# University of Barisal

Department of Physics
Syllabus for B.Sc. (Honors) in Physics
Session 2017-18 and onward

**Degree Name:** B.Sc. (Hons.) in Physics

**Course Structure**

Program duration: 4 Years

Total number of credit hours available: 140

Minimum credit hours is required to earn to be a graduate: 140

**Year-wise distribution of credits**

| Year | Credits |
|---|---|
| 1st year | 30.0 |
| 2nd year | 32.0 |
| 3rd year | 38.0 |
| 4th year | 40.0 |
| Total | 140 |

The course duration of the B.Sc. (Honors) program is four years and is year based. For the 2017-2018 Session the whole program consists of 140 credits among which 101 credits are allocated for theory courses, 29 credits for laboratory courses, and the rest 8 credits, for general viva.

## Examination System

A year-final examination will be held at the end of each year. The final examination will carry 60% of the total marks and continuous assessment (mid-term/attendance/presentation/class test/class performance/assignment/quiz test) will carry 40% marks. For each of the theory courses, there will be at least two mid-term examinations. To appear in the final examination as a regular student, one must have attendance percentage not below 60%. However, the chairman of the department may recommend the students having percentage between 50% to less than 60% after paying fees determined by the university authority.

For 4 (four) credit courses the duration of examination will be 3 (three) hours; there will be 8 (eight) questions from which 5 (five) to be answered. For 2 (two) credit courses the duration of examination will be 2 (two) hours; there will be 5 (five) questions from which 3 (three) to be answered.

**Grading System**

Total marks obtained in each course will be converted into LG (Letter Grade) and GP (Grade Point) as follows:

| Numeral Grade | Letter Grade | | Grade Point | Interpretation |
|---|---|---|---|---|
| 80% and above | A+ | (A plus) | 4.00 | Outstanding |
| 75% to less than 80% | A | (A regular) | 3.75 | Excellent |
| 70% to less than 75% | A- | (A minus) | 3.50 | Very Good |
| 65% to less than 70% | B+ | (B plus) | 3.25 | Good |
| 60% to less than 70% | B | (B regular) | 3.00 | Satisfactory |
| 55% to less than 60% | B- | (B minus) | 2.75 | Bellow Satisfactory |
| 50% to less than 55% | C+ | (C plus) | 2.50 | Average |
| 45% to less than 50% | C | (C regular) | 2.25 | Pass |
| 40% to less than 45% | D | | 2.00 | Poor |
| Less than 40% | F | | 0.00 | Fail |

The promotion in the department is yearly based. Students must have to earn a minimum CGPA 2.00 to get promotion from 1$^{st}$ year to 2$^{nd}$ year, and 2.25 from 2$^{nd}$ year to 3$^{rd}$ year and 3$^{rd}$ year to 4$^{th}$ year. If any student fails to get the requisite CGPA for promotion, he/she may seek readmission with the 1$^{st}$ year of the respective year with the subsequent available batch.

A student earning ‘F’ grade in any theoretical/practical course of any year will be required to improve ‘F’ grade(s) with the next available two consecutive batches. In case of students of 4$^{th}$ year who have already readmitted once or twice, the bindings of completion of the program with 6 (six) academic years may be relaxed for two more consecutive academic years to clear the ‘F’ grades of the courses of 4$^{th}$ year. Students earning the letter grade of less than ‘B’ (GP 3.00) in any theoretical course may choose to improve the grade by appearing at the year final examination with the next available batch. In case of improvement of the courses of 4$^{th}$ year, the bindings of completion of the program within 6 (six) academic years may be relaxed to one more academic year.

**Year wise course distribution**

Year-I

| Course Code | Course Title | Credit |
|---|---|---|
| PHY-101 | Mechanics and Properties of Matters | 4.0 |
| PHY-102 | Sound Waves and Oscillation | 4.0 |
| PHY-103 | Electricity and Magnetism | 4.0 |
| PHY-104 | Mathematics-I | 4.0 |
| PHY-105 | Chemistry | 4.0 |
| PHY-106 | Bangladesh and global studies | 2.0 |
| PHY-107 | Physics Lab-I | 4.0 |
| PHY-108 | Chemistry Lab | 2.0 |
| PHY-109 | Viva | 2.0 |
| Total | | 30 |

Year-II

| Course Code | Course Title | Credit |
|---|---|---|
| PHY-201 | Optics | 4.0 |
| PHY-202 | Mathematical Physics | 4.0 |
| PHY-203 | Heat and Statistical Mechanics | 4.0 |
| PHY-204 | Statistics | 4.0 |
| PHY-205 | Mathematics-II | 4.0 |
| PHY-206 | Introduction to Computer Fundamentals and Programing | 4.0 |
| PHY-207 | Physics Lab-II | 4.0 |
| PHY-208 | Computer Programing Lab | 2.0 |
| PHY-209 | Viva | 2.0 |
| Total | | 32 |

Year-III

| Course Code | Course Title | Credit |
|---|---|---|
| PHY-301 | Classical Mechanics | 4.0 |
| PHY-302 | Quantum Mechanics- I | 4.0 |
| PHY-303 | Solid State Physics-I | 4.0 |
| PHY-304 | Nuclear Physics-I | 4.0 |
| PHY-305 | Electronics | 4.0 |
| PHY-306 | Electrodynamics | 4.0 |
| PHY-307 | Atomic & Molecular Physics | 4.0 |
| PHY-308 | Physics Lab-III | 4.0 |
| PHY-309 | Physics Lab-IV | 4.0 |
| PHY-310 | Viva | 2.0 |
| Total | | 38 |

Year-IV

| Course Code | Course Title | Credit |
|---|---|---|
| PHY-401 | Quantum Mechanics- II | 4.0 |
| PHY-402 | Solid State Physics- II | 4.0 |
| PHY-403 | Nuclear Physics- II | 4.0 |
| PHY-404 | Digital Electronics | 4.0 |
| PHY-405 | Reactor physics | 4.0 |
| PHY-406 | Plasma Physics | 4.0 |
| PHY-407 | Method of Experimental Physics | 4.0 |
| PHY-408 | Material Science | 2.0 |
| PHY-409 | Physics Lab-V | 4.0 |
| PHY-410 | Physics Lab-VI | 4.0 |
| PHY-411 | Viva | 2.0 |
| Total | | 40 |

# Year-I

## PHY-101 Mechanics and Properties of Matters 4.0

1. **Particle Kinematics and Dynamics:** Motion in one, two and three dimensions; projectile motion, circular motion; Newton's law of motion; Frictional forces; Application of Newton's law.

2. **Momentum Conservation and System of Particles:** Conservation of momentum; rocket motion; Center of mass and its motion; Collision; elastic and inelastic collision in one dimension; Impulse of force.

3. **Energy Conservation:** Work and energy; The work-energy theorem; Conservative and non-conservative force and potential energy and their relation; Conservation of energy.

4. **Rotational Kinematics and Dynamics:** Relation between linear and angular kinematics for a particle in circular motion; Torque acting on a particle; Angular momentum; Conservation of angular momentum; The rotational dynamics of a rigid body.

5. **Rotational Motion:** Rotational kinematics; Moment of inertia and its calculation; Radius of gyration; Parallel-axis Theorem; Perpendicular-axis theorem

6. **Gravitation:** Newton's law of gravitation; Derivation of Kepler's laws of planetary motion from Newton's laws; Gravitational potential and field; Escape velocity; Calculation of potential and force in simple cases. Variation in acceleration due to gravity.

7. **Elasticity:** Stress and strain; Hook's law; Three types of elasticity; Relation between elastic constants; Poisson's ratio; Yield point; Elastic limit; Elastic fatigue; Limiting value of $\sigma$ ; Bending of beams; Cantilever, Torsion of a cylinder.

8. **Surface Tension and Viscosity:** General concepts of fluid flow; Streamline and Turbulent Flow Adhesive and cohesive forces; Molecular origin of surface tension; Capillarity; Poiseuille's formula; Stokes' law; Terminal velocity for falling bodies.; The equation of continuity; Bernoulli's equation and its applications; Viscosity, Newton's law of viscosity; Variation of viscosity with temperature and pressure.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | D. Halliday, R. Resnick& K.S. Krane | **:** | Physics Vol. 1 |
| **2.** | B. Brown | **:** | General Properties of Matter |
| **3.** | D.S. Mathur | **:** | Properties of Matter |
| **4.** | BrijLal & N. Subrahmanyam | **:** | Properties of Matter. |
| **5.** | Symon, K.R | **:** | Mechanics |
| **6.** | Heuvelen, A.V | **:** | Physics |
| **7.** | Imran and Ishaque | **:** | General Properties of Matter |

## PHY-102 Sound Waves and Oscillation 4.0

1. **Oscillations:**
   a) Definition of Simple Harmonic Motion (SHM); Mass-spring system; Energy conservation in mass energy system.
   b) Damping forces; Types of damping; Logarithmic decrement; Relaxation time and quality factor (Q); Electromagnetic damping; Damped SHM: under damped, over damped and Critical damped.
   c) Forced oscillations; Resonance: examples of resonance.
   d) Combination of simple harmonic oscillators: Lissajous' figures.
   e) Energy in a harmonic oscillator; Physical and torsional pendulum.

2. **Coupled Oscillators and Normal Modes of Continuous System:** Coupled oscillators; Normal coordinates and normal modes; Forced vibration of a coupled oscillator; N-coupled oscillator wave motion as a limit of coupled oscillation.

3. **Fundamentals of Waves:** Waves in elastic media; Types of waves; Wave generation; Wave equation and solution; Energy, power and speed of traveling waves; Transverse and longitudinal waves; amplitudes and phase; phase velocity; wave fronts; Plane and spherical waves; Mathematical representation of plane and spherical waves; Introduction to some wave phenomena in physics.

4. **Superposition of Periodic Motions:** Principle of superposition; super imposed vibration of equal and different frequencies; Stationary waves; Beats; Huygens principles.

