Department of Physics
DDU Gorakhpur University, Gorakhpur

SYLLABUS FOR 3 Yr B.Sc. Degree

B.Sc. I   **Total Marks: 200**

(A)	Theory Papers	Max. Marks
	Paper I: Mechanics	45
	Paper II: Oscillations and Waves	45
	Paper III: Electricity and Magnetism	45
(B)	Practical Work	65

B.Sc. II   **Total Marks: 200**

(A)	Theory Papers	Max. Marks
	Paper I : Thermal Physics	45
	Paper II : Optics	45
	Paper III: Electronics	45
(B)	Practical Work	65

B.Sc. III   **Total Marks : 300**

(A)	Theory Papers	Max. Marks
	Paper I : Mathematical Physics and Classical Mechanics	50
	Paper II : Quantum Mechanics	50
	Paper III: Statistical Mechanics and Modern Physics	50
	Paper IV: Spectra of atoms and molecules	50
(B)	Practical Work	100

3-year B.Sc. Physics Syllabus

SYLLABUS

B.Sc. Part I
PHYSICS

Paper I : Mechanics

1. Newtonian Mechanics : Inertial frame of reference, Galilean transformation, Velocity and acceleration in rotating coordinate system, Coriolis force, effect of rotation of earth on g, Foucault Pendulum.

2. Special Theory of Relativity : Michelson-Morley experiment, Principle of simultaneity, postulates of special theory of relativity, Lorentz transformation, length contraction, time dilation, addition of velocities, Doppler effect, Aberration of light.

3. Relativistic Dynamics : Relativistic momentum, variation of mass with velocity, relativistic energy, mass energy equivalence, transformations of momentum and energy.

4. Central Forces : Inverse square law, potential and field due to (i) spherical shell and (ii) sphere, gravitational self energy, two body problem and reduced mass, Kepler's laws, motion of a satellite, geostationary satellite.

5. Dynamics of rigid bodies : Equation of motion of a rigid body, moment of inertia, products of moment of inertia, radius of gyration, theorems of parallel and perpendicular axes, moments of inertia of a ring, disc, rectangular beam, hollow and solid cylinders, spherical shell, solid and hollow spheres, moment of inertia of fly wheel, compound pendulum.

6. Elasticity: Elastic constants and their mutual relations, theory of bending of beams, torsion of cylinder.

7. Properties of Liquids : Stream line motion, Reynold number, Poiseuille's equation, Stoke's law and terminal velocity, Surface tension and surface energy, molecular interpretation of surface tension, Pressure over curved surfaces, capillarity, Jager's method.

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Paper II : Oscillations and Waves

1. Free Oscillations : Concept of potential well, small oscillation approximation, differential equation of SHM and its solution, examples of mechanical and electrical systems, Addition of SHM, Lissajous figures with frequency ratio 1:1 and 2:1.

2. Damped Harmonic Oscillation : Mechanical and electrical systems, logarithmic decrement, relaxation time, LCR circuit, Moving coil galvanometer.

3. Forced Oscillations : Forced Oscillation of mechanical and electrical systems, transient and steady state behaviour, sharpness of resonance, quality factor (Q), energy dissipation, Mechanical and electrical impedances, LCR series and parallel resonance.

4. Oscillation of Coupled Systems : Normal modes of vibration of mechanical and electrical systems with two degrees of freedom, Vibrations of string and rectangular membrane, Forced oscillation of coupled system.

5. Wave Motion : Wave motion and its parameters, stationary waves, Wave velocity and group velocity.

6. Ultrasonics : Production, properties and uses of ultrasonic waves, Acoustic grating.

7. Fourier Analysis : Fourier theorem, evaluation of Fourier coefficients, analysis of (i) square wave, (ii) sawtooth wave, (iii) half and full wave rectifiers output.

8. Acoustics : The acoustics of Halls, Reverberation time, Sabine's formula.

Paper III : Electricity and Magnetism

1. Electrostatics : Field due to a charge distribution, Multipole expansion, Electric field due to uniform distribution of line charge, sheet charge and spherical charge, Gauss' law and its application for finding E for symmetric charge distribution. Electrostatic pressure, electrostatic field energy, force on a point charge in front of an infinite conducting sheet (method of images).

2. Electric field inside matter : Dielectrics, parallel plate capacitor with a dielectric, polarization; Concept of electronic, ionic and orientational polarization, polarizability, polarization vector P, displacement vector D, Electric susceptibility, Clausius-Mossotti equation.

