SYLLABUS FOR B.Sc. (Hons) COURSE
SUBJECT: PHYSICS

PATNA UNIVERSITY, PATNA

PATNA UNIVERSITY

SYLLABUS

B.Sc. (HONOURS) COURSE

SUBJECT: PHYSICS

B.Sc (HONS) in PHYSICS

Course Structure

The B.Sc. Physics (Hons) course will be of three (03) year duration spread over as Part – I, Part – II & Part - III. It is mandatory to study Mathematics as one of the subsidiary subjects. There shall be theory as well as practical paper in the course in each part. Total no. of theory papers are seven (07) and total no. of practical papers four (04). The final examination will be conducted by the Examination Board, Patna University at the end of every year. Students will be allowed to appear in the year end examination based on regularity in attendance (75%) and performance in the sent up examination conducted by the college. A candidate has to pass in the theory and practical paper separately in each part. The details of distribution of papers, full marks, pass marks and duration of examination is mentioned in the table below.

Title	Part	No of Papers	Paper No.	Full Mark	Pass Mark*	Examination Duration (HOUR)
B.Sc. PHYSICS (Hons)	**I**	Theory Paper	I	75		3
			II	75	67	
		Two (02)				
		Practical		50	23	4
		One (01)				
	II	Theory Paper	III	75		3
			IV	75	67	
		Two (02)				
		Practical		50	23	4
		One (01)				
	III	Theory Paper	V	100		3
			VI	100	135	3
		Three (03)	VII	100		3
		Practical	VIIIA	50	23	4
		Two (02)				

VIIIB 50 23 4

***In order to pass with Hons, 45% marks to be secured in aggregate of Hons subject.**

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PATNA UNIVERSITY

SYLLABUS

B.Sc. (HONOURS) COURSE

SUBJECT: PHYSICS (Subsidiary)

Course Structure

The B.Sc. (Hons) students opting for **PHYSICS (Subsidiary)** course will study Physics in Part – I and Part – II class. There shall be one theory and one practical paper in the course in each part. The final examination will be conducted by the Examination Board, Patna University at the end of every year. Students will be allowed to appear in the year end examination based on regularity in attendance (75%) and performance in the sent up examination conducted by the college. A candidate has to pass in the theory and practical paper separately in each part. The details of distribution of papers, full marks, pass marks and duration of examination is mentioned in the table below.

Title	Part	No of Papers	Paper No.	Full Mark	Pass Mark	Examination Duration (HOUR)
B.Sc. PHYSICS (Subsidiary)	**I**	Theory Paper One (01)	I	75	23	3
		Practical One (01)		25	10	3
	II	Theory Paper One (01)	II	75	23	3
		Practical One (01)		25	10	3

B.Sc. PHYSICS (Hons)

PART-I

The course shall consist of two theory papers of 75 marks each-Paper I (theory) and paper II (theory). The pass marks in the two theory papers taken together will be 67 and the examination in each paper will be of three hours duration. There will be one practical paper of 50 marks in which the pass marks will be 23. The examination will be of **4** hours duration in this paper.

The detailed syllabus is stated as follows.

B.Sc. PHYSICS (Hons) Part – I

Physics (Hons) Paper-I (theory)

[Full Marks: 75] [Time: 3 Hour]

(12 questions to be set, 6 to be answered,
at least one from Group-A, three from group- B & one from group-C)

Group-A (Special theory of Relativity - 3 questions)

Galilean transformation, inertial frame of reference, Michelson-Morley experiment, Lorentz-Fitzgerald contraction, Einstein's postulates, Lorentz transformation & its consequences, length contraction and time dilation, addition of velocities, dragging of light by moving medium, Relativistic Doppler effect for propagation of light waves, Aberration of light, variation of mass with velocity, mass-energy relation.

Group-B (Mechanics - 6 questions)

Inertial & non-inertial frames of reference, Centrifugal & Coriolis and their applications, Generalised coordinates, Constraints (holonomic & non-holonomic), D'Alembert's principle & Lagrange's equations of motion, Hamiltonian's equations of motion & their simple applications.

Motion in a central field, Kepler's laws, two paritcle motion in a central field , Collisions, centre of mass & laboratory frames, Rutherford scattering, differential scattering cross-section.