5. **Sound Waves and Acoustics:** Sources; Propagation of sound; intensity and loudness; Vibrations in strings, Bars and air column, Velocity of Transverse waves along a stretched string, Laws of transverse vibration of strings-verification, sonometer, Melde's experiment, Velocity of sound in fluid and solid media; Musical sound; Doppler's effect; Infrasonic and ultrasonic sound; Measurement of velocity of sound by Ultrasonic method, Applications of Ultrasonic. Recording and reproduction of sound; General idea of acoustics.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | C.A. Coulson | **:** | Waves |
| **2.** | A.B. Wood | **:** | A Text book of Sound |
| **3.** | N.W. Molechlan | **:** | Theory of Vibration |
| **4.** | A. P. French | **:** | Vibrations and Waves |
| **5.** | BrijLal | | Waves and Oscillations |

## PHY-103 Electricity & Magnetism 4.0

1. **Electric Field:**
    a) Point charges and Coulomb's law; Definition of Electric field; Electric field lines; Calculation of E; A point charge in an electric field; Electric field due to a dipole; Torque on a dipole in an uniform electric field.
    b) Flux of the electric field; Gauss's law and its applications; Coulomb's law from Gauss's law; Cases with planar, Spherical and cylindrical symmetry; Calculation of E from V; Gauss's law in differential form.
    c) Static electric field as a conservative vector field; Notion of a potential; equipotential surfaces; Potential and potential energy for a system of charges.
    d) Capacitance and capacitor; Analogy with springs; Parallel plate capacitors and spherical Capacitors; Energy stored in a capacitor; Capacitors in parallel and series; Concept of electron-volt; Electric field as the carrier of electrical energy and electrical energy density in terms of electric field.
    e) Dielectric media; Polarization vector, displacement vector and electric vector; Capacitor with a dielectric; Gauss's Law with dielectric.

2. **Current and Magnetic Field:**
    a) Motion of charge carrier in matter; Current density; Drift velocity; Conductor sand Ohm's law; Resistance and resistivity; Addition of resistances.
    b) Electromotive force and potential drop; Kirchhoff's law: junction and loop rules and their physical basis; Problems involving multi-loop circuits with resistor and batteries; Ammeter, voltmeter and their uses.
    c) Single loop RC circuit: charging and discharging of a capacitor and the time constant.
    d) Definition of magnetic field; Lorentz force; Properties of static magnetic fields; Gauss's law for magnetic fields; Motion of charged particles in magnetic fields; Hall effect.
    e) Magnetic fields due to current; Biot-Savart Law; Magnetic fields due to current carrying conductors; Ring current as a magnetic dipole; Ampere's law; Comparison between Biot-Savart law and Ampere's law; Field due to an infinite straight wire; Ideal solenoid and toroid.
    f) Magnetic properties of matter: paramagnetism, diamagnetism and ferromagnetism; Magnetization vector; Hysteresis.

3. **Time Varying Phenomena:**
    a) Faraday's law of electromagnetic induction; Lenz's law; Induction: self and mutual induction; Transformers.
    b) Inductors; Single loop RL circuit and the time constant; Energy stored in magnetic fields.
    c) Induced electric fields from time varying magnetic fields; Synchrotron and cyclotron.
    d) LC circuits; Energy transformation in LC circuit; Damped oscillation in LCR circuits.
    e) Alternating currents; RMS Value; Use of complex variables and Phasors for linear circuit analysis; Impedance and reactance; Q-factor and power factor; Response of RC, RL and RLC circuits to alternating currents.

| Books Recommended: | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | D. Halliday, R. Resnick & K.S. Krane | **:** | Physics vol. 2 |
| **2.** | A. Kip | **:** | Fundamentals of Electricity and Magnetism |
| **3.** | K.K. Tewari | **:** | Electricity and Magnetism with Electronics |
| **4.** | H.D. Young | **:** | University Physics |

## PHY-104 Mathematics-I 4.0

**Calculus**

1. **Functions:** Domain; Range; Functions and Graphs of Functions; Limits; Continuity.

2. **Ordinary Differentiation:** Differentiation; Indeterminate form; Successive differentiation and Leibnitz theorem.

3. **Expansions of Functions:** Rolle's theorem; Mean value theorem; Taylor's and Maclaurin's formulae.
4. **Maxima and Minima of Functions of One Variable.**

5. **Partial Differentiation:** Euler's Theorem; Tangents and Normals.

6. **Asymptotes.**

7. **Indefinite Integral:** Method of substitutions; Integration by parts; Special trigonometric functions and rational fractions.

8. **Definite Integrals:** Fundamental theorem; General properties; Evaluations of definite integrals and reduction formulae.

9. **Multiple Integrals:** Determination of lengths, areas and volumes.

**Co-ordinate Geometry**

1. Transformation of co-ordinates axes and its uses, Equation of conics and its reduction to standard forms, Pair of straight lines, Homogeneous equations of second degree, Angle between a pair of straight lines, Pair of lines joining the origin to the point of intersection of two given curves and circles, System of circles, Orthogonal circles, Radical axis, radical center, properties of radical axes, coaxial circles and limiting points.

2. Equation of parabola, Equation of ellipse and Equation of hyperbola in Cartesian and polar co-ordinates, Tangents and normal, pair of tangents, Chord of contact, Chord in terms of its middle points, Pole and polar parametric co-ordinates, Diameters, Conjugate diameters and their properties, Director circles and asymptotes.

| Books Recommended: | | | |
|---|---|---|---|
| | | | |
| | **Authors** | | **Books** |
| **1.** | F. Ayres | **:** | Calculus |
| **2.** | BC. Das & BN. Mukherjee | **:** | Differential Calculus |
| **3.** | BC. Das & BN. Mukherjee | **:** | Integral Calculus |
| **4.** | Edwards | **:** | Differential Calculus |
| **5.** | RE. Williamson | **:** | Integral Calculus |
| **6.** | Muhammad & Bhattacherjee | **:** | Differential Calculus |
| **7.** | Muhammad & Bhattacherjee | **:** | Integral Calculus |
| **8.** | Bell, J.T | **:** | Solid Geometry |
| **9.** | Smith | **:** | Co-ordinate Geometry |
| **10.** | Chaki, M. C | **:** | Co-ordinate Geometry |
| **11.** | Loney, S. L | **:** | Co-ordinate Geometry |
| **12.** | Askwith | **:** | Co-ordinate Geometry |
| **13.** | Rahman & Bhattacharjee | **:** | Co-ordinate Geometry |

## PHY-105 Chemistry 4.0

1. **Chemical Analysis:** Types of chemical analysis: Qualitative analysis, Quantitative analysis, Volumetric analysis; Types of titrations; Requirement of volumetric analysis; Acidimetry and alkalimetry; Primary and secondary standard substance; Different units of concentration; Equivalent weight of an acid, base, salt and oxidizing and reducing agents; Preparation of standard solution; Theory of neutralization reaction.

2. **Solution:** Types of solution; Factors influencing the solubility of a substance; Mechanism of dissolution; Liquefaction of gas; Properties of dilute solution; Osmotic pressure; Raoults' law of vapor pressure; Elevation of boiling point and depression of freezing point and their experimental determination.

3. **Chemical Kinetics:** First and second order reactions and their simple treatment; Simple theories for reaction rate (only outline of Arritenuum theory); Determination of order of reaction; Collision theory.

4. **Electrochemistry:** Electrolytic dissociation; Electrolytic conductance measurement; Ionic migration and transport number; Ionic product of water; Solubility product communion effect; e.m.f. of cells and their measurements; Buffer solutions; Indications; Concept of pH.

5. **Chemical Equilibria:** Law of mass action; Effects of temperature, pressure and concentration on chemical equilibria; Relationship between $k_p$ and $k_c$.

6. **Surface Chemistry and Colloids:** Absorption, Langmuir absorption isotherm; Colloids-classification, preparation, purification, properties and importance; Elementary ideas about insulsion and gels.

7. **Atomic Structure:** Elementary ideas of atomic structure; Electronic configuration of elements.

8. **Periodic Classification of Elements**: Modern periodic table; Periodic classification of elements; Correlation of periodic classification with electronic configuration; Investigation on some periodic properties; Atomic radius; Ionic radius; Covalent radius; Ionization potential; Electron affinity; Electro negativity.

9. **Group Study of Elements:** Alkali metals; Alkaline earth metals; Halogens; Inert gases and transition elements.

10. **Chemical Bonds:** Elementary different types of chemical bonding; Concept of hybridization; Molecular orbitals; Bond length and binding strength.

11. **Aliphatic Compounds:** Nomenclature of organic compounds; Preparation and properties of alcohols; Halides; Aldehydes; Ketones and carboxylic acids.

.

12. **Aromatic Compound:** Aromaticity; Orientations; Preparations and properties of benzene, phenol, nitrobenzene and aniline; Alicyclic and heterocyclic compounds.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | Daniels and Alberty | **:** | Physical Chemistry |
| **2.** | S. Glasstone | **:** | Physical Chemistry |
| **3.** | P.C. Rakshit | **:** | Physical Chemistry |
| **4.** | M.M. Hoque and M.A. Nawab | **:** | Principles of Physical Chemistry |
| **5.** | Bahl and Tuli | **:** | Essentials of Physical Chemistry |
| **6.** | S.Z. Haider | **:** | Modern Inorganic Chemistry |
| **7.** | T. Moeller | **:** | Modern Inorganic Chemistry |
| **8.** | E. Gilreath | **:** | Fundamental Concepts of Inorganic Chemistry |
| **9.** | D.K. Seberra | **:** | Electronic Structure and Chemical Bonding |
| **10.** | M. Ahmed & A. Jabbar | **:** | Organic Chemistry |
| **11.** | I.M. Finer | **:** | Organic Chemistry |
| **12.** | B.S. Bahl and A. Bahl | **:** | Advanced Organic Chemistry |

## PHY-106 Bangladesh and global studies 2.0

1. **Bengal in the Ancient period:** Land, people, society, culture; different Janopadas (areas or localities); Palas of Bengal; Senas of Bengal.

2. **Bengal in the Mediaeval and Pre-British Period:** Bengal under the Muslim rule; Turko-Afahan- Mughals; SwadhinNababi rule (1707-1757); Battle of Palashi (1757).

3. **British Rule and Twentieth Century Bengal:** Impacts of British rule; Socio-economic settings of twentieth century Bengal and Hindu-Muslim relations; Partition of Bengal and its annulment (1905-1911); foundation of All-India Muslim League (1906); C.R. Das Bengal Pact (1923); FazlulHaq's leadership in Bengal politics; Pakistan movement in Bengal and Bengali view of Pakistan; 1940Lahore Resolution and Statehood Ideal of the Bengalis; Suhrawardy's move for United Independent Bengal (1947) and partition of India.

4. **Emergence of Bangladesh as an Independent State:** Position of Bengalis in the Pakistan State: Disparities and denial of political role; Language Movement 1948,1952; 1954 election and Its aftermath; Ayub's military rule (1958-1969); Six-point movement and Students' eleven point movement; Agartala Conspiracy Case and 1969 upheaval; 1970 Elections and victory of Awami League; Bangabandhu's Non-cooperation Movement (2-25 March 1971); Bangabandhu's historic 7March (1971) Address; Declaration of Bangladesh's Independence; Mujibnagar government; genocide by the Pakistan occupation armies and their local collaborates; Victory in the War of Liberation and the emergence of Bangladesh; 1972 Constituting for the new-born State.

