Derive Sackur-Tetrod equation for a perfect gas.
8. Show that the pressure exerted by a Fermi gas at $T = 0$ is $P_F = \frac{2}{5}\left(\frac{N}{V}\right)E_F$, where E_F is Fermi Energy.
9. What is phase transition ? Explain the first order and the second order phase transitions. Discuss Landau theory of phase transition.
10. Write notes on any ***Two*** of the following :—
    (a) Bose-Einstein Condensation
    (b) Scale transformation in phase transition
    (c) Gibbs' paradox
    (d) Cluster expansion

* * *

NALANDA OPEN UNIVERSITY

M.Sc. Physics, Part-I

PAPER–V

(Nuclear and Particle Physics)

Annual Examination, 2023

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

Answer any Five Questions. All questions carry equal marks.

1. Define total and differential cross section. Describe experimental determination of cross section.
2. Give a brief account of Fermi's theory of β-decay and show how it was necessary to postulate the existence of neutrino.
3. Give an account of the nature of the force existing between a proton and a neutron in a deuteron of ground state.
4. Discuss neutron-proton scattering at low energies. What light does it throw on the nature of nuclear force ?
5. Show that the nuclear force is spin dependent. Justify your answer with substantive experimental facts.
6. Describe the compound nucleus theory of nuclear reactions. Give experimental evidences in support of this theory.
7. Describe Wu's experiment and give its interpretation to explain the non-conservation of parity in weak interaction.
8. Give the simple Briet-Winger 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.
9. Describe the basic ideas of Yukawa's meson exchange theory of the nuclear force. Give the properties of π-meson.
10. What are stripping and pick-up reactions ? Obtain an expression for the reaction amplitude using Butler theory for stripping and pick-up reactions.

* * *

NALANDA OPEN UNIVERSITY

M.Sc. Physics, Part-I

PAPER–VI

(Atomic and molecular Physics)

Annual Examination, 2023

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. Describe and explain the different types of coupling of vector atomic models. Give their respective merits.
2. Discuss briefly the various factors which contribute to the broadening of spectral lines.
3. State and explain Pauli's exclusion principle and discuss how this principle is connected with the symmetry of the wave function.
4. Write down Schrödinger equation of electron atom and solve it by the method of separation of variables. Explain the physical meaning of the different quantum numbers that come out in the solution.
5. How does the nuclear spin affect the hyperfine structure of the emission spectra of atoms.

GROUP 'B'

6. Describe the principal features of the rotational bond spectrum of a diatomic molecule. Estimate the energy difference between the rotational levels J = 0 and J = 1 of Hcl molecule. Its moment of inertia is 2.66×10^{-47} kg.m².
7. What do you mean by ESR ? Explain the basic principles of interaction of electrons spin and applied magnetic field.
8. Explain Tranc-condon principle and give its wave mechanical interpretation. How does it help in understanding the intensity distribution in Vibrational structure of the electronic transitions of a diatomic molecule.
9. Discuss the principal features of the electronic spectrum of a diatomic molecule.
10. Write notes on any ***Two*** of the following :—
    (a) Raman spectra of diatomic molecules
    (b) NMR spectroscopy.
    (c) Spin-spin coupling between two or more nuclei.
    (d) LS and JJ Coupling.

* * *

प्रायोगिक परामर्श कक्षा एवं प्रायोगिक परीक्षा का कार्यक्रम पार पृष्ठ पर देखें ।

NALANDA OPEN UNIVERSITY

M.Sc. Physics, Part-I

PAPER–VII

(Condensed Matter Physics)

Annual Examination, 2023

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

Answer any Five Questions. All questions carry equal marks.

1. Explain lattice, Bravais lattice, point group and space group. Show that the base centred and the face centred tetragonal do not give any new Bravais lattice.
2. What is crystal defect ? Describe different types of point defects. Derive an equation relating the number of vacancies found under equilibrium in a monatomic crystal at a constant temperature and the average energy required to create one vacancy.
3. Describe cellular method for studying the band structure of solids. What are the problems encountered in this method.
4. Discuss the quantization of electron orbits in a magnetic field.
5. What is a superconductor ? Explain how their properties differ from those of normal conductors.
6. What is quantum hall effect ? Give an account of the theory of this effect.
7. Give the qualitative description of the BCS theory. How does it account for the superconductivity.
8. What are Symmetry Operations ? Describe the principal symmetry operation applicable to a three dimensional lattice.
9. Write down the main characteristics of Fermi surface. Discuss the effects of the electric and the magnetic fields on the Fermi Surface.
10. Describe the powder method for X-ray diffraction. Discuss the formation of diffraction pattern on the photographic film & its utility.