Group- C ; (Waves & vibrations- 3 questions)

Differential equation of a wave, Equation of progressive waves, stationary waves, Compression waves in fluids & in extended solids.

Free, damped and forced oscillations in one dimension, Fourier series and its applications to rectangular and saw-toothed waves, analysis of vibration of plucked string, vibration of rectangular membrane.

B.Sc. PHYSICS (Hons) Part – I

Physics (Hons): Paper II (Theory)

(Full Marks: 75] [Time : 3 hour]

(12 questions to be set, 6 to be answered, 2 from Group A and 4 from Group B)

Group –A (Heat - 4 questions)

Derivation of Maxwell's laws of distribution of velocities and its experimental verification, equipartition of energy, mean free path.

Transport phenomena: Viscosity. Conduction & diffusion, Brownian motion- Langevin and Einstein's theories and experimental determination of Avogadro's no., Rectilinear flow of heat in a metal rod, relation between thermal & electrical conductivities, Vander waal's equation of state.

Group –B (Thermodynamics- 8 questions)

Zeroeth law of thermodynamics, definition of temperature, first, second laws and third law of thermodynamics, Carnot's engine & Carnot's theorem, absolute scale of temperature, Claussius-Clayperon inequality, entropy, entropy changes in reversible & irreversible processes, Enthalpy, Heimholtz & Gibbs function, Gibbs-Helmholtz equations and its applications to simple physical problems.

Thermodynamical description of phase transition, chemical potential, Latent heat of transition, Clapeyron equation.

Joule-Thompson effect, Liquefaction of gases with special reference to hydrogen and helium.

Black body radiation: Kirchoff's laws, Wien's law, Planck's law and its experimental verification, Einstein's & Debye's theories of specific heats of solids.

B.Sc. PHYSICS (Hons) Part – I

Practical Paper

Full Marks: 50

Pass marks: 23 **Time : 4 Hour**

The course shall include the following experiments :

1. g by Kater's pendulum
2. Young's modulus by flexure of beam
3. Elastic constants by Searle's method
4. Rigidity modulus by (i) Bartan's apparatus (ii) dynamical method
5. Surface tension by Capillary rise
6. Viscosity of water by Capillary flow method
7. Viscosity by Stoke's method
8. Laws of transverse vibration by Sonometer
9. Frequency of tuning fork by Melde's method
10. Velocity of ultrasonic waves in a liquid
11. Specific heat of liquid by cooling method
12. Thermal conductivity of copper
13. Thermal conductivity of ebonite by Lee's disc method
14. 'J' by Joule's calorimeter.

B.Sc. Part – I

PHYSICS (Subsidiary) Paper -I(theory)

[Full Marks: 75] [Time: 3 Hours]

[12 questions to be set, 6 to be answered,
at least two from Group-A, 1 from Group-B, and at least 2 from Group-C.]

Group- A (Mechanics, Relativity: 5 questions)

Galilean transformation, Inertial frame of reference, Michelson-Morley experiment, Lorentz-Fitzgerald contraction, Einstein's postulates, Lorentz transformations and their consequences, Length contraction and time dilation, addition of velocities, variation of mass with velocity, mass-energy relation.

Inertial and non-inertial frames of reference, Coriolis and centrifugal forces and their simple applications, motion in central field, Kepler's laws.

Group- B (Waves and Acoustics : 2 questions)

Differential equation of a wave, equation of progressive waves, stationary waves, free, damped and forced oscillations, Fourier analysis, Vibrations of strings, Ultrasonics.

Group- C (Thermal physics : 5 questions)

Maxwell's law of distribution of velocities and its experimental verification, degrees of freedom and equipartition of energy, mean free path and its experimental determination, perfect gas equations and Vander Waal's equation of state, laws of thermodynamics, absolute scale of temperature, Carnot's theorem and Carnot's cycle, entropy and its calculation in simple cases, Thermodynamic relations and their application to simple physical cases, Clausius-Clayperon equation, Joule-Thomson effect, liquefaction of gases with special reference to Helium,

Kirchhoff's law and Black Body radiation, Stefan- Boltzmann law, its deduction and experimental verification.