**Books Recommended:**

| | **Authors** | | **Books** |
|---|---|---|---|
| **1.** | নীহাররঞ্জন রায় | **:** | বাঙ্গালীর ইতিহাস: আদিপর্ব, কলকাতা, দে'জ পাবলিশিং, দ্বিতীয় সংস্করণ, ১৪০২ বাংলা সাল |
| **2.** | Nitish Sengupta | **:** | History of the Bengali Speaking People, New Delhi, USBPD 2002. |
| **3.** | Abdul Momin Chowdhury | **:** | Dynastic History of Bengal, Dacca: The Asiatic Society of Pakistan 1967 |
| **4.** | Jadunath Sarkar (ed.) | **:** | History of Bengal, Vol.II, University of Dhaka 1976 |
| **5.** | M.R. Tarafdar, Husain Shahi Bengal 1494-1538 A.D. | **:** | A Socio-Political Study Dacca: Asiatic Society of Pakistan 1965. |
| **6.** | Md. Aktaruzzaman | **:** | Society and Urbanization in Medieval Bengal, Dhaka: Asiatic Society of Bangladesh 2010 |
| **7.** | A.M. A. Muhith, Banglsdesh | **:** | Emergence of a Nation, Dhaka: Bangladesh Books Intenational1978 |

| | | | |
|---|---|---|---|
| **8.** | Sirajul Islam (ed.) | **:** | History of Bangladesh, 1704-1971, Vols. i-iii, Dhaka: Asiatic Society of Bangladesh 1992 |
| **9.** | Harun-or-Rashid | **:** | The Foreshadowing of Bangladesh: Bengal Muslim League and Muslim Politics, 1906-1947, Dhaka: University-Press Limited 1912 |
| **10.** | হারুন-অর-রশিদ | **:** | বাংলাদেশ: সরকার ও রাজনীতি, |
| **11.** | হারুন-অর-রশিদ | **:** | বাঙালির রাষ্ট্র চিন্তা ও স্বাধীন বাংলাদেশর অভ্যুদয়, ঢাকা: আগামী প্রকাশনী ২০০৩ |

## PHY-107 Physics Lab-I 4.0

### MECHANICS AND PROPERTIES OF MATTER

1. Determination of `g' by compound pendulum.
2. Determination of Young's and rigidity modulii by dynamic method.
3. Determination of rigidity modulus by static method.
4. Determination of surface tension of water by capillary tube method.
5. To determine the spring constant and effective mass of a given spiral spring and Hence calculate the rigidity modulus of the material of the spring.
6. To determine the moment of inertia of a fly-wheel about its axis of rotation.
7. To determine the acceleration due to gravity g by kater's pendulum.

### SOUND

8. To determine the mass per unit length and hence density of the material of a wire by a sonometer.
9. To determine the weight (mass) of a given bag or a brick by sonometer.
10. To find the frequency of tuning fork by Melde's experiment.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | Giasuddin Ahmad and, Md. Shahabuddin | **:** | Practical Physics for Degree Students |
| **2.** | C.L. Arora | **:** | B.Sc. Practical Physics |
| **3.** | Harnam Singh | **:** | B.Sc. Practical Physics |
| **4.** | Kalimuddin | **:** | B.Sc. Practical Physics |
| **5.** | Giasuddin Ahmad and, Md. Shahabuddin | **:** | Practical Physics for Degree Students |
| **6.** | C.L. Arora | **:** | B.Sc. Practical Physics |
| **7.** | Harnam Singh | **:** | B.Sc. Practical Physics |
| **8.** | Kalimuddin | **:** | B.Sc. Practical Physics |

**PHY-108 Chemistry Lab 2.0**

Laboratory works based on **PHY-105.**

**PHY-109 Viva 2.0**

# Year-II

## PHY-201 Optics 4.0

1. **Propagation of Light:** Light and electromagnetic spectrum, Velocity of light in Vacuum in terms of $\varepsilon_0$ and $\mu_0$; Super luminal light; Poynting vector and intensity of light; Hygen's principle, Fermat's principle; coherence properties of ordinary and laser light. Concept of reflection and Refraction; Reflection and Refraction of spherical surfaces; Refraction through lenses; Equivalent lens; Cardinal points.

2. **Interference:** Huygen's principle; superposition of waves; Young's experiments; Fresnel's biprism; Lloyd's mirror; Michelson's interferometer; Reflection from a film of varying thickness; Color of thin films; Newton's ring; Fabry-Perot interferometer; Antireflection coating; Interference filters.

3. **Diffraction:** Fresnel & Fraunhofer diffraction; Diffraction- single slit and double slit; Multiple slits diffraction phenomena; Half-period zones and strips; Diffraction by a circular aperture; Diffraction by a circular obstacle; Zone plates; Diffraction at a narrow edge; Cornu's spiral; Fresnel's integrals. Rayleigh's criterion for resolution; Plane diffraction grating; Dispersive and resolving power of a grating.

4. **Polarization:** Definition; Plane, circular and elliptic polarization; Polarization by reflection; Brewster's law; Optical activity; Birefringence; Optical axis; Full-wave, half-wave and quarter-wave plates; Nicol and Wollaston prisms; Dispersion; Cauchy and Sellmeir formula; Polarization by scattering; Rayleigh scattering; Scattering phenomena in the atmosphere; Faraday, Kerr and Pockels effects; Polarization by reflection, polarization by double refraction; Brewster's law; Optical activity; Full Wave, half-Wave and quarter wave plates; Nicol & Willaston prism; Malus law; Polarization by scattering. Polarizing Microscope; Optical activity.

5. **Optical Instruments:** Telescope; Microscope; Spectrometer; Polarimeter.

6. **Defect of images and optical instruments:** Aberrations; Spherical aberration at a single surface and in lens reducing spherical operations; Coma; Astigmatism; Distortion; Chromatic aberrations; Achromatic doublets.

7. **Fiber optics:** Basics concepts; Principle of light propagation through optical fibers; Numerical aperture; Fiber bundles; Types of fiber, Step-index and grad index fibers; Multimode and single mode fiber; Optical fiber communications.

8. **Holography:** Diffraction from apertures and edges; Production of holograms; Applications of hologram.

9. **The Laser:** Fundamental Principles; Stimulated emission; Einstein's relation; population inversion; Optical feedback; Types of lasers: Ruby, He-Ne, $CO_2$, Argon ion, dye, Semiconductor; Applications of laser.

**PHY-202** **Mathematical Physics** **4.0**

1. **Vector Analysis:** Applications of dot and cross products of vectors; Scalar triple product; Vector triple product; Ordinary derivatives of vectors; Space curves; Differentiation formulae; Partial derivatives of vectors; Differentials of vectors; The vector differential operator nabla ($\nabla$); Gradient; Divergence; Curl and their physical significance; Line integrals; Surface integrals; Volume integrals; Green's theorem in the plane; Stoke's theorem; Applications; frames of reference-rectangular; Spherical polar and cylindrical coordinates; Concept of curvilinear coordinates; Line arc length, surface and volume elements in different coordinates; div., curl and Laplacian in Cartesian, spherical polar and cylindrical polar coordinates

2. **Techniques of Complex Variables:** Function of a complex variables; The Cauchy-Riemann relations; Power series in a complex variables; Elementary function; Multi valued function and branch cuts; Jordan lemma; Singularities and zeros of complex functions. Complex integrals; Green's theorem; Cauchy's Theorem; Cauchy's Integral Formula and Its Expansion; Taylor and Laurent series; Residue theorems; Finding residues; Evaluation of definite integrals using the method of residue. Integrals of sinusoidal functions; infinite integrals.

3. **Elements of Tensor Algebra:** Definition of tensor; Importance of tensor in Physics; Rank, Covariant and contravariant tensors; Transformation of coordinates; Kronecker delta and Levi-Civita symbols; Einstein summation convention; Direct product; Symmetric and anti-symmetric tensors; Contraction; Tensor equations; Metrictensor and their determinants; General coordinate transformations and tensors.

4. **Matrices**: Different types of matrices and their definition, Matrix equivalence, The adjoint and innerse of a matrix, Orthogonal and unitary matrices, Vector spaces linear equations, Similarity transformation, Characteristic roots and vector diagonalization of matrices.

5. **Special function:** Gamma and Beta functions; Bessell's Functions; Legendre Function; Legendre Hermit; Legendre Polynomials; Dirac Delta Function; Hypergeometric functions; Fourier and Laplace transforms.

6. **Differential Equations:** Power series solutions; Solution of the differential equations by the method of separation of variables, Solution of Laplace's equation in spherical polar and cylindrical coordinates.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors/ Publisher** | | **Books** |
| **1.** | Schaum's Outline Series; McGraw-Hill International | **:** | Theory of Matrices |
| **2.** | H. T. M. Piaggio | **:** | An Elementary Treatise on Differential Equations and their Applications |
| **3.** | Schaum's Outline Series; McGraw-Hill International | **:** | Differential Equations |
| **4.** | Bukov | **:** | Mathematics for Physics |
| **5.** | B. D. Gupta | **:** | Mathematical Physics |
| **6.** | B. S. Rajput and Yog Prokash | **:** | Mathematical Physics |

## PHY-203 Heat & Statistical Mechanics 4.0

**Heat and Thermodynamics**

1. **Temperature:** Principles of measurement and establishment of temperature scales; Gas Thermometer; Electrical Resistance Thermometer; Thermocouple.

2. **The Kinetic Theory of Gases**: Macroscopic versus microscopic properties ;Brownian motion; Mean free path; Derivation of Maxwell-Boltzmann distribution; mean speed; most probable speed and r.m.s. speed; Deduction of the ideal gas equation; Equipartition of Energy. Degrees of freedom and specific heat: applications.

