The University of Burdwan
Syllabus for B.Sc. GENERAL COURSE
(1+1+1 Pattern)
in
PHYSICS
with effect from 2014-2015 onward

Course Structure

Part-I

Paper I (Theoretical) (100 marks):

Part II

Paper II (Theoretical) (100 marks):
Paper III (Practical Paper) (100 marks)

Part III

Paper IVA (Theoretical) (65 marks):

Paper V B (Practical) (35 marks):

PART- I (General)

PAPER-I   **FULL MARKS: 100**

[Units and dimensions, Vector, Mechanics, General properties of matter, Thermal physics, Vibration and Waves & Ray-Optics]

SI units and modern symbols are to be used. If otherwise not stated, mathematical derivation and analysis are necessary at relevant places.

Group – A : UNITS, DIMENSIONS & VECTOR

SI Units and Dimensions – Fundamental and derived, principle of dimensional homogeneity.   L1

Vector: Scalar and vector products of two vectors with examples (work done, surface area, angular momentum and torque), polar and axial vectors, scalar and vector fields with examples, gradient, divergence and curl (definition, expression and meaning only), triple products of vectors, Laplacian operator and curl of curl, line-integral, surface integral and volume-integral; statements of divergence and Stokes' theorem.   L6

MECHANICS

Principles of conservation of : Mass, linear momentum (including mathematical analysis of variable mass and rocket motion) angular momentum, energy and mass-energy [statement and explanations only]   L5

Force laws: Mass-spring, gravitational, electric and magnetic forces; application of Newton's 2nd law to each case of the above forces and corresponding differential equations (case of mass-spring: force law – force $\alpha(-x)$ or force = -Kx, Newton's 2nd law – mass x acceleration = force, then mass x acceleration = -kx and the differential equation m$\frac{d^2x}{dt^2}$ =-kx or $\frac{d^2x}{dt^2}$ +kx=0 ; Conservative force, path-integral, potential energy, kinetic energy and total energy; non-conservative forces (mentioning validity of conservation of energy).   L5

Central force : Central forces. Two-body central force problem and its reduction to two one-body problems. Reduced mass. Important properties of motion under central force. Velocity and acceleration and their radial and transverse components. Differential equation of the orbit. Inverse square law of force. Conditions for parabolic, elliptic and hyperbolic orbits. Kepler's laws. Motion of artificial satellites. Geocentric satellites.   L8

Dynamics of rigid body : Definition of rigid body, its translation in terms of centre of mass, linear momentum and force, pure rotation, rotational kinetic energy, rotational inertia (M.I.) and radius of gyration, angular momentum and torque; parallel and perpendicular axes theorems, calculation of M.I. about usual axes of symmetrical bodies (rod, disc and cylinder) and M.I. about a diameter of spherical shell and sphere; translation combined with rotation, rolling of spherical shell and solid sphere on horizontal and inclined planes.   L12

GROUP-B : GENERAL PROPERTIES OF MATTER

Gravitation : : Gravitation. Gravitational potential and intensity due to spherical and other symmetrical bodies. Principle of Boys' method for the determination of gravitational constant.   L4

Elasticity: Relation between elastic moduli, torsion of a cylinder and strain energy; bending of a beam, cantilever (simple deduction), light beam supported at a both ends and loaded at the centre.   L6

Fluid motion: Streamline and turbulent motion of liquid, continuity equation, critical velocity, Newtonian fluid, co-efficient of viscosity, Poiseuille's formula, dimensional analysis for critical velocity, Reynold's number and Stokes' law; Bernoulli's theorem using conservation of energy and illustration; Mention of variation of viscosity with temperature.   L6

Surfface Tension: Surface tension and surface energy, molecular theory, angle of contact, Newman's triangle capillary rise and fall of liquid column, Jurin's law verification, excess pressure in spherical bubble and drop, variation of surface tension with temperature (mention only), experimental determination of surface tension by capillary rise method   L6