B.Sc. Part – I

PHYSICS (Subsidiary) Practical Paper I

[Full Marks: 25, Pass Mark: 10] [Time: 3 Hour]

The course shall include the following experiments:

1. Determination of ‘g’ by bar pendulum
2. Determination of Young’s modulus by flexure of beam
3. Rigidity modulus by (1) statical method (2) dynamical method
4. Elastic constants by Searle’s method
5. Surface tension by capilliary rise
6. Viscosity of liquid by capillary flow method
7. Viscosity by Stoke’s method.
8. Thermal conductivity by Lee’s disc method
9. J by Joule’s Calorimeter
10. Frequency of tuning fork by Meldie’s experiment
11. Specific Heat of liquid by method of cooling.

B.Sc. PHYSICS (HONS) COURSE

Part II

The course shall consist of two theory papers of 75 marks each, paper III (theory) & paper IV (theory). The pass marks in the two papers taken together will be 67 and the examination in each paper will be of three hours duration. There will be also one practical paper of 50 marks. The pass marks will be 23. The examination will be of 4 hours in this paper.

The following will be the detailed course:

B.Sc. PHYSICS (Hons) Part –II

Physics (Hons) Paper - III (theory)

[Full Marks: 75] [Time: 3 Hour]

(12 questions to be asked, 6 to be answered, 4 from Group-A and 2 from Group-B)

GROUP- A (OPTICS- 8 questions)

Interference phenomena by division of amplitude and division of wavefront, Michelson Interferometer, Fabry-Perot interferometer, Diffraction—Fresnel's & Fraunhoffer's diffraction, Half period zones, zone plate, Fresnel's diffraction at straight edge and single narrow wire, Fraunhoffer diffraction by slits and circular aperture, Plane diffraction grating, Concave grating and its mountings, resolving power of prism, grating, telescope and microscope. Cornu's spiral and its use in diffraction problems.

Production of plane, circularly and elliptically polarized light, Nicol prism, Quarter wave plate, Babinet's compensator, and analysis of ellipticslly polarized light. Rotatory polarization and polarimeter.

GROUP- B (Electromagnetic theory- 4 questions)

Electromagnetic momentum, Maxwell's stress tensor, pressure of radiation, plane electromagnetic wave, Reflection, refraction and total internal reflection of polarized light, Double refraction of crystals, theory of dispersion. Optical properties of metals and dispersion in metals. Scattering by free and bound charges.

B.Sc. PHYSICS (Hons) Part – II

Physics (Hons): Paper - IV (theory)

[Full Marks: 75] [Time: 3 Hour]

(12 questions to be asked, 6 to be answered, 1 from Group-A, at least 2 from each of Groups – B & C)

Group-A (Electricity & Magnetism—2 questions)

Boundary conditions at the surface of separation of two dielectrics and refraction of lines of force. Scalar potential in electrostatics. The potential of a system of point charges, Dipole and quadrupole moments, energy stored in an electrostatic field, Poisson and Laplace's equations in Cartesian, polar & cylindrical coordinates and their solutions for simple geometries, Dielectric polarization. Relation between D, E, and P.

Properties of ferromagnetic materials, Hysteresis curve, methods for B-H curve, loss per cycle of magnetization. Energy stored in magnetic field. Langevin and weiss theories of dia-, para-,and ferromagnetism.

Group-B (Current electricity --- 5 questions)

Thermodynamic treatment of Seebeck, Peltier, and Thomson effects and their applications, Self-inductance & mutual inductance, Growth and decay of current in circuits containing L, C, and R. Simple applications of these circuits. A.C. circuits, Use of vectors, and complex numbers in A.C. circuit theory. Series and parallel resonant circuits, Power in A.C. circuits, A.C. Bridges-(i) De Sauty's bridge (ii) Anderson bridge (iii) Carey-Foster bridge.

Group—C (Modern Physics—5 questions)

Measurement of charge of an electron by Millikan's method, Measurement of specific charge of an electron by Thomson's method, natural radioactivity, Rutherford- Soddy's theory of radioactive decay, Geiger-Muller counter. Discovery of neutron, Isotopes, Artificial radioactivity, Elementary ideas about nucleus and its structure, Nuclear fission, reactors, Aston's mass spectrograph. Cyclotron, Betatron.