* * *

प्रायोगिक परामर्श कक्षा एवं प्रायोगिक परीक्षा का कार्यक्रम पार पृष्ठ पर देखें ।

NALANDA OPEN UNIVERSITY

M.Sc. Physics, Part-I

PAPER–VIII

(Electronic Devices)

Annual Examination, 2023

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

Answer any Five Questions.
All questions carry equal marks.

1. Describe the design and operating characteristics of tunnel diode. What is meant by tunneling ?
2. Describe the mechanism of current flow in a properly biased BJT. Define the various parameters of BJT.
3. How can NMOS device be used to implement memory device ? Explain it.
4. What are Lyotropic Liquid Crystals ? Discuss generic progression of phases going from low to high amphiphile concentration.
5. Give an account of the theoretical treatment of liquid crystals.
6. What is meant by magneto optic effect ? Explain it with special reference to Faraday effect and magneto-optic-Kerr effect.
7. State and explain (i) Electrostrictive effect and (ii) Magnetostrictive effect.
8. What are ferroelectric materials ? Discuss their classification. Give the important properties of these materials.
9. Explain the transmissive and the reflective type LCDs.
10. What do you mean by piezoelectricity ? Discuss the applications of piezoelectric materials in sensors and actuators.

* * *

प्रायोगिक परामर्श कक्षा एवं प्रायोगिक परीक्षा का कार्यक्रम पार पृष्ठ पर देखें ।

NALANDA OPEN UNIVERSITY

M.Sc. Physics, Part-II

PAPER–IX

(Computational Mathematics)

Annual Examination, 2023

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

Answer any Five Questions.
All questions carry equal marks.

1. Using Newton-Raphson formula, find a root of the equation $x \sin x + \cos x = 0$.

2. Explain Monte-Carlo Method. Describe various areas where this method is applied. Explain Monte-Carlo Simulation and Monte-Carlo Integration.

3. What do you understand by eigenvalues and eigenvectors of a matrix ? Let $\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$ be a matrix. Find its eigenvalues and eigenvectors.

4. Using the matrix inversion method, find the solution of the following set of algebraic equation $3x + y + 2z = 3$, $2x - 3y - z = -3$ *and* $x + 2y + z = 4$.

5. Find a Gauss's formula $I = \int_{\partial}^{\ell} x\,dx$ in terms of abscissa and weights of Gaussian integration.

6. Use 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 $h = 0.1$.

7. Use the finite difference formula for solving Poisson's equation, solve the following Poisson's equation $\nabla^2 f = 2x^2y^2$, over the square $0 \leq x \leq 3$ and $0 \leq y \leq 3$ with $f = 0$ on the boundary and $h = 1$.

8. Describe the 'Crank-Nicholson Method' to solve the parabolic differential equation. Give a suitable example.

9. Explain the use of the Cubic Spline Method in numerical differentiation with illustrative examples.

10. Obtain the values of $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ for $x = 1.2$ using the table :—

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

* * *

EXAMINATION PROGRAMME-2023

M.Sc. Physics, Part-II

Date	Papers	Time	Examination Centre
30.09.2023	Paper–IX	2.30 PM to 5.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
04.10.2023	Paper–X	2.30 PM to 5.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
06.10.2023	Paper–XI	2.30 PM to 5.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
09.10.2023	Paper–XII	2.30 PM to 5.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
12.10.2023	Paper–XIII	2.30 PM to 5.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
14.10.2023	Paper–XIV	2.30 PM to 5.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
17.10.2023	Paper–XV	2.30 PM to 5.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna
19.10.2023	Paper–XVI	2.30 PM to 5.30 PM	Nalanda Open University, 2nd Floor, Biscomaun Bhawan, Patna

NALANDA OPEN UNIVERSITY

M.Sc. Physics, Part-II

PAPER–X

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

Annual Examination, 2023

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

Answer any Five Questions. All questions carry equal marks.