Group-C : THERMAL PHYSICS

Kinetic theory of gases: Ideal gas, pressure exerted by it, kinetic interpretation of temperature, Maxwell's distribution of moleculer speeds (only statement and explanation with distribution curve), idea of mean, r.m.s. and most probable speeds; degrees of freedom, principle of equipartition of energy with application in simple cases; C_p and C_v - two molar specific heats of gases, $C_p - C_v = R$ and pVT-relations for adiabatic changes; variation of atmospheric pressure and temperature with height; Andrew's experimental results on CO_2, Behaviour of real gases, Vander Waal's equation (simple derivation), critical constants in terms of Vander Wasl's constants.   L12

Thermal conduction: Steady and variable state, thermal conductivity and diffusivity, Fourier equation for one dimensional heat flow and its solution, theory of Ingen Hausz's experiment, cylindrical flow of heat, experimental determination of thermal conductivity by Lee's method; statement of Wiedemann and Franz's Law.   L6

Group D: THERMODYNAMICS

System and surroundings, thermal equilibrium and zeroth law of thermodynamics - concept of temperature (T), state variables and state functions; 1st law of thermodynamics - concept of internal energy (U) and work-energy conversion, different processes (isothermal, adiabatic, reversible and irreversible) for change of states, work done and p-v diagram; Carnot cycle, Carnot engine and its efficiency; 2nd law of thermodynamics - concept of entropy (S), physical interpretation of entropy, change in entropy in reversible and irreversible processes, Carnot theorem, thermodynamic scale of temperature; Joule Thomson effect, enthalpy and temperature of inversion; Joule Thomson cooling versus adiabatic cooling.   L15

Thermal radiation: Nature of radiation, emissive and absorptive power, black body and blackbody radiation, Kirchhoff's law, Stefan's law, Newton's law of cooling; Planck's idea of quantization, Planck's distribution law (statement only) and graphical interpretation, Wien's displacement law (statement and graphical explanation); pyrometer principle.   L4

Group E : MECHANICAL VIBRATION AND WAVES

Vibration: Superposition of two S.H. vibrations (collinear and perpendicular), Lissajous' figures; damped and forced vibration, resonance and its sharpness (using complex quantity).   L4

Waves: Wave motion and differential equation of plane progressive waves, energy and intensity, bel and decibel; loudness and phon; velocity of longitudinal wave in solid and gas, velocity of transverse wave in string (simple theory), qualitative discussion of standing waves and energy-distribution with examples; Doppler effect.   L8

Group E : Ray – Optics

(Rational or Cartesian sign convention to be followed)

Fermat's principle and laws of reflection and refraction at plane surfaces; refraction law at spherical surface, lens maker's formula, combination of thin lenses and equivalent focal length.   L8

Dispersion of light, dispersive power, chromatic aberration and its remedy, mention of other Seidel aberrations; Huygen and Ramsden eyepieces.   L8

[Problems related to physical theories to be covered]

Part II (General)

Paper – II   Full Marks : 100

[Electromagnetism, Wave- optics, Modern Physics and Electronics]

If otherwise not stated, mathematical derivation and analysis are necessary at relevant places.

ELECTROMAGNETISM

(SI units and modern symbols are to be used)

Group A

[Electromagnetism is a single subject of electricity and magnetism. An electric charge appears to be static with respect to (w.r.t.) one observer and moving w.r.t. another. First observer finds only electric field E, but the second detects simultaneous existence of both electric field E and magnetic field B. An electric current I (moving charge) transports electric charge q, and set up magnetic field B too. Then a suitable choice of unit for I will lead to consistent units of both q and B.]

Unit of electric current: Ampere (A), the fundamental SI unit of electromagnetism; Definition of 1A in terms of force between two long straight filamentary parallel currents; 1 coulomb = 1A x 1s, net charge transported by 1 A in 1 second – derived SI unit of electric charge.   L1

Electrostatics (both q and E statics): Electric field, force on a charge q, Millikan's oildrop experiment, idea of quantized charge and value of e, the electronic charge, conservation or electric charge;. Electric flux through an surface area. Gauss's law and its application in simple cases. Relation between field and potential in electrostatics. Electric dipole, dipole placed in an electric field. Field and potential due to electric dipole at any point   L8