Bohr's theory and Bohr-Sommerfeld theory of hydrogen atom, Stern-Gerlach experiment.

Photoelelectric emission, Einstein's photoelectric equation, photo-emissive, photoconductive and photovoltaic cells. Matter waves, deBroglie relation, Davisson-Germer experiment, Uncertainty relation, X-rays, Mosley law, Compton effect, Bragg's law and determination of x-ray wavelength, Simple ideas of elementary particles and their classification.

B.Sc. PHYSICS (Hons) Part –II

Practical Paper

Full Marks: 50

Pass marks: 23 **Time : 4 Hour**

The course shall include the following experiments:

1. Refractive index by spectrometer
2. Calibration of prism spectrometer
3. Determination of Cauchy's constants
4. Wavelength by plane diffraction grating and identification of gas in a dischargr tube
5. Wavelength by Newton's rings
6. Resolving power of a telescope
7. Study of series resonant circuit
8. Study of parallel resonant circuit
9. Characteristics of p-n junction and Zener diodes
10. Characteristics of a bipolar transistor
11. Measurement of voltage & frequency by Cathode ray Oscilloscope.

B.Sc. (Hons) Part –II

Physics Subsidiary Paper II (Theory)

Full Marks: 75

Pass marks: 23 **Time: 3 Hour**

(12 questions to be set, 6 to be answered, one from Group-A, 3 from Group-B, and 2 from Group-C)

GROUP—A (Electrostatics, Magnetism- 2(1+1) questions)

Boundary conditions at the surface of separation of two dielectrics, Electric doublets, Dipole moment, Dielectric polarization.

Langevin's and Weiss theory of dia, para, and ferromagnetism, Curie Law.

GROUP---B (Current electricity, Modern Physics-6 questions) Thermodynamic treatment of Seebeck, Peltier and Thomson effects and their applications, Growth and decay of currents in electric circuit, Oscillatory discharge of a condenser.

A.C. and D.C. circuits, use of vectors and complex quantities in A.C. circuit theory (L-R, R-C, and L-R-C circuits), De Sauty bridge, Carey Foster's bridge.

Measurement of charge by Millikan's method and specific charge of an electron by Thomson method, Natural radioactivity, Rutherford-Soddy's theory of radioactive decay, Geiger-Muller counter, Discovery of neutron, Isotopes, Artificial radioactivity, Elementary ideas of about nuclei and its structure, Nuclear fission reactors, Aston's mass spectrograph.

Photo-electric emission, Einstein's photo-electric equation, photo-emission, Photo-conductive and Photo-Voltaic cells.

Compton Effect, Bragg's law and determination of X-ray wavelength.

Bipolar Transistor and its use in amplifier and oscillator.

GROUP—C (Optics—4 questions)

Newton's ring, Michelson interferometer, Fresnel's diffraction at straight edge, Fraunhoffer's diffraction: single slit, double slit, plane transmission grating. Resolving power of microscope and telescope, Polarisation: production of plane, circularly and elliptically polarized lights, Nicol prism, Quarter Wave plate, Half shade polarimeter, Babinet compensator.

Theory of hydrogen spectra, Principle of laser action, Ruby laser.

Maxwell's equations, equation of plane electromagnetic waves and its solution.

B.Sc. Part –II

PHYSICS (Subsidiary) Practical Paper II

[Full Marks: 25, Pass Mark: 10] [Time: 3 Hour]

The course shall include the following experiments:

1. Refracting index by spectrometer
2. Wavelength by Newton's ring
3. Wavelength by plane transmission grating
4. Magnifying power of telescope
5. Resolving power of a telescope
6. Dip by (i) Dip circle (ii) Earth's inductor
7. Calibration of Ammeter and Voltmeter by potentiometer
8. Temperature variation of electric resistances
9. Static characteristics of a p-n junction.

B.Sc. PHYSICS (Hons) Part –III

The course will consist of three theory papers and two practical papers.

The theory papers will be Paper V theory, Paper VI theory and Paper VII theory, each of marks 100 and the examination in each theory paper will be of three hours duration. Fifty percent of the questions would be problem based on the pattern of model questions. The candidate has to secure at least 135 marks in theory papers for passing.