3. **Thermodynamics:**
   a) Zeroth law of thermodynamics: Thermal equilibrium and temperature scales; Concept of intensive and extensive variables.
   b) P-V diagrams; Isotherms and adiabatics; Equation of states; ideal gas vs real gases; Vander Waals equation; Critical parameters.
   c) First law of thermodynamics; Difference between heat and work; Internal energy; Reversible and irreversible process; Quasi static process; Calculation of work; Heat and internal energy in different process.
   d) Second law of thermodynamics; Heat engines; Efficiency of heat engines; Carnot cycle and Carnot's theorem; Absolute scale of temperature; The concept of entropy as a state function; Change of entropy in irreversible and cyclic process; Clausias and Kelvin statements of the second law. Entropy as a measure of microscopic states and the Boltzmann formula for entropy. Calculation of entropy via microscopic methods; Third law of thermodynamics.
   e) Thermodynamic potentials: Enthalpy; Helmholtz and Gibbs free energies; Legendre transformation; Gibbs-Duhem equation; exact differential form and Maxwell relations; Heat capacities and other response function and their relations.

f) Applications: i) Cooling of gasses by free expansion and throttling (Joule-Thomson Process), ii) Adiabatic demagnetization, iii) Thermoelectric phenomena: Seebeck, Peltier and Thompson effects.
g) Phase transitions: Classification of phase transitions; First order and second order phase transition and their examples; Clausius-Clapeyron equation; Chemical potential; Gibbs phase rule.

4. **Radiation:** Black body radiation; Thermodynamics of radiation; Stefan's law; Rayleigh-Jeans law and ultraviolet catastrophe; Wien's displacement law, Planck's distribution law for blackbody radiation and quantum hypothesis.

**Statistical Mechanics**

5. **Statistical System:** The scope of statistical physics; Postulates of classical statistical mechanics; Macroscopic and microscopic states; Thermodynamic functions and their equilibrium conditions.

6. **Ensembles**: Phase space; Lieuvilles theorem; Microcanonical Ensemble; Canonical Ensemble-its Connection with thermodynamic parameters; Ideal monatomic gas; Harmonic oscillator; Specific heat of solids; Grand canonical ensemble; Maxwell velocity distribution and mean values.

7. **Statistical Distribution:** Maxwell-Boltzmann distribution; Bose-Einstein distribution and Planck's radiation law; Fermi-Dirac distribution and heat capacity of free electron gas.

8. **Quantum Statistics:** Need of quantum statistics; Indistinguishability and quantum statistics; Exchange symmetry of wave function; Exchange degeneracy; Average value and quantum statistics; The density matrix.

9. **Quantum Mechanical Gases:** Fermi gas; Fermi-Dirac distribution; Fermi energy; Degenerate Fermi system; Heat capacity of free electron gas; Bose gas; Bose-Einstein distribution; Photon; Phonon; Bose-Einstein condensation; Thermodynamic properties of diatomic molecules; Nuclear spin effects in diatomic molecules.

**Books Recommended:**

| | **Authors** | | **Books** |
|---|---|---|---|
| **1.** | Brij Lal, Dr. N. Subrahmanyam and P.S Hemne | **:** | Heat Thermodynamics & Statistical Physics |
| **2** | Hossain, T | **:** | Text Book on Heat |
| **3.** | Saha, MN and Srivastava, BK | **:** | A Treatise on Heat |
| **4.** | Zemansky, MW | **:** | Heat and Thermodynamics |
| **5.** | Miah, W | **:** | Fundamentals of Thermodynamics |

## PHY-204 Statistics 4.0

1. **Statistics:** Definition and scope: definitions of statistics, past and present, its nature and characteristics, population and sample, descriptive and inferential statistics, scope and applications of statistics, abuse of statistics, sources of statistical data, primary and secondary sources; Data collection tools, types etc; Construction of questionnaire and other field; problems of data collection; Types of data: cross sectional, longitudinal, follow-up and panel data.

2. **Processing of Data:** Measurement scales; Variables; Attributes; Classification; Characteristic and basis of classification; Array formation; Tabulation; Different types of tables; Frequency distribution.

3. **Presentation of Data:** Graphical presentation of data; Details of different types of graphs and charts with their relative merits and dements; Concept of explorative data analysis; Stem and leaf plot; Schematic plots; Extremes and median; Hinge; Outliers and 5 number summaries.

4. **Characteristics Of Statistical Data:** Measures of location; Dispersion; Skewness; Kurtosis and their properties; Moments box and whiskers plots; Trimean, trimmed mean, interpretation of data with these measures.

5. **Correlation Analysis:** Bivariate data; Scatter diagram; Simple correlation; Rank correlation; Correlation ratio; Multiple and partial correlations; Intraclass and biserial correlation.

6. **Regression Analysis:** Basic concept of regression; Regression model; Estimation of parameters (OLS method) in regression model; Properties of estimators; Interpreting the constants; Some ideas of polynomial regression; 3-variable regression; Estimation of parameters; Standard error and other properties.

7. **Association of Attributes:** Concepts of independence; Association and disassociation; Contingency table; Measure of association for nominal and data in contingency tables; Partial association; Different forms of correlation table.

8. **Elements of Probability:** Experiment; Random experiment; Sample specimen events; Event space; Union and intersection of events; Different types of events.

9. **Basic Concepts of Probability:** Different approaches of defining probability: classical, axiomatic, empirical and subjective; Laws and theorems of probability; Conditional probability; Bayes' theorem and its importance in statistics.

10. **Random Variable and Its Probability Distribution:** Discrete and continuous random variables; Probability mass function; Probability density function; Distribution function; Function of random variable and its distribution; Joint distribution; Marginal and conditional distributions; Independence of random variables.

11. **Mathematical Expectation:** Concept, expectations of sums and products of random variables; Conditional expectation and conditional variance; Moments and moment generating functions; Cumulants and cumulant generating functions; Relation between moments and cumulants; Probability generating functions; Characteristic function.

12. **Some Basic Distributions:** Detailed study of binomial; Poisson, normal, uniform, geometric, negative binomial, hypergeometric, exponential, gamma, beta distributions.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | A.J.B. Anderson | **:** | Interpreting Data |
| **2.** | M.G. Bulm r | **:** | The Elements of Probability Theory |
| **3.** | W. Feller | **:** | Introduction Statistics |
| **4.** | U. Yule and Kendal | **:** | Introduction to Theory of Statistics |
| **5.** | D.V. Lindley | **:** | Introduction to Probability and Statistics |
| **6.** | M.G. Mostafa | **:** | Method of Statistics |

## PHY-205 Mathematics-II 4.0

**Linear Algebra**

1. **Vectors in $R^n$ and $C^n$:** Review of geometric vectors in $R^2$ and $R^3$space; Vectors in $R^n$ and $C^n$; Inner product; Norm and distance in $R^n$ and $C^n$.

2. **Matrices:** Notion of matrix, types of matrices, matrix operations, laws of matrix algebra; Cofactors; Elementary row and column operations and row-reduced echelon matrices; Invertible matrices; Block matrices.

3. **System of Linear Equations:** System of linear equations (homogeneous and non-homogeneous) and their solutions; Application of matrices and determinants for solving system of linear equations.

4. **Vector Spaces:** Notions of groups and fields; Abstract vector space, subspace; Linear independence of vectors; Basis and dimension of vector spaces; rank of matrices; Solution spaces of systems of linear equations.

5. **Linear Transformations:** Linear transformations; Kernel and image of a linear transformation and their properties; Matrix representation of linear transformations; Change of bases.

6. **Eigenvalues and Eigenvectors:** Eigenvalues and eigenvectors; Diagonalization; Cayley-Hamilton theorem and its applications.

**Numerical Analysis**

7. **Solution of Equation in One Variable:** Bisection algorithm, Method of false position, fixed point iteration, Newton-Raphson method, Error Analysis for iterative method, Accelerating limit of convergence.

8. **Interpolation and Polynomial Approximation:** Taylor polynomials, Interpolation and Lagrange polynomial, Iterated interpolation, Extrapolation.

9. **Differentiation and Integration:** Numerical differentiation, Richardson's extrapolation, Elements of Numerical Integration: Trapezoidal rule, Simpson's 1/3 Rule, Adaptive quadrature method, Romberg's integration, Gaussian quadrature.

10. **Solutions of Linear Systems:** Gaussian elimination and backward substitution, pivoting strategies, LU decomposition method.

| **Books Recommended:** | | | |
|---|---|---|---|
| | | | |
| | **Authors** | | **Books** |
| **1.** | Bamside and Pantion | **:** | Theory of Equations |
| **2.** | Bemard and Child | **:** | Higher Algebra |
| **3.** | Hall, HS and Knight, SR | **:** | Higher Algebra |
| **4.** | S. S. Sastry | **:** | Introductory Methods to Numerical Analysis |
| **5.** | E. Balagurusamy | **:** | Numerical Methods. |
| **6.** | R. L. Burden & J. D. Faires, | **:** | Numerical Analysis. |
| **7.** | Kalimuddin M. A. Celia & W. G. Gray, | **:** | Numerical Methods for Differential Equations. |
| **8.** | S. S. Sastry | **:** | Introductory Methods to Numerical Analysis |
| **9.** | E. Balagurusamy | **:** | Numerical Methods. |
| **10.** | R. L. Burden & J. D. Faires, | **:** | Numerical Analysis. |
| **11.** | *Kalimuddin* M. A. Celia & W. G. Gray, | **:** | Numerical Methods for Differential Equations. |
| **12.** | L. W. Johson& R. D. Riess, | **:** | Numerical Analysis. |

## PHY-206 Introduction to Computer Fundamentals and Programing 4.0

1. **Computer Fundamentals:** Evolution of computers; Elements of a computer system; Types of computer; Basic computer architecture; Applications of computer, Number systems and fundamental logic gates.

2. **Personal Computer Hardware:** Processor; Main memory; Input and output devices; Storage devices; Modem.

3. **Softwares:** Categories of softwares; System softwares; Functions of an operating system; Types of processing; Language translators; Utility programs; PC operating systems; Computer viruses: categories and preventions.

4. **Application Software:** Word-processing: creating, editing and formatting features; Spreadsheet: creating and editing worksheets; Spreadsheet analysis: formula, functions and charting features; Multimedia presentations.

5. **Networking and Internet:** Different types of networks; Network topologies; Communication media; Internet services: e-mail and e-commerce.

6. **Elements of Computer Structures and Programming Languages:** Different type of Computer Languages; Principles of programming; Structured programming concepts; Programming algorithms and flow charts construction; Introduction of C programming language; Basic structure of C program.

7. Writing, Debugging and Running programs using C; Variables; Arithmetic expressions; Data types; Operators and expressions; Character and Logical Data; Control flow; Loops and Logical Expressions; Functions and program structures; Pointers and arrays; Structures; Input/output systems in C; File Processing; Applications to Various Statistical and Physical Problems; Introduction to Simple structures in C++, Introduction to object oriented programming using C++ .