1. What is a Computer Programme ? Explain the terms : Machine Language, Compiler, Interpreter and Assembler. What is the difference between a hardware and a software ?
2. Write a FUNCTION subprogram which calculates the sum of the elements in a linear array with N elements.
3. Explain integer and real data types representation in the Fortran Language with examples.
4. What are special operators used in the C^{++} language to perform particular type of operation ? Discuss all such operators in detail.
5. Discuss the characteristics of OPEN, READ, END FILE and CLOSE FILE statement used in file format of Fortran.
6. Write a programme in C^{++} to perform the work of finding (i) the area of a triangle, (ii) the circumference of a circle.
7. What is the relationship between a pointer and an array ? Explain how a pointer to function can be declared in C^{++}.
8. Summarize the syntactic rules of the following loop statements :–
   (i) While loop,
   (ii) DO-while loop
9. What is meant by conditional compilation ?
10. What is multidimensional array and how is it different from a one dimensional array ?

* * *

NALANDA OPEN UNIVERSITY
M.Sc. Physics, Part-II
PAPER–XI
(Physics of Nano Materials)
Annual Examination, 2023

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

Answer any Five Questions. All questions carry equal marks.

1. Using the collision-time concept, derive an expression for the electrical conductivity of a free electron gas. Does this result explain the experimental value of resistivity of a metal ?
2. Explain the band formation in the hydrogen molecule. What do you understand by energy bands in Crystal ?
3. Classify crystalline solids into metals, semiconductors and insulators on the basis band theory. Explain the concept of effective mass of charge carriers.
4. Obtain the eigenvalues and normalized eigenfunctions of a particle in one dimensional infinite potential box of side 'a'.
5. What is a quantum wire ? Describe the various methods for its fabrication.
6. What is a quantum dot ? Discuss the structure and characteristics of different kinds of quantum dots.
7. What is Raman effect ? Discuss the variations in Raman Spectra of nanomaterials.
8. Describe the citrate precursor technique for preparation of nanoparticles.
9. Describe the Hartree-Fock Approximation of the coulomb interaction between 3D confined electrons. Mention the application of Hund's rule in quantum dots.
10. What do you mean by Multiferric Magnetoelectric materials ? Describe the application of such materials.

* * *

M.SC. PHYSICS, PART-II

Practical Counseling and Practical Examination Programme, 2023

Practical Programme for Paper-X of All Students

Venue : School of Computer Education & IT, Nalanda Open University, 12th Floor, Biscomaun Tower, Patna-800001

Enrollment No.	Date of Online Counselling	Time	Enrollment No.	Date of Exam	Time
All Old & New Students	01.11 2023	3.00 PM to 7.00 PM	180280001 to 200280460	02.11.2023	10.30 AM to 12.30 PM
			200280461 to 200281300	02.11.2023	1.00 PM to 3.00 PM
			210280001 to 210280220	02.11.2023	3.30 PM to 5.30 PM
			210280221 to 210280490	03.11.2023	10.30 AM to 12.30 PM
			210280491 to 210280740	03.11.2023	1.00 PM to 3.00 PM
			210280741 to 210281000	03.11.2023	3.30 PM to 5.30 PM

Practical Programme for Paper-XII, XIV, XV & XVI

Venue : Physics Lab, 1st Floor Biscomaun Tower, Patna-800001

For Enrollment No. 180280001 to 200280800

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
20.10.2023 & 21.10.2023	08.00 AM to 11.00 AM	XII	20.10.2023	XV	21.10.2023	11:00 AM to 2:00 PM
		XIV	20.10.2023	XVI	21.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 200280801 to 210280300

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
26.10.2023 & 27.10.2023	08.00 AM to 11.00 AM	XII	26.10.2023	XV	27.10.2023	11:00 AM to 2:00 PM
		XIV	26.10.2023	XVI	27.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 210280301 to 210280700

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
28.10.2023 & 29.10.2023	08.00 AM to 11.00 AM	XII	28.10.2023	XV	29.10.2023	11:00 AM to 2:00 PM
		XIV	28.10.2023	XVI	29.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 210280701 to 210281000

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
30.10.2023 & 31.10.2023	08.00 AM to 11.00 AM	XII	30.10.2023	XV	31.10.2023	11:00 AM to 2:00 PM
		XIV	30.10.2023	XVI	31.10.2023	2:15 PM to 5:15 PM

NALANDA OPEN UNIVERSITY
M.Sc. Physics, Part-II
PAPER–XII
(Science and Technology of Renewable Energy)

Annual Examination, 2023

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

Answer any Five Questions. All questions carry equal marks.