Dielectric and Capacitor: Polarisation and three electric vectors, $\mathbf{E}$, $\mathbf{P}$ and $\mathbf{D}$, polarisability, $\mathbf{D}=\varepsilon_0\mathbf{E}+\mathbf{P}$; Gauses's law in dielectric constant, parallel plate and cylindrical capacitors with dielectric inside, energy density in electric field.   L2

4

Group-B

Direct current (steady): Electric current density **J**, $I = \int J \cdot ds$, and equation of continuity; voltage source and current source; linear passive circuit elements, Kirchhoff's laws and analysis of multi-loop circuits; Thevenin and Norton theorems (statements and explanation) and reduction of two-terminal linear network. Calculation of galvanometer- current in an unbalanced Wheatstone bridge with ideal voltage source by Thevnin theorem; applications of Wheatstone bridge principle; potentiometer – principle and applications.   L6

Magnetostatics (Static magnetic field B): Defining equation of B (magnetic induction vector) – the fundamental magnetic vector, **F=qv×B** or **F=H×B** i.e., Lorentz force equation, Thomson experiment for the determination of em , Dempster's mass spectrometer; nonexistence of magnetic monopole - $\nabla.\mathbf{B}=0$ (Maxwell's 2nd equation) i.e, non existence of magnetic charge, causes of magnetic field B: electric current, electromagnet, permanent magnet, time varying electric field, some atoms, molecules and some elementary particles; Biot-Savart law, Ampere' law in magnetostatics **B.dl=μ₀I** enclosed→ $\nabla\times\mathbf{B}=\mu_0\mathbf{J}$, **B** due to long straight filamentary current, force between two long parallel currents and $\mu_0=4\pi\times10^{-7} NA^{-2}$ (assigned value); B on the axis of circular current, solenoidal current and toroidal current; torque on a current loop in uniform B, magnetic moment of a magnetic dipole, equivalence of current loop with magnetic dipole.   L10

Materials and magnetization: Three magnetic vectors - **B, M & H=B/μ₀ - M** and illustration referred to a bar magnet; magnetic susceptibility and relative permeability; dia, para and ferromagnetic properties, idea of domain theory, statement of Curie's law; hysteresis and hysteresis loss. L5

Electromagnetic Induction: Magnetic flux, $\phi_S = \int B \cdot ds$, flux-linkage with a coil of N turns, Faraday's law and Lenz's law of electromagnetic induction, $e=-\partial\emptyset/\partial t$ for a single turn, integral form $\int E \cdot dl = \frac{\partial}{\partial t} \int B \cdot ds$, using Strokes' theorem differential form $\nabla\times\mathbf{E}=-\frac{\partial B}{\partial t}$ (Maxwell's 3rd equation); self (L) and mutual inductances, calculation of L for circular and solenoidal coils; energy stored in current carrying inductor and energy density in magnetic field.   L5

Direct current (varying): Growth and decay of current in L R circuit, charging and discharging of a capacitor through a resistor using voltage source.   L3

Alternating current (steady state): Sinusoidal voltage and current, mean and effective (r.m.s) values, steady state solution (using complex quantity) for current in LR and CR series circuit excited by sinusoidal voltage; reactance, impedance, phase angle and phasor diagam; power analysis and power factor, resonance in series RLC and parallel RLC circuit (using complex quantity and phasor diagram), sharpness of resonance including Q factor and bandwidth; basic idea about transformer.

Electromagnetic waves : Laws of electromagnetism before Maxwell: $\nabla.\mathbf{E}=\frac{\rho}{\varepsilon_o}$, $\nabla.\mathbf{B} =0$, $\nabla\times\mathbf{E}=\frac{\partial B}{\partial t}$, $\nabla\times\mathbf{B}=\mu_0\mathbf{J}$, (only expressions), introduction of displacement current density $\frac{\partial}{\partial t}$ and Maxwell's equation: : $\nabla.\mathbf{E}=\frac{\rho}{\varepsilon_o}$, $\nabla.\mathbf{B} =0$, $\nabla\times\mathbf{E}=\frac{\partial B}{\partial t}$, $\nabla\times\mathbf{B}=\mathbf{J}+\frac{\partial D}{\partial t}$. (electromagnetic wave equations in free space), wave speed $\frac{1}{\sqrt{\mu_o \varepsilon_o}} = 3\times10^8$ m/s, speed of light in free space and wave nature of light.