**Books Recommended:**

| | **Authors** | | **Books** |
|---|---|---|---|
| **1.** | V. Rajaraman | **:** | Fundamentals of Computers |
| **2.** | S. k. Sarkar and A. K Gupta | **:** | Elements of Computer Science |
| **3.** | Peter Norton and John Goodman | **:** | Inside the PC |
| **4.** | Peter Norton | **:** | Introduction to Computers |
| **5.** | M. Lutfar Rahman | **:** | Computer Fundamentals |
| **6.** | ITL Education Solutions Limited | **:** | Introduction to Computer Science |
| **7.** | Norton, P Peter Norton's | **:** | Introduction to Computers |
| **8.** | SE Hutchinson & SE Sawyer, | **:** | Computer and Information System |
| **9.** | Taylor, G G CSE | **:** | Computer Studies |

## PHY-207 Physics Lab-II 4.0

### HEAT

1. To determine the specific heat of a liquid by the method of cooling.
2. To determine the coefficient of thermal conductivity of a metallic bar by Searle's apparatus.
3. To determine the value of J. the mechanical equivalent of heat, by electrical method.
4. To determine the electro-chemical equivalent of copper by using an ammeter and copper voltammeter.

### OPTICS

5. To determine the focal length and hence the power of a concave lens using an auxiliary convex lens.
6. To determine the refractive index of a liquid by pin method using a plane mirror and a convex lens.
7. To determine by boys method (a) The radius of curvature of a lens and (b) the refractive index of the material of the lens.
8. To determine the angle of a prism (by rotation of the telescope).
9. To determine the radius of curvature of a lens by Newton's rings.
10. To determine the Wavelengths of various spectral lines by a spectrometer using a plane diffraction grating.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | Giasuddin Ahmad and, Md. Shahabuddin | **:** | Practical Physics for Degree Students |
| **2.** | C.L. Arora | **:** | B.Sc. Practical Physics |
| **3.** | Harnam Singh | **:** | B.Sc. Practical Physics |
| **4.** | Kalimuddin | **:** | B.Sc. Practical Physics |

**PHY-208 Computer Fundamentals and Programming Lab. 2.0**

1. **Word Processor:** Students will learn to use a popular word processor to create a camera ready text file complete with figures, columns and tables.

2. **Spread Sheet:** Students will learn to use a popular Spread Sheet to maintain a small database, minor book keeping and statistical and graphical analysis of data.

3. **Presentation Package:** Students will learn how to create multimedia slides and animation.

4. Students will complete at least three projects with proper documentation as assigned by teacher, based on course

**PHY-209 Viva 2.0**

**PHY-301 Classical Mechanics 4.0**

**Classical Mechanics**

1. **Lagrangian Formulation:** Generalized Coordinates; Constraints; Degrees of freedom; D'Alembert's Principle and Langrange's Equations; Hamilton's Principle and Lagrange's Equations; Conservation Theorems.

2. **The Two-Body Central Force Problem:** Two Body Central Force Problem Reduction to Equivalent One-Body Problem; Classification of Orbits; Differential Equation for the Orbit; Inverse Square Law of Force; Scattering in a Central Force Field; Scattering Problem.

3. **Rigid Bodies:** Kinematics and dynamics of rigid bodies; Independent co-ordinates: Euler's angles; Force free motion; Euler's equation of motion; Symmetrical top.

4. **Hamilton's Equation of Motion:** Legendre transformation and Hamilton's equations; Derivation from variational principle; Principle of least action and its applications.

5. **Canonical Transformations:** Equations of canonical transformation; Integral invariant of Poincare; Lagrange and Poisson brackets.

**Relativity (Special & General)**

1. **Special Theory of Relativity:** Inertial frames of reference; Michelson Morley Experiment; Galilean transformation; Lorentz transformation; Postulates of the special theory of relativity; Four vectors; Length contraction; Time dilation; Twin paradox; Newtonian mechanics; Relativistic mass; Relativity of simultaneity; Proper time; Velocity addition; LIGO.

2. **Relativistic Mechanics:** Equivalence of mass and energy; Mass and momentum; Relativistic energy; Momentum energy four vector; Relativistic force law; Relativistic lagrangian.

3. **General Relativity:** Postulates of General Relativity; Photons and Gravity; Doppler effect and Gravitational red shift; Principle of Equivalence; Principle of General Relativity; Motion of a particle in a Gravitational field; The constant Gravitational field.

4. **Field Equation:** Energy-Momentum tensor; Maxwell's field Equation; Schwarchild solution; Experimental tests of general relativity.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | S.L. Gupta, H.V Sharma & V Kumar G. | **:** | Classical Mechanics |
| **2.** | Goldstein | **:** | Classical Mechanics |
| **3.** | N.C. Rana & P.S. Joag | **:** | Classical Mechanics |
| **4.** | K.C. Gupta | **:** | Mechanics of Particle & Rigid Bodies |
| **5.** | D'Inverno, R | **:** | Introducing Einstein's Relativity |
| **6.** | Resnick, R | **:** | Introduction to Special Relativity |
| **7.** | Bergmann, P G | **:** | Introduction to the Theory of Relativity |

## PHY-302 Quantum Mechanics- I 4.0

1. **Physical Basis**: Failures of classical mechanics and emergence of quantum mechanics; Quantum theory of radiation and photons; Bohr atom and old quantum theory; Wilson-Somerfield quantum conditions; Domain of quantum mechanics; Heisenberg uncertainty principle.

2. **Wave Nature of Matter:** Wave particle duality; De Broglie hypothesis; Wavelength and velocity; Phase and group velocity of matter wave; Wave packet; The Heisenberg uncertainty relation and applications.
3. **Formulation**: Concepts and physical postulates of quantum mechanics; Operators, state function and state function space; Eigenvalue equation, eigenfunctions and basis vectors; Measurements in quantum mechanics and expectation values; Eigenfunction orthogonality and the sharing of eigenfunction states.
4. **Schrödinger's Equation**: Time-dependent and time-independent Schrodinger's equations; The development of wave function and its interpretation; Significance of wave functions; Normalization of wave function; Coordinate and momentum representation of wave function; Significance; Probability current density; Ehrenfest's theorems; Time variation of expectation values. Momentum wave function for free particle and particle in a box; Box normalization; Dirac delta normalization.
5. **Problems in One-dimension With Schrödinger Equation:** Free particle in quantum mechanics; Particles incident on a potential step and on a potential barrier; Particles in a finite and infinite square potential well; Reflection and transmission coefficients; Energy levels calculation; Quantum mechanical tunneling; Harmonic oscillator; Solution of the Schrodinger's equation for the Harmonic oscillator; Expectation values of some observables in pure and mixed states.
6. **Spherically Symmetric Systems:** Hydrogen atom; Schrodinger's equation for the Hydrogen atom in spherical coordinates; Separation of variables and its solutions; Angular momentum; Operators in spherical coordinates; commutation relations.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | White, R. L. | **:** | Basic Quantum Mechanics |
| **2.** | Eisberg | **:** | Fundamentals of Modern Physics |
| **3.** | Feynman, R. P., Leighton, R. B. and Sands, M. | **:** | The Feynman Lectures in Physics |

| | | | |
|---|---|---|---|
| **4.** | Ghatak, A. K. | **:** | Introduction to Quantum Mechanics |
| **5.** | Matthews, P.T. | **:** | Quantum Mechanics |
| **6.** | Messiah, P.T. | **:** | Quantum Mechanics |
| **7.** | Schiff, L. I. | **:** | Quantum Mechanics |
| **8.** | Powell, J. L. & Crasemann, B. | | Quantum Mechanics |
| **9.** | Harun-ur-Rashid, A. M. | | Quantum Mechanics |
| **10.** | Sherwin, C.W. | | Introduction to Quantum Mechanics |

## PHY-303 Solid State Physics-I 4.0

1. **Crystal System:** Crystalline and non-crystalline states; Unit cell; Bravais lattices; Miller indices; Simple crystal structures; Packing factor; Inter-planar spacing; Concept of reciprocal lattice; Brillion zones.

2. **Crystal Diffraction:** Bragg's law; Laue equation; Diffraction of X-rays by crystals; Atomic and crystal structure factors; Thermal vibrations; Temperature factor; Absorption

3. **Crystal Bindings:** Crystals of inert Gas; Ionic crystals; Binding energy and bulk modulus; Covalent; Metal and hydrogen bonded crystals.

4. **Crystal Bonding :** Interatomic forces and crystal bonding; Ionic crystal; Calculation of electrostatic energy; Madelung constant and bulk modulus; Covalent crystals; Crystals of inert gases; Van der Waals and repulsive interactions.

5. **Dynamics of Crystal Lattice:** Concept of phonon; Elastic vibration of a continuous medium; One-dimensional monoatomic and diatomic lattices; Theories of lattice; Specific heat: Einstein model and Debye model.

6. **Free Electron Theory of Metals:** Classical electron theory; Somerfield theory; Box quantization; Density of states; Fermi surface; Fermi energy; Electrical conductivity; Wiedemann-Franz law; Hall effect in metals.

7. **Band Theory of Solids:** The Bloch theorem; The Kronig-Penney model; The motion of electrons in one dimension; Distinction between metals, insulators and intrinsic semiconductors; The concept of a hole.

| **Books Recommended:** | | | |
|---|---|---|---|
| | ***Authors*** | | **Books** |
| **1.** | C. Kittle | **:** | Introduction to Solid State Physics |
| **2.** | A. J. Dekker | **:** | Solid State Physics |
| **3.** | M. Omar Ali | **:** | Elementary Solid State Physics |
| **4.** | R. L.Singhal | **:** | Introduction to Solid State Physics |
| **5.** | Saxena, Gupta & Saxena | **:** | Fundamental of Solid State Physics |

## PHY-304 Nuclear Physics-I 4.0

1. **Nuclear Properties:** Constituents of Nuclei; Nuclear charge, size and density; Mass defect; Binding energy; Semi empirical mass formula; Nuclear force; Angular momentum; Spin; Parity and Symmetry; Magnetic dipole moment and electric moments.

2. **Natural Radioactivity:** Radioactivity ;Types of radioactivity ;Units of radioactivity; General properties of radioactive radiations; Identification of radioactive elements; Identification of α-particles; Properties of α-rays; Properties of β-rays; Conservation of nuclear energy during beta disintegration; Properties of λ-rays; Electron-positron pair production; Gamma decay; Radioactive disintegration; Laws of radioactive disintegration; Radioactive decay constant (λ); Average life; Method of finding radioactive constant; Determination of half-life; Radioactive series; Similarities between radioactive series; Isotopes; Isomers; Isobars; Isotones and isodiapheres; Radioactive growth and decay; Radioactive equilibrium; Cerenkov radiations; Secondary radiations; Photographic emulsions; Radiation damage; Applications of radioactive radiations.