1. What is meant by air mass and how is it related to standardized solar spectrum ? What are major atmospheric effects limiting the performance of photovoltaic applications ?
2. Explain 'Green House Effect' and the co-relation of the rise of atmospheric carbon dioxide concentration with the rise in average temperature.
3. Discuss the efficiency of a solar cell and explain the importance of Fill Factor in a solar cell.
4. State and explain drift velocity. Derive expression for conductivity and mobility.
5. Derive expression for total current in (a) Wide-Base Diode and (b) Narrow-Base Diode.
6. Explain the perspectives of hydrogen energy in the World. Give an account of the pilot programmes. What are safety risks involved with the applications of hydrogen fuel ?
7. (a) What is Geotherwial Power ? Discuss its advantages and disadvantages.
   (b) Give the methods of harnessing (i) Wave energy and (ii) Tidal energy.
8. Explain surface texturing and light trapping mechanism for a Silicon Solar Cell. What is a Lambertian Rear Reflector ?
9. What do you understand by band gap ? Describe the formation of intrinsic carriers and their concentration variation with temperature.
10. Explain capacity factor of wind farms. How does it help in increasing the reliability of wind farms.

* * *

M.SC. PHYSICS, PART-II

Practical Counseling and Practical Examination Programme, 2023

Practical Programme for Paper-X of All Students

Venue : School of Computer Education & IT, Nalanda Open University, 12th Floor, Biscomaun Tower, Patna-800001

Enrollment No.	Date of Online Counselling	Time	Enrollment No.	Date of Exam	Time
All Old & New Students	01.11 2023	3.00 PM to 7.00 PM	180280001 to 200280460	02.11.2023	10.30 AM to 12.30 PM
			200280461 to 200281300	02.11.2023	1.00 PM to 3.00 PM
			210280001 to 210280220	02.11.2023	3.30 PM to 5.30 PM
			210280221 to 210280490	03.11.2023	10.30 AM to 12.30 PM
			210280491 to 210280740	03.11.2023	1.00 PM to 3.00 PM
			210280741 to 210281000	03.11.2023	3.30 PM to 5.30 PM

Practical Programme for Paper-XII, XIV, XV & XVI

Venue : Physics Lab, 1st Floor Biscomaun Tower, Patna-800001

For Enrollment No. 180280001 to 200280800

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
20.10.2023 & 21.10.2023	08.00 AM to 11.00 AM	XII	20.10.2023	XV	21.10.2023	11:00 AM to 2:00 PM
		XIV	20.10.2023	XVI	21.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 200280801 to 210280300

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
26.10.2023 & 27.10.2023	08.00 AM to 11.00 AM	XII	26.10.2023	XV	27.10.2023	11:00 AM to 2:00 PM
		XIV	26.10.2023	XVI	27.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 210280301 to 210280700

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
28.10.2023 & 29.10.2023	08.00 AM to 11.00 AM	XII	28.10.2023	XV	29.10.2023	11:00 AM to 2:00 PM
		XIV	28.10.2023	XVI	29.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 210280701 to 210281000

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
30.10.2023 & 31.10.2023	08.00 AM to 11.00 AM	XII	30.10.2023	XV	31.10.2023	11:00 AM to 2:00 PM
		XIV	30.10.2023	XVI	31.10.2023	2:15 PM to 5:15 PM

NALANDA OPEN UNIVERSITY
M.Sc. Physics, Part-II
PAPER–XIII
(Environmental Physics)
Annual Examination, 2023

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

Answer any Five Questions. All questions carry equal marks.

1. What do you mean by contact temperature ? Obtain an expression for it.
2. What do you mean by Baroclinic models ? What is Reynolds number Re ?
3. What are the elements of weather and climate ? What is common between General Circulation Model (GCM) and Numerical Weather Production (NWP) model ?
4. What do you mean by renewable energy ? Describe the various types of renewable energy. Point out the economic importance of the renewable energy.
5. Explain Raman, Rayleigh and Mie scatterings. Distinguish between Raman and Mie scattering. Explain Resonance Raman scattering.
6. Discuss the diffusion of guest particles in a medium.
7. Discuss the working principle of Gratzed Cell. Give the properties of these cell.
8. Discuss the power from nuclear fission and nuclear fusion. How will you optimize the reactor size based on fission ?
9. What is Urban Heat Island ? Explain the causes of Heat Island.
10. 'Bio-fuels are renewable energy sources', why ? Explain, in brief, the four generations of bio-fuels.