Group – C : WAVE – OPTICS & LASER

Wave Optics :

Huygen's principle: Idea of wave fronts – plane, spherical and cylindrical; secondary wavelets, construction and propagation of wave front   L2

Interference: Young's experiment, intensity redistribution, condition of stable interference-pattern, coherent source, interference by division of amplitude and Newton's ring experiment, interference by division of wave front and experiment with Fresnel's biprism; idea of coherence-time and coherence-length.   L5

Diffraction: Fresnel and Fraunhofer classes, Fresnel's half period zones, zone plate, explanation of rectilinear propagation of light and zone-plate; Fraunhofer diffraction in single slit, double slit and plane diffraction grating (simple theory), Resolving power and the Rayleigh criterion for resolution (statement), grating spectra versus prism spectra.   L6

Polarization: Transverse nature of light (e.m.) wave, different states of polarization, plane polarized light, Brewster's law, double refraction; uniaxial crystal, Polaroid and Nicol prism (qualitative function); optical activity and rotation of plane of polarization.   L6

Laser: Spontaneous and stimulated emission, Einstein's A & B coefficients; idea of population inversion, principle of laser, laser versus ordinary light, Ruby Laser.   L3

Group D : Modern Physics

Special Theory of Relativity: Reference frames, postulates of special theory of relativity, Lorentz transformation formula (only explanation) and consequences such as length contraction and time dilatation: relativistic transformation of velocity and mass, mass-energy relation and total energy, zero and finite rest masses.   L5

Elements of statistical mechanics: System of very large number of particles, microscopic and macroscopic properties, most probable behavior; MB, BE and FD statistics (only distribution formulae with explanation) and respective kind of particles.   L2

Elements of Quantum Physics: Failure of classical physics to explain black body radiation, photoelectric effect, Compton effect, Raman effect etc. and success of quantum theory (qualitative discussion only); Bohr's theory of hydrogen spectra, principal quantum numbers, limitations, correspondence principle, qualitative introduction of four quantum numbers and Pauli's exclusion principle; wave-particle duality, De Broglie wave length, Davisson and Germer experiment; Superposition of two waves, wave packet and group velocity; Heisenberg's uncertainty relation (statement and explanation): Idea of wave function and Schordinger equation (time dependent and time independent parts), interpretation of wave function in terms of probability, just mention of the remarkable results of application of Schrodinger equation (A) particle in a box , (B) Linear harmonic oscillator and (C) barrier penetration problem.   L11

Crystal nature of solid: Diffraction of x-rays, Bragg's law; Mosley's law and its importance   L2

Nuclear physics: Nucleus (mass, size, nucleons & binding energy), binding energy-mass number curve and explanation of stability, fission and fusion of nuclei, radioactive disintegration, successive equilibrium, radio isotopes and uses; nuclear reactor, nuclear reaction, thermonuclear reaction and stellar energy, basic information about some elementary particles, principles of operations of G.M. counter as detector and cyclotron as accelerator.   L9

Group- E : SOLID STATE DEVICES ELECTRONICS

Semiconductor physics: Qualitative ideas of energy bands at 0 K, generation of hole-election pairs at room- temperature and intrinsic semiconductor, carrier density; doping and impurity semiconductor, majority and minority carriers, p-type and n-type semiconductors, advantage of silicon over germanium as semiconductor device material, p-n junction and its properties (depletion region, barrier voltage, barrier width and junction- capacitance).   L4

Devices and circuits: Junction diode, forward and reverse biased characteristics, diode equation (I-V expression only), a.c. and d.c. resistances of a diode, use of diode as rectifier, calculation of ripple facor and efficiency of half and full wave rectifier. qualitative explanation of use of capacitor filter, properties and uses of zener and light emitting diodes, bipolar junction transistor (n-p-n and p-n-p), current components in a transistor under normal bias and current gain, CE output characteristics and current gain , use of transistor as CE amplifier, h-parameter model of BJT CE amplifier, basic idea of feedback in amplifier and principle of oscillator.   L8