3. **Artificial Radioactivity:** Discovery of artificial radioactivity; Discovery of radio-sodium; Researches in artificial radioactivity; Radioisotopes of transuranic elements; Isotope tables and nuclide charts; Uses of isotopes; Diagnostic applications of radioisotopes; Industrial applications of radioisotopes; Isotopic dating in geology, Stable and unstable nuclei; Natural and artificial radioactivity; Radioactive decay law; Half-life; Mean life; Successive radioactive transformations; Secular and transient equilibrium; Radioactive series; Uses of radioisotopes; Radioactive dating.

4. **Alpha, Beta and Gamma Emissions:** Alpha instability; Fine structure; Long range alpha particles; Theory of alpha decay; Beta decay and its energy measurement; Conservation of energy and momentum in Beta decay; Neutrino hypothesis; Orbital electron capture; Positron Emission; Gamma Decay; Mean lives for Gamma emission; Internal conversion.

5. **Stopping and detecting of Nuclear Radiation:** Ionization; Multiple scattering; Stopping power; Energy loss of electron and other charged particles; Pair Production; Pair annihilation; Radiation length.

6. **Nuclear reaction, Fission and Fusion:** Nuclear reaction and chemical reaction; Reaction dynamics; Q-value and threshold energy; Neutron and neutron flux; Fission process; Energy release in Fission; Chain reaction; Nuclear Fusion; Thermonuclear reaction in stars.

7. **Nuclear Detectors and particle accelerators:** Van de Graff accelerator; Cyclotron; Betatron; Ionization chambers; Proportional counter and gm counter; Gas Filled counter; Solid- state counter; Scintillation counter; Neutron detection.

8. **Neutron Physics:** Sources of neutrons, interactions of neutrons with matter; Thermal neutrons; Cross-section for neutron induced reactions; Scattering; Absorption cross-section.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | Burcham,WE | **:** | Nuclear Physics |
| **2.** | Enge, HA | **:** | Introduction to Nuclear Physics |

| | | | |
|---|---|---|---|
| **3.** | Krane, K | **:** | Introductory Nuclear Physics |
| **4.** | Kaplan, I | **:** | Nuclear Physics |
| **5.** | Wong, SSM | **:** | Introduction to Nuclear Physics |
| **6.** | Smith, CMH | **:** | Text Book of Nuclear Physics |
| **7.** | Cohen, BL | **:** | Concepts of Nuclear Physics |
| **8.** | Islam, AKMA & Islam, MA | **:** | Nucleo Padartha Vigan (Bangla) |
| **9.** | Islam, GS | **:** | Paramanbik Ebong Nucleo Padarthabijan, Vol.II |
| **10.** | Evans | **:** | Atomic Nucleus |
| **11.** | Meyerhof, WE | **:** | Elementary Nuclear Physics |
| **12.** | Beiser | **:** | A Concepts of Modern Physics |


## PHY-305 Electronics 4.0

1. **Circuit Analysis:** Constant current **a**nd constant voltage sources; Network theorem– Nortan's theorem, Thevenin's theorem, Maximum power transfer theorem; Superposition theorem.

2. **Semiconductor Diode:** Semiconductor; Energy band description of semiconductors; Effect of temperature on semiconductors; Hole current; Different types of semiconductors; Majority and minority carriers; pn- junction; Properties of pn-junction; Semiconductor diode; Forward and reverse bias, I-V curve, Diode equation, Equivalent circuits; DC and AC Resistances; Load line analysis of a diode circuit, Breakdown: Avalanches and Zener mechanism. Special Diode: Zener diode, LED and Tunnel diode, Photodiode; Semiconductor diode rectifiers; Half-wave rectifier; Full-wave rectifier; Efficiency of half-wave and full-wave rectifier; Ripple voltage and factor; PIV rating; Capacitor smoothing; Voltage stabilization; Zener diode as a voltage stabilizer.

3. **BJT:** Construction and operation; amplifying action; CB, CE, CC configuration; CB and CE characteristics; active, cut-off, and saturation region; Alpha and beta; DC load line, Operating point or Q-point, Active region for linear application; Leakage current in a transistor, Thermal runway of a transistor; Transistor as a switch; Different methods for transistor biasing; Fixed bias, Collector feedback, and voltage divider bias; emitter feedback for bias stabilization; AC load line.

4. **FET**: JFET configuration; operation and characteristics; MOSFET construction; operation and characteristics; biasing of FETs; Dc load line; Common source JFET amplifier; ; Switching circuits using FETs; Introduction to CMOS.

5. **Equivalent models and circuits:** modeling and equivalent circuit of BJTs and FETs. Parameters models of transistor: Ebers moll model, Z, Y and h equivalent model. Classification of amplifiers; Single stage and multi-stage transistor amplifiers; R-C coupled and transformer coupled transistor amplifiers; Power amplifier: class A, class B and class C amplifiers; Push-pull amplifier, Tuned amplifier ;distortions in amplifiers; Variations in

amplifier gain with frequency; stray capacitance and miller effect capacitance; multistage frequency effects.

6. **Feedback and Oscillator Circuits:** Feedback: Principles; Characteristics; Current and voltage feedback amplifiers; Positive feedback; Negative feedbacks; forms of negative feedback; advantages of negative feedback; Oscillator: Condition for sustained oscillation; barkhausen criterion for oscillation; Phase-Shift; Wein-Bridge; Hartley; Colpitt's and Crystal, negative resistance oscillator. 10

7. **Operational Amplifiers (OPAMP):** Basic concept on difference amplifier as the input stage of an amplifier ; differential and common mode operation; common mode rejection ratio; the ideal op-amp ; the practical op-amp; frequency response of an op-amp; gain bandwidth product; slew rate; offset voltage and currents. Linear application of op-amp; inverting and non-inverting amplifier: voltage gain; adder, subtractor, comparator, integrator, differentiator, active filters, Schmidt trigger; application in milivoltmeter and current meter.

8. **Voltage regulator**: Series voltage regulation with feedback using transistor and op-amp, load and source regulation, current limiting, IC regulators, switched mode power supply.

9. **Radio Transmitter and Receiver:** Types of modulation; AM modulation; Modulation factor; Analysis of amplitude modulated wave; Demodulation; Linear diode detection; Linear envelop detection; Discriminator circuit. Radio Transmitter and Receiver : Transmitter: Classification of radio transmitter; AM transmitter; FM transmitter; Phase modulated type FM transmitter; Reactance tube FM transmitter; Armstrong FM transmitter; Receiver classification: AM receiver; TRF receiver; Superhetrodyne FM receiver; AVC and AFC system.

10. **Power Electronics:** SCR: Construction; V-I characteristics; Applications of SCR; UJT: Construction; V-I characteristics; Applications of UJT; Triac: Construction; Characteristics; Diac: Operation; Characteristics; Application of diac.

**Books Recommended:**

| | **Authors** | | **Books** |
|---|---|---|---|
| **1.** | A.P. Malvino | **:** | Electronic Principles |
| **2.** | R.L. Boylestad and L. Nashelsky | **:** | Electronic Devices and Circuit Theory |
| **3.** | B. Grob | **:** | Basic Electronics |
| **4.** | V.K. Mehta | **:** | Principles of Electronics |
| **5.** | B. L. Theraja | **:** | Basic Electronics Solid State |
| **6.** | James J. Brophy | **:** | Basic Electronics for Scientists |
| **7.** | R. L.Boylestad, L. Nashelsky | **:** | Electronic Devices & Circuit Theory |
| **8.** | J. Millman & A. Grabel | **:** | Microelectronics |
| **9.** | V. K. Mehta | **:** | Principle of Electronics |
| **10.** | G. K. Mithal | **:** | Electronic Devices & Circuit |
| **11.** | Dr.S.L.Gupta and Dr.V. Kumar | **:** | Hand Book of Electronics |

**PHY-306** **Electrodynamics** **4.0**

1. **Framework:**
   a) Review of Maxwell's equations in vacuum and in matter-integral and differential formulation; Boundary conditions at an interface.
   b) Vector and Scalar potentials; Gauge invariance; Lorentz and Coulomb gauge; Lorentz force in terms of potentials.
   c) Polynting's theorem and Energy-Momentum conservation for electromagnetic fields and charges.

2. **Boundary Value Problems in Electrostatics:**
   a) Poisson equations and Laplace equations; Uniqueness of the solution with Dirichlet Neumann equation.
   b) Method of image charges; Solution of Laplace's equations in two and three dimensions in Cartesian, cylindrical and spherical coordinates; Associated Legendre polynomials and spherical harmonics.
   c) Field inside dielectrics; Boundary value problems involving dielectrics.

3. **Elements of Magneto-statics:** Calculation of the vector potential for current carrying loop; Boundary value problems in magneto-statics.

4. **Propagation of Electromagnetic Waves in Isotropic Media:** Boundary conditions on the field vectors; Reflection and refraction of electromagnetic waves; Total internal reflection.

5. **Propagation of Electromagnetic Waves in Crystalline Media:** Isotropic and anisotropic crystals; Light propagation in uni-axial crystals; Maxwell's equation inside anisotropic crystal, Propagation of plane electromagnetic wave through uniaxial crystal.

6. **Wave Guides:** Solution of the wave equation in a cylindrical and rectangular waveguide; TE mode in rectangular waveguide; Electromagnetic wave through a waveguide; phase and group velocities in a waveguide.

7. **Electromagnetic Radiation:** Electric Dipole radiation; Larmor formula; Lienard and Wicehart potentials; Power Radiated by a point charge; Classical Bremsstrahlung, Radiation Reaction and Abraham Lorentz formula.

8. **Radiation, Scattering & Dispersion:** Scattering by an individual free electron; Normal and anomalous dispersion; Scattering by a bound electron; Absorption of radiation by an oscillator; Rayleigh scattering and Thomson scattering.

**Books Recommended:**

| | **Authors** | | **Books** |
|---|---|---|---|
| **1.** | Reitz J. R. and Milford, F. J. | **:** | Foundations of Electromagnetic Theory |
| **2.** | Penofsky, W. R. H and Philolps M. | **:** | Classical Electricity and Magnetism |
| **3.** | Corson D. R. and Lorrain P. | **:** | Introduction to Electromagnetic Fields and Waves |
| **4.** | Griffiths D. J. | **:** | Introduction to Electrodynamics |
| **5.** | Jackson J. D. | **:** | Classical Electrodynamics |
| **6.** | J.D. Fackson | **:** | Classical Electrodynamics |
| **7.** | N. Tralli | **:** | Classical Electromagnetic Theory |
| **8.** | R. Reifz& F. J. Milford | **:** | Foundations of Electromagnetic Theory |
| **9.** | D. R.. Corson & Lorrain | **:** | Introduction to Electromagnetic Fields and Waves |

## PHY-307 Atomic & Molecular Physics 4.0

1. **Atomic Structure:** Rutherford scattering experiment, Atomic spectra, Bohr atom model, Energy levels, Hydrogen atomic spectra, Atomic excitation, The Franck-Hertz Experiment, The correspondence principle.