* * *

M.SC. PHYSICS, PART-II
Practical Counseling and Practical Examination Programme, 2023
Practical Programme for Paper-X of All Students
Venue : School of Computer Education & IT, Nalanda Open University, 12th Floor, Biscomaun Tower, Patna-800001

Enrollment No.	Date of Online Counselling	Time	Enrollment No.	Date of Exam	Time
All Old & New Students	01.11 2023	3.00 PM to 7.00 PM	180280001 to 200280460	02.11.2023	10.30 AM to 12.30 PM
			200280461 to 200281300	02.11.2023	1.00 PM to 3.00 PM
			210280001 to 210280220	02.11.2023	3.30 PM to 5.30 PM
			210280221 to 210280490	03.11.2023	10.30 AM to 12.30 PM
			210280491 to 210280740	03.11.2023	1.00 PM to 3.00 PM
			210280741 to 210281000	03.11.2023	3.30 PM to 5.30 PM

Practical Programme for Paper-XII, XIV, XV & XVI
Venue : Physics Lab, 1st Floor Biscomaun Tower, Patna-800001

For Enrollment No. 180280001 to 200280800

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
20.10.2023 & 21.10.2023	08.00 AM to 11.00 AM	XII	20.10.2023	XV	21.10.2023	11:00 AM to 2:00 PM
		XIV	20.10.2023	XVI	21.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 200280801 to 210280300

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
26.10.2023 & 27.10.2023	08.00 AM to 11.00 AM	XII	26.10.2023	XV	27.10.2023	11:00 AM to 2:00 PM
		XIV	26.10.2023	XVI	27.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 210280301 to 210280700

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
28.10.2023 & 29.10.2023	08.00 AM to 11.00 AM	XII	28.10.2023	XV	29.10.2023	11:00 AM to 2:00 PM
		XIV	28.10.2023	XVI	29.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 210280701 to 210281000

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
30.10.2023 & 31.10.2023	08.00 AM to 11.00 AM	XII	30.10.2023	XV	31.10.2023	11:00 AM to 2:00 PM
		XIV	30.10.2023	XVI	31.10.2023	2:15 PM to 5:15 PM

आवश्यक सूचना

आपको ज्ञात है कि आपके पाठ्यक्रम की परीक्षा दिनांक 30.09.2023 से संचालित है, जिसमें Paper-IX की परीक्षा दिनांक 30.09.2023 को प्रथम एवं द्वितीय पाली में आयोजित हुयी । आप में से कतिपय परीक्षार्थियों ने विश्वविद्यालय प्रशासन से लिखित रूप में (BPSC Admit Card के साथ) यह अनुरोध किया था कि उक्त दिवस को हीं BPSC की परीक्षा बिहार के विभिन्न जिलों में आयोजित है । लिखित रूप में प्राप्त अभ्यावेदन पर सहानुभूतिपूर्वक विचार करते हुये विश्वविद्यालय प्रशासन ने यह निर्णय लिया है कि, दिनांक 30.10.2023 की परीक्षा से वंचित वैसे परीक्षार्थी जिन्होंने अपना BPSC Admit विश्वविद्यालय में जमा कर दिया है, **वे दिनांक 18.10.2023 को अपराह्न 2.30 से 5.30 के बीच आयोजित की जाने वाली Paper-IX की परीक्षा में सम्मिलित हो सकते हैं ।** परीक्षा में सम्मिलित होने के लिए परीक्षार्थियों को **500/– रुपये** का बैंक ड्राफ्ट या SBI Collect का चालान या POS की रसीद के साथ उपस्थित होना होगा ।

NALANDA OPEN UNIVERSITY
M.Sc. Physics, Part-II
PAPER–XIV
(Photonics)
Annual Examination, 2023

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

Answer any Five Questions. All questions carry equal marks.