3. Magnetostatics : Lorentz force, Definition of B, Biot-Savart's law, Ampere's law, Magnetic field due to a straight wire, circular coil, Helmholtz's coils, solenoid, toroid, Lorentz force; Magnetisation, magnetisation current, Magnetic permeability and susceptibility. Electromagnetic induction, Induced electric field, Faraday's law; integral and differential forms, Series and parallel combination of inductances, mutual induction, coupled circuits and ideal transformer.

4. Electromagnetic waves : Displacement current, Maxwell's equations, E.M. field energy density, EM waves in vacuum, Poynting vector.

5. A.C. Bridges : J operator, Anderson, Schering, Robinson and Wein's bridge.

6. Network analysis : T and Π networks and their equivalence, Thevenin's, Norton's and Maximum Power Transfer Theorems, Low and high pass filters.

3-year B.Sc. Physics Syllabus

PRACTICALS
List of Experiments

Students are required to do any eight experiments from each group.

Group A : General Physics

1. Moment of inertia of fly wheel.
2. Compound pendulum; Acceleration due to gravity and radius of gyration.
3. Modulus of rigidity by Maxwell's needle.
4. Young's modulus of rectangular bar by cathetometer or optical lever method.
5. Sextant
6. Elastic constants by Searle's apparatus.
7. Surface tension of water by Jaeger's method.
8. Coefficient of viscosity of water by Poiseuille's method.
9. Thermal conductivity of rubber.
10. Spectrometer
11. Frequency of electrically maintained tuning fork.
12. Frequency of A.C. mains using sonometer.

Group B : Electricity and Electronics

1. Verification of Child's law.
2. Characteristics of triode valve and determination of its parameters.
3. Characteristics of Tetrode/ Pentode.
4. Temperature co-efficient for platinum resistance thermometer using Carey Foster's bridge (M.P. of wax)
5. Thermocouple calibration and melting point of wax.
6. Current sensitivity of a dead beat moving coil galvanometer.
7. Charge sensitivity of a ballistic galvanometer by capacity discharge method.
8. Characteristics of P-N junction and Zener diode.
9. Reduction factor of Helmholtz galvanometer.
10. Calibration of energy meter using ammeter and voltmeter.
11. Potentiometer: Calibration of voltmeter and ammeter,
12. Determination of low resistance by potentiometer.

3-year B.Sc. Physics Syllabus

Practical Examination

There will be one practical examination. Duration of the examination shall be four hours. Candidates will be required to perform two experiments, one from group A and other from group B. The distribution of marks will be as follows :

	Student appearing as	
	Regular student	Ex - student
Experiment 1	20	20
Experiment 2	20	20
Viva - Voce	15	25
Record	10	00
Total	65	65

3-year B.Sc. Physics Syllabus

SYLLABUS

B.Sc. Part II

PHYSICS

Paper I: Thermal Physics

1. Kinetic Theory of Gases : Maxwell's law of distribution of molecular speeds, Law of equipartition of energy, specific heat of ideal gas; Mean free path, Transport phenomena: conduction, viscosity and diffusion.

2. Equation of state : Andrew's experiment and discussion of results, Specific heat of saturated vapour, Van der Waal's equation of state, Boyle's temperature, Critical constants.

3. Thermodynamics and Entropy : Reversible and irreversible processes, Carnot's theorem, Absolute scale of temperature; second law of thermodynamics; Entropy and its physical significance, Entropy of simple reversible and irreversible processes.

4. Maxwell Thermodynamical Relations : Maxwell thermodynamical relations and their applications to, Clausius-Calpeyron latent heat equations, TdS equations, Joule-Thomson effect, internal energy equation, Specific heat equations, Magneto-caloric effect, Reversible electrolytic cell.

5. Cryogenics : Principle of refrigeration, Porus-plug experiment, Principle of Regenerative cooling, Liquefaction of air, hydrogen and helium, Solidification of helium, Adiabatic demagnetisation of paramagnetic salt.

6. Conduction : Mathematical analysis of rectilinear flow of heat, acceretion of ice at the surface of ponds, Conductivity of bad conductors.

7. Radiation : Black body radiation, Kirchoff's law and its application, Pressure and energy density of diffuse radiation, Stefan-Boltzmann's law, Spectral distribution, Solar constant and temperature of sun, Wien's displacement law, Rayleigh-Jean's law, Planck's hypothesis and its application to black body radiation.