2. **Particle Properties of Ways:** Quantum theory of radiation, Photoelectric Effect, Einstein's quantum theory of light and Einstein's photoelectric equation, Compton effect, Pair production and Pair annihilation.

3. **Wave properties of particles:** Wave particle duality, De Broglie waves, Phase and Group velocities, particle diffraction, Davission-Germer Experiment, Uncertainty principle and its application.

4. **X-Ray:** Production and Properties of x-rays, Continuous and Characteristic X-ray diffraction of X-ray, Bragg's Law, X-ray spectrum, Moseley's Law, Absorption of X-ray.

5. **Many-Electro Atoms:** Electron spin, Sterm-Gerlach experiment, Pauli Exclusion Principle, Quantum numbers, Electronic configuration of the atom, Vector atom model, coupling schemes, Hund's rule.

6. **Multiple structure:** Explaining the fine structure, $H_\alpha$ line of Hydrogen spectra, Zeeman Effect, Normal and anomalous Zeeman Effect, Zeeman splitting of sodium $D_1$ and $D_2$ lines, Paschen-Back effect, Stark effect.

7. **Molecular spectra:** Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibrational spectra, Selection rule, Electronic spectrum of molecules, Raman Effect.

8. **Laser:** Laser principle, Stimulated emission, Population inversion, Laser idea, Properties of Laser beam, Ruby and He-Ne lasers.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | Beiser, A. | **:** | Concepts of Modern Physics |
| **2.** | Beiser, A. | **:** | Perspective of Modern Physics |
| **3.** | Eisberg, R.M. | **:** | Fundamental of Modern Physics |
| **4.** | Enge, Wehr and Richards | **:** | Physics of the Atom |
| **5.** | Ohanian | **:** | Modern Physics |

## PHY-308 Physics Lab-III 4.0

**ELECTRICITY**

1. To Determine the Specific Resistance of A Wire Using a Meter Bridge.
2. Determination of the unknown resistance and verification of the laws of combination of resistance using a P.O box.
3. To determine the Internal Resistance of a Cell by Potentiometer.
4. To determine the resistance of a galvanometer by half deflection method
5. To determine the resistance per unit length of meter bridge wire.
6. To determine the Internal Resistance of a Cell by Potentiometer.
7. To determine the logarithmic decrement of ballistic galvanometer and hence to determine its critical damping resistance.
8. To study the frequency response characteristic of a RC low pass and high pass filter circuits
9. To draw the characteristic curves of a PN junction.
10. To draw the characteristic curves for a Zener diode and to study it as a voltage regulator.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | Giasuddin Ahmad and, Md. Shahabuddin | **:** | Practical Physics for Degree Students |
| **2.** | C.L. Arora | **:** | B.Sc. Practical Physics |
| **3.** | Harnam Singh | **:** | B.Sc. Practical Physics |
| **4.** | Kalimuddin | **:** | B.Sc. Practical Physics |
| **5.** | Giasuddin Ahmad and, Md. Shahabuddin | **:** | Practical Physics for Degree Students |
| **6.** | C.L. Arora | **:** | B.Sc. Practical Physics |
| **7.** | Harnam Singh | **:** | B.Sc. Practical Physics |
| **8.** | Kalimuddin | **:** | B.Sc. Practical Physics |

## PHY-309 Physics Lab-IV 4.0

**ELECTRONICS**

1. To design and construct a half-wave rectified power supply and to find the efficiency and ripple factor.
2. To design and construct a full-wave rectified power supply and to find the efficiency and ripple factor.
3. To study the static characteristic a npn or pnp transistor in common base (ii) common emitter arrangement
4. To construct and study a two transistor radio receiver.
5. To construct and study a two transistor radio transmitter.
6. To design and construct a summing amplifier using a 741 OP-AMP and Show the summing in a tabular form for three different values of gain.
7. To study the frequency response of a LCR series circuit and determination of a factor.
8. To study the frequency response of a LCR parallel circuit and determination of a factor.
9. To draw the static characteristics of a field effect transistor (FET) and to determine its parameters.
10. To construct an astable (free running) multi-vibrator and to measure its frequency from the display of its output waveforms on an oscilloscope screen.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | Giasuddin Ahmad and, Md. Shahabuddin | **:** | Practical Physics for Degree Students |
| **2.** | C.L. Arora | **:** | B.Sc. Practical Physics |
| **3.** | Harnam Singh | **:** | B.Sc. Practical Physics |
| **4.** | Kalimuddin | **:** | B.Sc. Practical Physics |
| **5.** | Giasuddin Ahmad and, Md. Shahabuddin | **:** | Practical Physics for Degree Students |
| **6.** | C.L. Arora | **:** | B.Sc. Practical Physics |
| **7.** | Harnam Singh | **:** | B.Sc. Practical Physics |
| **8.** | Kalimuddin | **:** | B.Sc. Practical Physics |

## PHY-310 Viva 2.0

## Year-IV

## PHY-401 Quantum Mechanics- II 4.0

1. **Operator Method in Quantum Mechanics:** Postulates of quantum mechanics; Operators; Wave functions; Eigenvalues; Eigen-value equations; Expectation values; Matrix representation of operators, Hilbert space; Dirac's Bra and Ket notations; Eigen-values and their corresponding eigen-vectors of a matrix; State vectors; Linear vector spaces; Matrix representation of state vectors and operators; Diagonalization of a matrix. The exclusion principle; Spin and statistics; Spin matrices.

2. **Quantum Dynamics:** Schrödinger, Heisenberg and Dirac pictures; Equations of motion in Schrödinger, Heisenberg and Dirac pictures; Linear harmonic oscillator.

3. **Theory of Angular Momentum:** Orbital angular momentum operators and their representation in spherical polar co-ordinates; Commutation relations among orbital angular momentum operators; Ladder operators; Eigenvalues and eigenfunctions of orbital angular momentum operators; Spin angular momentum; Total angular momentum operators; Eigen-values and eigenfunctions of total angular momentum operators; Angular momentum matrices.

4. **Theory of Scattering:** Differential and Total scattering cross-section; Center of mass and laboratory coordinates; Quantum mechanical description of scattering cross-section; Scattering by spherically symmetric potential: Partial wave analysis; Optical theorem.

5. **Perturbation Method:** Concept of approximation methods; Conditions for applying perturbation methods; first and second-order time independent perturbation theory; perturbed harmonic oscillator.

6. **Variation Method:** Necessity of variation method; Basic principle of variation method; Description of variation method; Application of variation method to different quantum mechanical systems.

7. **WKB Method:** Necessity of WKB method; Criteria for the validity of WKB method; Solution of Schrödinger equation by using WKB method; Density of states and transition probability; important applications.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | R. L. White | **:** | Basic Quantum Mechanics |
| **2.** | A. K. Ghatak | **:** | Introduction to Quantum Mechanics |
| **3.** | A. M. Harun-ur-Rashid | **:** | Quantum Mechanics |
| **4.** | S. L. Gupta et al. | **:** | Quantum Mechanics |

## PHY-402 Solid State Physics- II 4.0

1. **Defects in Crystals:** Classification of defects; Point defects; Dislocations; Screw and edge dislocations; Diffusion in metals; Plane defects; Crystal grains and grain boundaries; Energy of grain boundaries.

2. **Energy Bands and Semiconductors:** Nearly free electron model: Energy bands of metal, insulator and semiconductor; Fermi-Dirac distribution in insulators and semiconductors; Electrons, holes and their effective masses; Density of states in intrinsic semiconductors; Impurities in semiconductors; p-and n-type semiconductors; Electrical conductivity and Hall effect; Motion of electrons in one and three dimensions in a periodic potential.

3. **Magnetism:** Origin of magnetism; Classification of magnetic materials; Diamagnetism, Paramagnetism and ferromagnetism; Ferromagnetic domain; Bloch Wall hysteresis loop; Magnetic anisotropy; Antiferromagnets and ferrites.

4. **Dielectric Properties:** Macroscopic electric field; Local electric field; Dielectric constant; Electronic, ionic and orientational polarizabilities; Clausius-Mossotti relation; Measurement of dielectric constant; Dielectrics in an AC field; Relaxation and dielectric loss.

5. **Thermal Properties of Solids:** Specific heats of solids; Breakdown of classical theory; Einstein theory; Debye theory and its modification by Born; Gruneisen constant; Harmonic crystal interaction; Thermal expansion; Thermal conductivity; Thermal resistivity; Umklapp process.

6. **Electrical Properties of Solids:** Dielectric and ferroelectric properties of solids; Dielectric constant and polarizability; Liddane-Sachs-Teller relation; Dielectric relaxation time; Dipole theory of ferro-electricity; Antiferro electricity; Piezo electricity.

7. **Superconductivity:** Introduction; Zero resistance; Meissner effect; Critical field; Two fluid model; Intermediate states; Persistent current; Type I and type II superconductors; Isotope effect; Thermodynamics of superconductivity; London equation; Cooper pairs; Brief ideas on BCS theory and its application.

**Books Recommended:**

| | **Authors** | | **Books** |
|---|---|---|---|
| **1.** | A. J.Dekker | **:** | Solid State Physics |
| **2.** | C.Kittel | **:** | Introduction to Solid State Physics |
| **3.** | Mckelvey | **:** | Solid State Semiconductor Physics |
| **4.** | F.Brailsford | **:** | Principles of Magnetism |
| **5.** | Chikazum | **:** | Physics of Magnetism |
| **6.** | R.L. Singha | **:** | Introduction to Solid State Physics |

## PHY-403 Nuclear Physics- II 4.0

1. **Nuclear Force and Nuclear Models:** General Properties and Characteristics of nuclear force; Exchange forces; Yukawa proposal; Meson theory of nuclear forces; Shell model-single particle shell model; Introductory collective model; Magic numbers; L-S coupling; J-J coupling.

2. **Interaction of nuclei with Electromagnetic Radiation:** Introduction; Multiple radiation and selection rules; The probability of multiple emission and absorption; Radiative transition between low-laying states of nuclei; Transition involving highly excited states.