1. Describe band gap and fill factor of a p-n cell. How does fill factor depend on the normalized open circuit voltage ?
2. What do you mean by photonics ? How is it different from electronics ? Comment on the future of this branch of physics.
3. Describe a Light Emitting Diode (LED). What do you mean by injected holes and electrons ?
4. Describe an injection laser. What is double heterojunction injection laser ? Explain the term injection.
5. What is mode locking operation in laser ? Prove that the output of mode locked laser in n times the power of the same laser with modes uncoupled. Describe a technique developed for achieving mode locking. What is passive mode locking ?
6. What do you mean by beats ? Explain the concept of beats from acoustic to optical region.
7. Obtain a relation between divergence and waist size of the beam for a Gaussian distribution of wave energy.
8. Explain the difference between analog and digital communication. Why digital communication is more suitable with modern day requirement ?
9. Obtain expressions for the following terms related to an optical fibre : (i) Critical angle, (ii) Numerical aperture, (iii) Acceptance angle, (iv) Relative refractive index difference.
10. Starting from the Maxwell's field equations, derive the wave equations for E_z and H_z components for an e.m. wave travelling along positive z-direction.

* * *

M.SC. PHYSICS, PART-II

Practical Counseling and Practical Examination Programme, 2023

Practical Programme for Paper-X of All Students

Venue : School of Computer Education & IT, Nalanda Open University, 12th Floor, Biscomaun Tower, Patna-800001

Enrollment No.	Date of Online Counselling	Time	Enrollment No.	Date of Exam	Time
All Old & New Students	01.11 2023	3.00 PM to 7.00 PM	180280001 to 200280460	02.11.2023	10.30 AM to 12.30 PM
			200280461 to 200281300	02.11.2023	1.00 PM to 3.00 PM
			210280001 to 210280220	02.11.2023	3.30 PM to 5.30 PM
			210280221 to 210280490	03.11.2023	10.30 AM to 12.30 PM
			210280491 to 210280740	03.11.2023	1.00 PM to 3.00 PM
			210280741 to 210281000	03.11.2023	3.30 PM to 5.30 PM

Practical Programme for Paper-XII, XIV, XV & XVI

Venue : Physics Lab, 1st Floor Biscomaun Tower, Patna-800001

For Enrollment No. 180280001 to 200280800

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
20.10.2023 & 21.10.2023	08.00 AM to 11.00 AM	XII	20.10.2023	XV	21.10.2023	11:00 AM to 2:00 PM
		XIV	20.10.2023	XVI	21.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 200280801 to 210280300

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
26.10.2023 & 27.10.2023	08.00 AM to 11.00 AM	XII	26.10.2023	XV	27.10.2023	11:00 AM to 2:00 PM
		XIV	26.10.2023	XVI	27.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 210280301 to 210280700

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
28.10.2023 & 29.10.2023	08.00 AM to 11.00 AM	XII	28.10.2023	XV	29.10.2023	11:00 AM to 2:00 PM
		XIV	28.10.2023	XVI	29.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 210280701 to 210281000

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
30.10.2023 & 31.10.2023	08.00 AM to 11.00 AM	XII	30.10.2023	XV	31.10.2023	11:00 AM to 2:00 PM
		XIV	30.10.2023	XVI	31.10.2023	2:15 PM to 5:15 PM

आवश्यक सूचना

आपको ज्ञात है कि आपके पाठ्यक्रम की परीक्षा दिनांक 30.09.2023 से संचालित है, जिसमें Paper-IX की परीक्षा दिनांक 30.09.2023 को प्रथम एवं द्वितीय पाली में आयोजित हुयी । आप में से कतिपय परीक्षार्थियों ने विश्वविद्यालय प्रशासन से लिखित रूप में (BPSC Admit Card के साथ) यह अनुरोध किया था कि उक्त दिवस को हीं BPSC की परीक्षा बिहार के विभिन्न जिलों में आयोजित है । लिखित रूप में प्राप्त अभ्यावेदन पर सहानुभूतिपूर्वक विचार करते हुये विश्वविद्यालय प्रशासन ने यह निर्णय लिया है कि, दिनांक 30.09.2023 की परीक्षा से वंचित वैसे परीक्षार्थी जिन्होंने अपना BPSC Admit विश्वविद्यालय में जमा कर दिया है, **वे दिनांक 18.10.2023 को अपराह्न 2.30 से 5.30 के बीच आयोजित की जाने वाली Paper-IX की परीक्षा में सम्मिलित हो सकते हैं ।** परीक्षा में सम्मिलित होने के लिए परीक्षार्थियों को **500/– रुपये** का बैंक ड्राफ्ट या SBI Collect का चालान या POS की रसीद के साथ उपस्थित होना होगा ।