The practical papers will be Paper VIII A and Paper VIII B, each of 50 marks and four (04) hours duration. Pass Marks in practical papers will be 23.

B.Sc. PHYSICS (Hons) Part –III

Physics (Hons) Paper- V (theory)

[Full Marks: 100] [Time: 3 Hour]

(12 questions to be set, 5 to be answered selecting not more than 2 questions from each group)

GROUP –A

(Methods of Mathematical Physics - 4 questions to be set)

Curvilinear coordinates—Cartesian, spherical, polar and cylindrical coordinates, orthogonal transformations of coordinates, scalar and vector fields, Gradient, Divergence and Curl, Line, Surface and Volume integrals, Theorems of Gauss, Stokes and Green. Tensor and its elementary properties.

Partial differential equation and its solution by separation of variables, Laplace equation and its solution, wave equation and its solution, Poisson's equation and its solution.

Fundamentals of complex variables, Cauchy-Riemann equations, conformal transformation, Cauchy's theorem and Cauchy's integral formula, Residue theorem, Integration of Complex functions.

GROUP—B

(Classical Mechanics—4 questions to be set)

Calculus of variation, Euler-Lagrange equations, principle of least action, conservation theorem and symmetry properties, application of Hamiltonian dynamics to simple problems, charged particle in electromagnetic field (non-relativistic and relativistic cases), Laws of motion of rigid bodies.

Gyroscopic motion, Motion on a symmetrical top, canonical transformation, Poisson Brackets, Jacobi identity, Hamilton-Jacobi equation, Action-angle variables, small oscillations.

GROUP—C

(Quantum Mechanics - 4 questions to be set)

Inadequacy of classical mechanics, dual nature of matter and radiation, deBroglie's relation, concept of quantum state, correspondence principle, Eigen functions and eigen values. Uncertainty relation, postulates of quantum mechanics, Schrodinger wave equation and its physical meaning, its application to problems of free particle, potential step, and one dimensional square well, particle in a box, linear harmonic oscillator, rigid rotator, Hydrogen atom, commutation rules of orbital angular momentum, spin half angular momentum,

symmetric and antisymmetric wave functions, Pauli's exclusion principle.

B.Sc. PHYSICS (Hons) Part –III

Physics (Hons) Paper - VI (theory)

[Full Marks: 100] [Time: 3 Hour]

(12 questions to be set, 5 to be answered with at least two from each group)

GROUP—A

(Statistical Physics - 6 questions to be set)

The fundamental assumptions of classical statistical mechanics, The phase space, Phase density, Micro state and macro state, Thermodynamic Probability, Probability and entropy, Liouville theorem. Maxwell-Boltzmann distribution law, Partition function and its correlations to thermodynamic functions, Applications of MB statistics to perfect gas, Limitations of classical statistical mechanics, Gibb's paradox, Sackur Tetrode equation.

Elements of Ensemble theory, Thermodynamic variables in Canonical and Grand Canonical ensemble, Energy fluctuation in Canonical Ensemble, Density and energy fluctuations in Grand Canonical Ensemble.

Assumptions of Quantum Statistical Mechanics, Fermi-Dirac distribution and applications to free electron gas, Bose-Einstein distribution and applications to photons.

A brief introduction to first order and second order phase transformation, critical exponent, Introduction to fluctuation, Probability and thermodynamic fluctuation.

GROUP—B

(Electronics - 6 questions to be set)

Circuit theory; Thevenin, Norton, Reciprocity, superposition and maximum power transfer theorems, one port & two port networks (only h- parameters). T and Pi equivalence of two port network, solid state electronics, semiconductor devices: P-N junction, Zener diode, opto-electrical devices, photodiodes, LDR, photovoltaic cell, phototransistor.

Equivalent circuits of BJT and FET, Half and full wave rectifiers, Power supply with special reference to smoothing circuit and voltage stabilization, amplifiers (R-C), feedback amplifiers, push-pull power amplifiers, simple circuit for oscillation, L-C Hartley and Colpitts oscillators, R-C oscillator.

Principle of amplitude modulation, solid state amplitude modulator or average and envelope detection, Radio receivers, Superheterodyne receivers, simple idea of transmitters, CRO and its applications.