Digital electronics: Binary numbers, binary-decimal inter-conversion, binary addition, OR and NOT gates, De Morgan's theorem, NOR & NAND universal gates, XOR gate, half adder and full adder (using half adders).   L4

[Problems related to physical theories to e covered]

Paper – III : Full Marks 100

At least 16 (sixteen) different experiments of the list given below are to be set up in each laboratory, and to be performed by the students in each college from the session 2014; and 4 (four) other experiments of the list are to be set up and performed for the session, 2014-2015

Theory, record of experimental data, results with calculation, and discussion are to be entered in "standard" bound laboratory note books (LNB) by the students; and to be signed by the class-teachers during the laboratory classes regularly; and these notebooks are to be submitted at the time of final examination. For each group of experiments, separate LNB is Necessary. No fair notebook other than that used in the class-work will be accepted. One experiment from Group-A and one from Group-B of the list given below are to be performed by each candidate in the final part-I examination. Each experiment will be allotted 50 marks, and is to be completed in 3 hours-time during examinations.

List of Exeriments
Group-A

1. Moment of inertia of cylindrical body about an axis passing through its centre of gravity.

2. Young's modulus of the material of a wire by Searle's method.

3. Rigidity modulus of the material of a wire by dynamical method.

4. Frequency f (or v) versus 1/l curve for a sonometer-wire and hence unknown frequency of a tuning fork.

5. Coefficient of linear expansion of the material of a rod using optical lever (or using traveling microscope)

6. Pressure coefficient of air.

7 Focal length of a convex lens by combination method and calculation of its power.

8. Verification of Thevenin and maximum power transfer theorems using Wheatstone bridge with load- resistances in place of the galvanometer.

9. To draw I-V characteristics of a suitable resistance and that of a junction diode within specified limit on a graph, and hence to find d.c. and a.c. resistances of both the elements at the point of intersection.

Group- B

1. Refractive index μ of water by traveling microscope.

2. Refractive index μ of the material of a lens by lens-mirror method.

3. Refractive index μ of the liquid by lens-mirror method.

4. Refractive index μ of the material of a prism for a monochromatic light by spectrometer.

5. Horizontal component of the earth's magnetic field B at the place using deflection and vibration magnetometers.

6. Resistance of a suspended coil galvanometer by half deflection method and hence the current sensitivity of the galvanometer.

7. Temperature-coefficient of the material of a given resistance with the help of a meter-bridge (without end correction).

8. Potential difference across a low resistance and hence the current through it with the help of a potentiometer (potentiometer resistance and the source voltage to be supplied).

9.. Output characteristics of a transistor (silicon) in CE mode and hence β_{dc} and β_{ac} at any operating point.

10. Verification of truth table of NAND gate using IC chip and to construct NOT & OR/AND gates from NAND gates and to verify respective truth tables on breadboard.

Part III (General)

PAPER – IV :   Full Marks 100

Theory Marks: 65 (**Paper IVA**)   Practical Marks: 35 (**Paper: IVB**)

THEORY

Guide lines for setting questions (to be sent to the paper setter)

Short answer questions on physical theory and principles involved.   [20]

Short answer questions on construction and functions of each part of a system   [30]

Objective questions based on information.   [15]

Paper IV A   (Theory Portion)   Full Marks: 65

Application oriented topics covering different branches of physics: Basic theories and principles of operations (without long mathematical derivation and complicated involvements) to be studied.

[1 compulsory question of objective type based on information from the topics of the entire syllabus and 5 other questions out of 8 to be answered]

1. **LASESR :** Principle of Laser action. He-Ne Laser, Holography principle only.   L4

2. **MAXWELL EQUATIONS:** Maxwell equations inside matter. Gauge fields, Poynting theorem, Poynting vector, Transverse nature of e.m. field. Dispersion and scattering (elementary idea), blueness of sky and redness of setting sun.   L10

3. **FIELD EFFECT TRANSISTOR :**   Field effect transistor, Comparison between FET and BJT, Construction and characterstics of FET. , FET parameters and their dependence , MOSFET, Construction and characterstic of MOSFET. Fabrication of IC.   L7

4. **OSCILLATORS :** Principle of oscillators, Barkhausen Criteria, Phase shift   oscillator, LC & RC oscillators.   L5