NALANDA OPEN UNIVERSITY
M.Sc. Physics, Part-II
PAPER–XV
(Advanced Condensed Matter Physics)
Annual Examination, 2023

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. What is Mossbaur Effect ? Give an account of the quantum theory of Mossbaur Effect.
3. Obtain dispersion relation for a one dimensional crystal with two types of atoms and discuss the nature of optical and acoustic modes.
4. What is skin effect ? Distinguish between normal and anomalous skin effect. Give the mathematical theory of anomalous skin effect. How do you get information about Fermi surface with the help of this effect ?
5. Derive equation of state for solids and obtain Gruneisen Law.
6. Give an account of Ginzberg-Landau theory of the phenomenology of the superconducting state. How do you get coherence light ?
7. Discuss the theory of interaction of electron with optical phonons in case of polar lattice.
8. What are cooper pairs ? Calculate the interaction energy of the electron pair.
9. Describe the inelastic scattering of neutrons. What are the two methods used for defining and measuring neutron energies ?
10. Discuss A. C. Josepson effect. Show that the current oscillates with frequency $\omega = \frac{2eV}{\hbar}$.

* * *

M.SC. PHYSICS, PART-II
Practical Counseling and Practical Examination Programme, 2023

Practical Programme for Paper-X of All Students

Venue : School of Computer Education & IT, Nalanda Open University, 12th Floor, Biscomaun Tower, Patna-800001

Enrollment No.	Date of Online Counselling	Time	Enrollment No.	Date of Exam	Time
All Old & New Students	01.11 2023	3.00 PM to 7.00 PM	180280001 to 200280460	02.11.2023	10.30 AM to 12.30 PM
			200280461 to 200281300	02.11.2023	1.00 PM to 3.00 PM
			210280001 to 210280220	02.11.2023	3.30 PM to 5.30 PM
			210280221 to 210280490	03.11.2023	10.30 AM to 12.30 PM
			210280491 to 210280740	03.11.2023	1.00 PM to 3.00 PM
			210280741 to 210281000	03.11.2023	3.30 PM to 5.30 PM

Practical Programme for Paper-XII, XIV, XV & XVI

Venue : Physics Lab, 1st Floor Biscomaun Tower, Patna-800001

For Enrollment No. 180280001 to 200280800

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
20.10.2023 & 21.10.2023	08.00 AM to 11.00 AM	XII	20.10.2023	XV	21.10.2023	11:00 AM to 2:00 PM
		XIV	20.10.2023	XVI	21.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 200280801 to 210280300

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
26.10.2023 & 27.10.2023	08.00 AM to 11.00 AM	XII	26.10.2023	XV	27.10.2023	11:00 AM to 2:00 PM
		XIV	26.10.2023	XVI	27.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 210280301 to 210280700

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
28.10.2023 & 29.10.2023	08.00 AM to 11.00 AM	XII	28.10.2023	XV	29.10.2023	11:00 AM to 2:00 PM
		XIV	28.10.2023	XVI	29.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 210280701 to 210281000

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
30.10.2023 & 31.10.2023	08.00 AM to 11.00 AM	XII	30.10.2023	XV	31.10.2023	11:00 AM to 2:00 PM
		XIV	30.10.2023	XVI	31.10.2023	2:15 PM to 5:15 PM