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Paper II : Optics

1. Fermat's principle, Principle of extremum path, the aplanatic points of a sphere and other applications.

2. General theory of image formation: Cardinal points of an optical system; general relationships, thick lens and lens combinations, telephoto lenses.

3. Aberration in images: Chromatic aberrations; achromatic combination of lenses in contact and separated lenses, Monochromatic aberration and their reduction, aspherical mirrors and Schmidt corrector plates, oil immersion objectives.

4. Optical instruments: Entrance and exit pupils, need for a multiple lens eyepiece, common type of eyepieces.

5. Interference of light: The principle of superposition; two-slit interference, coherence requirements for the sources, Fresnel biprism localised fringes in thin films, transition from fringes of equal thickness to those of equal inclination. Newton's ring, Michelson interferometer; its uses for determination of wavelength, Wavelength difference and standardisation of meter. Intensity distribution in multiple beam. Interference: Tolansky fringes, Fabry - Perot interferometer and etalon.

6. Fresnel diffraction: Half-period zones, zone plate, circular apertures and obstacles, straight edge, explanation of rectilinear propagation.

7. Fraunhofer diffraction: Diffraction at a slit, circular aperture and a circular disc. Resolution; Rayleigh criterion, Resolving power of human eye, telescope, microscope, grating and prism.

8. Diffraction grating: Diffraction due to two slits, Diffraction at N parallel slits; plane diffraction grating, concave grating.

9. Polarisation: Linearly polarised light, its production and detection, Brewster's law, law of Malus, Double refraction, Nicol prism, double image prism, Huygen's theory of double refraction in uniaxial crystals, circularly and elliptically polarised light; its production and detection, optical rotation, polarimeters.

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Paper III : Electronics

1. Basic Semiconductor Physics: Basic features of energy band theory of solids; energy band pictures of semiconductors, electron-hole densities, electrical conductivity of intrinsic and extrinsic semiconductors, minority and majority charge carriers, drift and diffusion currents, concept of continuity equation for minority charge carrier.

2. P-N Junction: Built in potential, width and capacitance of depletion region; Current flow in biased p-n junction, Varactor diode; Zener breakdown mechanism, Zener diode and its characteristics, Photo diode and Solar cell.

3. Transistors: n-p-n and p-n-p transistors, current flow in transistors, potential divider biasing of transistors, characteristics in all three configurations; α, β and hybrid parameters and their relationship, FET and MOSFET, Principle of operation, characteristics and parameters.

4. Amplifiers and Oscillators: Small signal hybrid equivalent circuit of BJT, RC coupled CE amplifiers, frequency and phase response. Amplifier circuit using FET, Oscillator as positive feed back amplifier, Barkhausen criteria of sustained oscillation, LC tuned collector oscillator, Hartley and Colpitts transistor oscillator (derivation of formule not needed).

5. Modulation and Demodulation: Definition of three kinds of modulations, expression for AM, FM and PM waves, Vander-Brijl modulator, Linear diode detector.

6. Radio Transmitter and Receiver: AM transmitter (block diagram and function of different blocks); Principle of simple and super heterodyne radio receiver, Qualities of radio receiver (selectivity, sensitivity, fidelity), Standard broadcast radio receiver, Image frequency, AVC and tuning indicator.

7. Digital Electronics: Binary system, Boolean algebra, De Morgan's theorem. OR, AND, NOT, NAND, NOR and XOR gates. Universality of NOR and NAND gates.

3-year B.Sc. Physics Syllabus

PRACTICALS

List of Experiments

Candidates are required to do any eight experiments from each group.

GROUP A: Optics

1. Focal length of thin lenses and their combination by Nodal slide.
2. Wavelength of light by grating using spectrometer.
3. Wavelength of light using bi-prism.
4. Wavelength of light by Newton's rings method.
5. Breadth of single slit by diffraction of light using spectrometer.
6. Resolving power of plane transmission grating.
7. Resolving power of telescope.
8. Specific rotation of cane sugar using polarimeter.
9. Refractive index using Brewster's law.
10. Characteristics of photocell or photodiode.
11. Wavelength of light by Young's double slit experiment (using spectrometer)
12. Thickness of mica sheet by biprism.