Logic circuits: Binary number system, addition and subtraction in complement numbers, Hexadecimal and BCD codes. Logic gates, AND, NOT, OR, NAND, NOR and exclusive-OR gates.

Fundamental concepts of Computers and Basics of Programming: Types of computers, Components of Computer, Input-Output devices.

Programming : Programming for simple physical problems using Python Language.

B.Sc. PHYSICS (Hons) Part –III

Physics (Hons) Paper - VII (theory)

[Full Marks: 100] [Time: 3 Hour]

(12 questions to be set, 5 to be answered, selecting not more than 2 from each group)

GROUP—A

(Plasma and Electrodynamics - 4 questions)

Plasma: definition, characteristics and various theories, Plasma oscillation, Debye length, Debye screened potential, MHD equations and their use in non-magnetic plasma, Kinetic theory of plasma, Landau damping, Pinch effect, Saha's theory of thermal ionization, Wave propagation in isotropic plasma, Ionospheric reflection, Alfven wave. Applications of Plasma.

Retarded and advanced potentials, Field due to an oscillating current element and oscillating dipole, Lienard-Wiechert potentials, potential and field due to uniformly moving charge.

Four vector formalism, Covariance of Maxwell's field equations under Lorentz transformation, Transformation equations for electromagnetic fields.

GROUP—B

(Solid State Physics - 4 questions to be set)

Elements of Crystallography: Crystal system, Bravais lattices, Miller indices, point group symmetry, space group symmetry.

Diffraction of X-rays: Bragg's law, Laue equations, Reciprocal lattice, Ewald's construction, Brillouin Zones.

Crystal binding: Ionic crystals, Covalent crystals, metal crystals, molecular crystals, Hydrogen-bonded crystals, binding energies of ionic crystals of inert gases.

Lattice vibration: one- dimensional monoatomic and two-dimensional lattices, optical branch.

Free electron theory of metals: Heat capacity of electron gas, Thermal conductivity, Drude model, Electrical conductivity, Wiedemann-Franz relation, Boltzmann transport equation, Sommerfeld theory of electrical conductivity.

Band theory of solids: Bloch theorem, Kronig-Penny model, distinction between metal, semiconductor and insulator, Hall effect.

GROUP—C

(Physics of atoms, molecules and nuclei - 4 questions)

Origin of atomic spectra, Bohr's theory and Bohr-Sommerfeld theory of H-atom, Spectra of alkali and alkaline- earth metals, selection rules, excitation potential, fine structure, Stern-Gerlach experiment, Vector model of the atom, Zeeman effect and Paschen-Beck effect of single valence atom, Mosley's law, Origin of X-ray spectra, rotational, vibrational spectra of diatomic molecules, introduction to NMR & ESR spectroscopy.

Laser: principle, He-Ne laser, Ruby laser.

General properties of nuclei: mass, charge, spin, static magnetic moment, size and stability, Nuclear models-liquid drop model and mass formula, Shell model, deuteron problem, elementary ideas of nuclear forces.

B.Sc. PHYSICS (Hons) Part –III

Physics (Hons) Paper – VIII A (Practical)

[Full Marks: 50

Pass Marks - 23] **[Time: 4 Hour]**

The course consists of the following experiments:

1. Static characteristics of P-N junction
2. Static characteristics of Zener diode
3. Study of voltage stabilization by simple zener diode circuit
4. Static characteristics of BJT common base configuration
5. Static characteristics of BJT common emitter configuration
6. Input and output characteristics of UJT
7. Output characteristics of FET
8. h-parameters of BJT
9. Measurement of band gap in semiconductors
10. Logic gates- AND, OR, NOT, Exclusive-OR from NAND gates

Physics (Hons) Paper – VIII B (Practical)

[Full Marks: 50

Pass Marks - 23] **[Time: 4 Hour]**

The course consists of the following experiments:

1. Measurement of Cauchy's constants
2. Resolving power of a prism
3. Resolving power of a plane grating
4. Fraunhoffer diffraction due to a single slit
5. Schering bridge method of measuring capacitances
6. Anderson bridge of measuring inductance
7. Study of series LCR resonance
8. Study of parallel LCR resonance
9. Verification of Thevenin's, Norton and Maximum Power Transfer Theorem

10. Characteristics of LDR