आवश्यक सूचना

आपको ज्ञात है कि आपके पाठ्यक्रम की परीक्षा दिनांक 30.09.2023 से संचालित है, जिसमें Paper-IX की परीक्षा दिनांक 30.09.2023 को प्रथम एवं द्वितीय पाली में आयोजित हुयी । आप में से कतिपय परीक्षार्थियों ने विश्वविद्यालय प्रशासन से लिखित रूप में (BPSC Admit Card के साथ) यह अनुरोध किया था कि उक्त दिवस को हीं BPSC की परीक्षा बिहार के विभिन्न जिलों में आयोजित है । लिखित रूप में प्राप्त अभ्यावेदन पर सहानुभूतिपूर्वक विचार करते हुये विश्वविद्यालय प्रशासन ने यह निर्णय लिया है कि, दिनांक 30.09.2023 की परीक्षा से वंचित वैसे परीक्षार्थी जिन्होंने अपना BPSC Admit विश्वविद्यालय में जमा कर दिया है, **वे दिनांक 18.10.2023 को अपराह्न 2.30 से 5.30 के बीच आयोजित की जाने वाली Paper-IX की परीक्षा में सम्मिलित हो सकते हैं ।** परीक्षा में सम्मिलित होने के लिए परीक्षार्थियों को **500/– रुपये** का बैंक ड्राफ्ट या SBI Collect का चालान या POS की रसीद के साथ उपस्थित होना होगा ।

NALANDA OPEN UNIVERSITY
M.Sc. Physics, Part-II
PAPER–XVI
(Advanced Electronics)
Annual Examination, 2023

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

Answer any Five Questions. All questions carry equal marks.

1. What is an Op-Amp ? What are the characteristics of an ideal Op-Amp ? Draw the block diagram of Op-Amp.
2. What is level translator circuit ? Why is it used with the cascaded differential amplifier ?
3. Define an oscillator. What is the principle of operation of an oscillator ? How are oscillators classified ?
4. What is logarithmic amplifier ? Show that in a logarithmic amplifier, output voltage changes as the logarithmic of the input voltage.
5. What is the difference between asynchronous and synchronous counters ? What is the advantage of an asynchronous counter ?
6. What is an adder circuit ? Explain the implementation of a half adder and a full adder circuits. Also, explain the difference between them.
7. What is a multiplexer ? Draw the logic circuit for four-to-one multiplexer. Write the Boolean equation and describe the truth-table.
8. What is encoder ? Discuss 4-bit priority encoder.
9. Describe basic hardware blocks of a computer.
10. Explain the architecture of 8086 microprocessor.

* * *

M.SC. PHYSICS, PART-II

Practical Counseling and Practical Examination Programme, 2023

Practical Programme for Paper-X of All Students

Venue : School of Computer Education & IT, Nalanda Open University, 12th Floor, Biscomaun Tower, Patna-800001

Enrollment No.	Date of Online Counselling	Time	Enrollment No.	Date of Exam	Time
All Old & New Students	01.11 2023	3.00 PM to 7.00 PM	180280001 to 200280460	02.11.2023	10.30 AM to 12.30 PM
			200280461 to 200281300	02.11.2023	1.00 PM to 3.00 PM
			210280001 to 210280220	02.11.2023	3.30 PM to 5.30 PM
			210280221 to 210280490	03.11.2023	10.30 AM to 12.30 PM
			210280491 to 210280740	03.11.2023	1.00 PM to 3.00 PM
			210280741 to 210281000	03.11.2023	3.30 PM to 5.30 PM

Practical Programme for Paper-XII, XIV, XV & XVI

Venue : Physics Lab, 1st Floor Biscomaun Tower, Patna-800001

For Enrollment No. 180280001 to 200280800

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
20.10.2023 & 21.10.2023	08.00 AM to 11.00 AM	XII	20.10.2023	XV	21.10.2023	11:00 AM to 2:00 PM
		XIV	20.10.2023	XVI	21.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 200280801 to 210280300

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
26.10.2023 & 27.10.2023	08.00 AM to 11.00 AM	XII	26.10.2023	XV	27.10.2023	11:00 AM to 2:00 PM
		XIV	26.10.2023	XVI	27.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 210280301 to 210280700

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
28.10.2023 & 29.10.2023	08.00 AM to 11.00 AM	XII	28.10.2023	XV	29.10.2023	11:00 AM to 2:00 PM
		XIV	28.10.2023	XVI	29.10.2023	2:15 PM to 5:15 PM

For Enrollment No. 210280701 to 210281000

Counselling Class Programme		*Practical Examination Programme*				
Date	*Time*	*Paper*	*Date*	*Paper*	*Date*	*Time*
30.10.2023 & 31.10.2023	08.00 AM to 11.00 AM	XII	30.10.2023	XV	31.10.2023	11:00 AM to 2:00 PM
		XIV	30.10.2023	XVI	31.10.2023	2:15 PM to 5:15 PM