GROUP B: Electricity and Electronics

1. Determination of high resistance by method of leakage.
2. Measurement of inductance of a coil using Anderson's bridge.
3. Measurement of capacity and power factor of a capacitor using Schering's Bridge.
4. Study the behaviour of LCR circuit.
5. Measurement of magnetic field of an electromagnet at different current using search coil.
6. H and angle of dip by earth inductor.
7. Characteristics curves of Beam power tube and determination of tube parameters.
8. Characteristics of p-n-p transistor in common-emitter configuraton and determination of current gain β.
9. Characteristics of p-n-p transistor in common-base configuration and determination of current transfer ratio.
10. Determination of electronic charge by Millikan's oil drop method.
11. Measurement of dc and ac voltages and frequency using cathod ray oscilloscope.
12. Verification of truth table of OR, AND and NOT gates.

3-year B.Sc. Physics Syllabus

PRACTICAL EXAMINATION

There will be one practical examination. Duration of examination shall be FOUR hours. Candidates will be required to perform two experiments one from group A and other from group B. The distribution of marks shall be as follows:

	Student appearing as	
	Regular student	Ex - student
Experiment 1	20	20
Experiment 2	20	20
Viva - voce	15	25
Record	10	-
Total	65	65

3-year B.Sc. Physics Syllabus

SYLLABUS

B.Sc. Part III

PHYSICS

Paper I: Mathematical Physics and Classical Mechanics

Mathematical Physics

1. Orthogonal transformations, transformation matrix, proper and improper rotations, Euler angles (notation of Goldstein)

2. Curvilinear coordinates: tangent basis vectors, scale factors, spherical, polar and cylindrical coordinate systems, gradient of a scalar, Divergence and curl of a vector, Laplace equation in spherical, polar and cylindrical coordinate systems and its solution.

3. Special Functions: Legendre, Hermite, Laguerre differential equations; their generating functions, recurrence relations, Rodrigue's formula and orthogonality properties. Associated Legendre polynomial.

Classical Mechanics

1. Mechanics of a system of particles: Conservation Theorems, Constraints, Generalised coordinates, D' Alembert's principle, Lagrange's Equation, Generalised Momentum, Principle of least action, cyclic coordinates, Lagrangian for a free particle

2. Two Body Problem: Reduction to one-body problem, centre of mass, Kepler's problem

3. Canonical Formulation: Hamilton's equations, canonical transformations, Poisson's bracket, Angular momentum Poisson's brackets, Hamilton Principal function, Hamilton-Jacobi equation, Harmonic Oscillator Problem, Hamilton characteristic Function, separation of variables, Central Force problem.

4. Motion of rigid bodies: Angular Momentum, Inertia Tensor, Torque free motion of a rigid body, Symmetrical top, Precession.

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Paper II: Quantum Mechanics

1. Matter and Radiation; Photoelectric effect, Compton effect. de Broglie's hypothesis; Davison-Germer experiment, wave packet. Uncertainity principle:, Complementarity principle.
   Angular momentum and magnetic moment of an electron due to orbital motion: Bohr magneton, electron spin, Stern-Gerlach experiment.

2. Schrödinger equation: time independent and time dependent formulations. Postulatory approach to wave mechanics, physical interpretation of $\Box$, conditions to be satisfied by the Schrödinger equation as an operator equation, observables and measurements, eigen values and eigen functions. Classical limit and Correspondence principle. Normalization and Orthogonality of wave function, degeneracy and parity of wave function. Probability current density and its interpretation, expectation value of an observable, Ehrenfest's theorem.

3. Operators: linear operators, product of two operators, commuting and non commuting operator, simultaneous eigen functions, Hermitian operators and their properties.

4. Simple one dimentional problems: Particle in a box, concept of potential well; Wave function and energies for ground and excited states. Step potential, penetration through rectangular barrier, transmission coefficients, quantum mechanical tunneling.

5. One dimensional harmonic oscillator, eigen value and eigen functions of ground and excited states, zero point energy.

6. Hydrogen atom : Schrödinger equation and its solution, angular momentum operators and their commutative relation, its eigen values of L2 and Lz and their degeneracy. Rigid rotator.

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Paper III : Statistical Mechanics and Modern Physics

Statistical Mechanics:

1. Statistical basis of thermodynamics, principle of equal a priori probability, probability distribution, average properties. Phase space representation, the mu and gamma space, density of states, ergodic surface, Liouville's theorem, Idea of statistical equilibrium, Microcanonical, Canonical and Grand-Canonical ensambles.

2. Thermodynamic equilibrium, Probability and entropy, Boltzman entropy relation, statistical interpretation of the second law of thermodynamics, Maxwell-Boltzman distribution, Maxwell distribution of speeds in an ideal gas.