5**.** **BONDING IN SOLIDS** : Different types of interatomic binding in solids. Ionic crystals. Electrostatic energy.. Cohesive energy of ionic crystals with repulsive interaction.   L 5

6.   **DIELECTRICS :** Dielectric materials. Polarization. Lorentz local field. Clausius-Mosotti relation. Induced and orientational polarization. Dipolar polarizability.   L5
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7 **GENERATORS & MOTORS :** Electric generator, transformer and motor. (d.c. & a.c.)   L4

8. **Building Acoustics** : Reverberation, Sabine Formula and absorption coefficient, Acoustic requirements for an ideal auditorium.   L5

9. **DIGITAL ELECTRONICS :** FLIP FLOPS, 4 : 1 Multiplexor and Demulitplexor, construction using NAND Gates and truth table. A/D and D/A convertor.   L5

10. **TRANSISTOR BIASING :** Transistor biasing (self bias), CE voltage amplifier power amplifier (emitter follower and class B push pull complementary symmetry); OPAMP and its uses as inverting and non-inverting amplifiers, Differentiator and Integrator.   L8

11.**Principles of Communications**: Analog modulation and demodulation for AM and FM; digital modulation-basic idea; Radio transmitter and receiver in block diagrams; elements of television system; satellite communication. Optical fibre communication, principle, Step and Graded index fibre, N.A., Advantage of optical fibre communication. Radio-wave spectrum and different modes of radio-wave propagation (qualitative discussion).   L12

12. **COMPUTER FUNDAMENTAL :** Computer hardware: basic building blocks, central processing units, memory, hard disc, RAM. ROM, CD-ROM, DVD, pen drive, memory units: bits and bytes, input-output devices, (ii) Computer software: Operating system, Windows /Linux (iii) Programmingin C: basic structure, character set, keywords, idea   L5

Paper IV B (Practical)

Full Marks: 35   **Time : 3 Hours**

1. Reports on the experiments are to be written in "Standard" laboratory work books in the classrooms under the guidance of the teachers. Daily work-report recorded in the LWB is to be signed by he teachers regularly. No other laboratory note book than that used in the lab-class will be accepted.

2. Final examination and assessment will be made by a board of examiners consisting of internal examiners and an external examiner on the practical and viva-voce test.

Performance	20 marks
Daily report on the Laboratory workbook	05 marks
Viva voce on the practical	10 marks

List of Practical

1. Young's modulus by flexure method using single length.
2. Construction of a one-ohm coil and measurement of the length wire of one ohm.
3 . Study of Zener diode chracterstics and its application as voltage regulator.
4. Band gap measurement for themistor..
5 Study of an OPAMP (741C) circuit for i) inverting, ii) non inverting and iii) adder circuit..
6. Design an IC regulated dc power supply and study of bridge rectifier using bed board.
7. Study of LCR circuit.
8. conversion of ammeter into voltmeter and voltmeter into ammeter.

Books recommended for **3-year Degree General Course i**n Physics

Part-I

1. Physics I & II – Halliday & Resnik (W.E.)

2. College physics (I-IV) volumes – Sinha & Das Sharma (Modern Book Agency)

3. All vol. of physics – Dr. D.P. Roychowdhuri ('Chayan' in old publication.)

4. Optics – A.K. Ghatak.;

5. Classical & Modern optics – Meyer – Arendt (PH I)

6. Electricity & Magnetism – Mahajan & Rangwala (TMG);

7. Electricity and Magnetism – Chatterjee & Rakshit (Central Book Agency) Books Allied (P) Ltd.

8. NCERT Physics Vol. II (Part I & II)

9. Introduction to Electrodynamics – Griffith (PH I)

10. Concepts of Modern Physics – Beiser (TMG);

11. Modern Physics – Mani & Mehta (Affiliated East West Press);

12. Modern Physics – Patil (TMG)

13. Foundation of Electronics – Chatterjee, Rakshit et al.;

14. Digital computer Electronics – Malvino & Brown (TMG)

15. Physics of the atom – Wehr, Richard, Adair (Addison – Wesley world student series)

16. Series by D.C. Tayal (Himalaya Publishing)