3. Quantum statistics; Cell size, as nature's constant, indistinguishability and symmetry considerations. Fermi-Dirac and Bose-Einstein Distributions, Planck's law, Saha's theory of Thermal Ionisation, Richardson-Dushman Equation.

Modern Physics:

1. Magnetism, Diamagnetism, Paramagnetism due to free ions and conduction electrons; Curie's law, ferromagnetism, domains, hysteresis loops.

2. Lasers and Masers : Stimulated and Spontaneous emission of radiation, Einstein's coefficients, population inversion by pumping and cavity, Working principle of three level laser, Ruby and Helium-Neon laser, elementary idea of masers.

3. Nucleus and Nuclear models: Rutherford-Particle scattering and concept of nucleus, Static properties (size, spin, magnetic moment, parity and quadruple moment) of nucleus. Liquid drop model, Semiempirical mass and binding energy formula and Bohr-Wheeler theory of nuclear fission; Nuclear fusion, Bethe's theory of nuclear energy; Shell model, Explanation of magic numbers.

4. Nuclear instruments : Cyclotron, Synchrotron, Betatron and Geiger-Muller counter.

5. Elementary particles : Classification, Elementary ideas of strong, electromagnetic, weak and gravitational interactions, Basic idea of Quark model.

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Paper IV : Spectra of atoms and molecules

1. Atomic model: Summerfield model and fine structure of Hα line, Vector atom model, Paulie's exclusion principle and electronic configuration of atom.

2. Atomic Spectra of one valence electron system: Optical spectra of Alkali atoms, electron spin and fine structure, spin orbit interaction; Zeeman and Paschen-Back effects, Stark effect.

3. Atomic spectra of two valence electrons system: Spectra of helium and alkali earth elements, different types of coupling schemes and interaction energies, Zeeman effect, Paschen-Back effect, Intensity of spectral lines.

4. Molecular spectra of diatomic molecules: Quantum mechanical interpretation of near and far infra-red spectra of diatomic molecules, Rotation, vibration and rotation-vibration spectra, P, Q, R branches; Classification of moleculer electronic status of a diatomic molecules, symmetry properties of electronic eigen functions, coupling of rotation and electronic motion. Electronic band systems, sequences and progressions, Franck-Condon principle

5. Fluorescence and Raman spectra.

PRACTICALS

Candidates are required to do any eight experiments from each group listed below.

List of Experiments

GROUP A : Optics

1. To determine the wavelength and separation between D1 and D2 line with the help of Michelson Interferometer.
2. To study the characteristics of photocell and to determine Planck's constant using photocell.
3. To determine the Young's modulus by Cornue's Fringes or Newton's rngs.
4. To determine the velocity of ultrasonic wave by diffraction method.
5. To determine the refractive index of a liquid by total internal reflection method.
6. To determine the wavelength of sodium light by interference due to three/ four slits.
7. To determine the wavelength of sodium light by interference due to four slits.
8. To determine the wavelength of a given diode laser by interference method (Young's double slit).
9. To determine the radius of curvature of a cylindrical and plano convex lens by Interference method.
10. To determine the diameter of a thin wire by interference in a wedge shape air film.
11. To determine the dimensions (open and closed portion) of a double slit from the Fraunhofer diffraction pattern produced using a monochromatic source.
12. To determine the dimensions of a rectangular aperture by its Fraunhofer diffraction pattern.

GROUP B: Electricity and Electronics

1. To determine the specific charge (e/m) of the electron by kenotron/helical method.
2. Verification of Richardson-Dushman equation and evaluation of work function of cathode material.
3. To draw the charecteristics and to determine the parameters of a field effect transistor.
4. To study the charecteristics of low/high pass filter.
5. To determine the magnetic susceptibility of a liquid by Quincke's Capillary rise method.
6. To study the characteristics of an audio frequency transistor amplifier.
7. To study the characteristics of R-C network.
8. To study the characteristics of interstage audio transformer.
9. To study the characteristics of a rectifier circuit.
10. To study the characteristics of of an unregulated power supply.
11. To study Zener diode voltage ragulating characteristics.
12. To study the universality of NOR and NAND gates.

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PRACTICAL EXAMINATION

There will be one practical examination. Duration of examination shall be six hours. Candidates will have to perform two experiments: one from Group A and other from Group B. The distribution of marks shall be as below:

	Student appearing as	
	Regular student	Ex - student
Experiment	50	50
Viva	30	50
Record	20	00
Total	100	100

3-year B.Sc. Physics Syllabus