3. **Nuclear Reactions:** Different types of Reactions; The energies of Nuclear Reactions; Conservation of Physical Quantities in Nuclear Reaction; Nuclear cross-section; Breit-wigner dispersion formula for an s-state; Compound nucleus; Bohr compound nucleus hypothesis; Elastic and inelastic process; Direct reaction; Optical model; Neutron cycle and four factor formula; Nuclear reactors; Homogeneous and in homogeneous reactor system.
4. **Two- Nuclear system (Deuteron problem):** Ground state of deuteron; Normalization of the deuteron wave function; Central potentials; Non-existence of excited states; Tensor force; Magnetic dipole moments and electric quadruple moments of deuteron.

5. **Scattering:** N-P and P-P scattering at low and high energies; Spin dependence of N-P scattering; Scattering length; Phase shift; Coherent scattering of thermal neutrons; Effective range theory; Ortho and Para hydrogen.

6. **Nuclear Shell Model:** Shell model; Single particle shell model; Wave Function and energy levels; Magic numbers; Prediction of spin and magnetic moments; Schmid values and lines; L-S coupling and J-J coupling.

7. **Collective Model:** Rotational energy spectrum and nuclear wave function for ever-ever nuclei and for odd-odd nuclei; Beta and gamma decay; Auger effect; Neutrino hypothesis.

8. **Optical Model:** Optical potential energy; Averaged cross-section; Optical model at low energy.

9. **Elementary particles:** Fundamental interactions; Unification of forces; Particle- antiparticle; Classification and general properties; Quantum number and their conservation; Idea of quarks; Gluon color.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | H.A Preston | **:** | Physics and Nucleus |
| **2.** | Blatt and Weisskopf | **:** | Theoretical Nuclear Physics |
| **3.** | M.A. Enge | **:** | Introduction to Nuclear Physics |
| **4.** | R.R Roy, and B.P. Nigam | **:** | Nuclear Physics: Theory and Experiment |
| **5.** | L.R. Elton | **:** | Introduction to Nuclear Physics |
| **6.** | C. M. H Smith | **:** | A Text Book of Nuclear physics |

| | | | |
|---|---|---|---|
| **7.** | S.E Liverhant | **:** | Elementary Introduction to Nuclear Physics |
| **8.** | G Suresh, Feroz Ahmed and L.S Kotheri | **:** | Physics of Nuclear Reactor |
| **9.** | Kenneth, S. Krane | **:** | Introductory Nuclear Physics |
| **10.** | I. Kaplan | **:** | Nuclear Physics |

## PHY-404 Digital Electronics 4.0

1. **Digital Electronics-an overview**: Analog and digital world; advantages in error free communication and processing; Number system; Logic gates: definition, symbol and truth table; universal gates; Boolean algebra; SOP; POS; maxterm; minterm; algebraic simplification; simplifications using K-maps; don't care condition; Diode gate; DTL gate; TTL gate; comparison of important characteristics of IC logic families.

2. **Flip-flops and related devices:** NAND gate latch; Nor gate latch; Clock signal and clocked FF: S-C, J-K,D, and T FFs; Master slave FFs; FF timing consideration; race around condition; FF application: register; Counters: Design of synchronous and asynchronous counter; Modulo-N counters; Ring counters; Jonson counters; application of counters.

3. **Arithmetic circuit:** Half adder and full adder; parallel binary adder; parallel adder ICs; BCD adder; subtract circuit; multiplier circuit; Typical arithmetic logic unit (ALU).

4. **Decoding and encoding**: Decoder, BCD to 7 segments decoder; BCD to decimal decoder; Encoder. Multiplexing and demultiplexing: Multiplexer and demultiplexers; applications; comparator; parity check and generator.

5. **Converters:** Digital to analog converter; Weighted register DAC R-2R ladder; DAC specifications; Analog to digital converters; Digital ramp ADC; Successive approximation ADC; Flash ADC; ADC and DAC IC;

6. **Semiconductor Memories:** Memory organization and operations; Expansions of word size; classification and characteristics of memory. Memory Terminology: RAM and Rom; SRAM and DRAM.

7. **Multi-vibrator and switching circuit:** Astable with BJT, JFET, and timer ICs; Monostable with BJT and timer IC; Schmitt trigger with BJT, astable, monostable, bistable multi-vibrator; sine-wave oscillator with op-amp; Triangular wave generator; saw-tooth wave generator; voltage controlled oscillator; blocking oscillator; voltage time base generator; exponential sweep circuit; the miller circuit and the bootstrap circuit; current time base generator; trapezoidal waveform; sweep circuit for TV receiver.

| Books Recommended: | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | A. P. Malvino, and Leach. D.P | **:** | Digital Principles and Applications |
| **2.** | A. P. Malvino | **:** | Digital Computer Electronics |
| **3.** | Mano, M. Morris | **:** | Digital Logic and Computer Design |
| **4.** | Tocci | **:** | Digital Systems, Principles and Applications |
| **5.** | L. Nashelsky | **:** | Introduction to Digital Computer Technology |

## PHY-405 Reactor physics 4.0

1. **Nuclear Reaction:** Interaction of Neutrons with matter; Neutron cross- section; Energy dependence of neutron cross-section; Fission cross-section.

2. **Diffusion and Slowing Down of Neutrons:** Thermal neutron diffusion; Diffusion equations; Fast neutron diffusion and Fermi age equation; Energy distribution and cross-section of thermal neutrons; Slowing down of Neutrons; Transport mean free path; Critical equation and reaction buckling, equation of continuity, Fick's law, Diffusion equation, lethargy, average logarithmic decrement.

3. **Reactor Theory:** Neutrons lifetime; Reactor kinetic equation; Delayed neutron; Prompt neutron; Basic principle of reactor control; Multiplication factor; The Four factor formula; Neutron leakage and critical size; Calculation of k for homogeneous reactors; Classification of reactors; Research reactors; Swimming pool water boiler; Power and breeder reactors; Heterogeneous reactors; Calculation of k for heterogeneous reactors.

4. **Reactor Fuels:** The fuel cycle; Production of reach fuels; Sources of uranium; Separation of uranium isotopes; Reprocessing of irradiated fuel; Radioactive Waste disposal.

5. **Energy Removal:** Thermal problems in reactors design; Design for cooling system; Heat sources in reactors systems; Reactor coolants.

6. **Control of Nuclear Reactors:** Reactor kinematics; General factors of reactor control; Effect of temperature on reactivity; Design of control system and reactor operation; Fission product poisoning.

7. **Radiological Physics:** Units and measurement, Biological effects of ionizing and non-ionizing radiations, external effects, internal effects, and low level radiation effect and radiation protection guide.

8. **Reactor and Fuel cycle Technology:** Thermal discharges, BAEC research reactor (TRIGA), gas-cooled reactor accident risks, Loss of coolant accident.

| Books Recommended: | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | Liverhant, S. E. | **:** | Elementary Introduction to Nuclear Reactor Physics |
| **2.** | Glasstone, S. and Edelund M. G. | **:** | Elementary of Nuclear Reactor Theory |
| **3.** | Lamarsh, J. R | **:** | Introduction to Nuclear Reactor Theory |
| **4.** | Lamarsh. J. R. | **:** | Nuclear Reactor Engineering |
| **5.** | Glasstone, S. and Sessonske, A. | **:** | Nuclear Reactor Engineering |
| **6.** | Beck L. K. | **:** | Nuclear Reactor for Research |
| **7.** | Suresh, C., Feroz. A., Kothari. L. S. | **:** | Physics of Nuclear Reactors |

## PHY-406 Plasma Physics 4.0

1. **Introduction to Plasma:** Occurrence of plasma in nature; Definition of plasma; Basic concepts of temperature; Debye length; Plasma parameters; Distribution function; Plasma frequency; Criteria for plasmas; Plasma production; Application of plasma physics.

2. **Single-particle Motions:** The equations of motion; Motion of charged particles in static homogeneous Electric and magnetic fields; Motion of charged particles in nonuniform E and B fields; Motion of charged particles in time-varying E and B fields; Adiabatic invariants.

3. **Plasma as a Fluid:** Relation of plasma physics to ordinary electromagnetic; the fluid equation of motion; the complete set of fluid equations; fluid drifts; plasma approximation.

4. **Waves in Plasmas:** Representation of waves; Group velocity and phase velocity; Plasma oscillations; Electron plasma waves; Sound waves; Ion waves; Comparison of ion and electron waves; Electrostatic electron and ion waves in magnetic fields; Electromagnetic waves in magnetic fields.

5. **Kinetic Theory:** The meaning of distribution function f (v); Equations of kinetic theory; Derivations of fluid equations; Plasma oscillations and Landau damping.

| Books Recommended: | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | Chen, F. F. | **:** | Introduction to Plasma Physics. And Controlled Fusion |
| **2.** | Krall, N. A and Tricvelpiece, A.W. | **:** | Principles of Plasma Physics |
| **3.** | Bittencourt, J. A. | **:** | Fundamentals of Plasma Physics |
| **4.** | Ichimau, S. | **:** | Plasma Physics |
| **5.** | Arimovich, L. A. | **:** | Elementary Plasma Physics |

## PHY-407 Method of Experimental Physics 4.0

1. **Optical Measurements:** Characterization technique: Scanning Electron microscopy (SEM), Transmission Electron microscopy (TEM), Energy dispersive X-ray spectroscopy (EDX), Magnetic force microscopy (MFM), Atomic force microscopy (AFM), Optical transmittance; UV-visible Spectrophotometer; Reflectance and absorption co-efficient.

2. **Electrical Measurements:** Resistance; Two terminal resistance probe; Four terminal resistance probe; van-der Pauw technique; Hall probe; Measurement of conductivity; A.C. dielectric parameters.

3. **Magnetization Measurements:** Vibrating sample magnetometer (VSM); Superconducting Quantum Interference Device (SQUID); permeability; Complex permeability measurement technique.

4. **Phase Sensitive Detection:** Lock-in amplifier; SCR type temperature controller.

5. **Thin Film Technique:** Production and characterization of thin film; Thickness measurement; Interferometric and gravimetric methods.

6. **Gamma-Camera and NMR/ Transducer:** Principle and operation of gamma camera; NMR and NMR imaging techniques.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | Marton and Marton | **:** | Methods of Experimental Physics Vol. 2 |
| **2.** | J. Brophy | **:** | Basic Electronics for scientists |
| **3.** | Kings lake | **:** | Applied Optics Vol. IV |

## PHY-408 Material Science 2.0

1. **Engineering Materials:** Classification of Engineering Materials; Structures and Properties of Non-metallic Materials; Portland cement; Ceramics; Polymers; Refractories; Glassy-metals and Glass Ceramics; Cermet.

2. **Elastic Properties and Hardness of Materials:** Elastic Constants and Moduli of Elasticity; Elastic Waves and Moduli of Elasticity; Elastic and Plastic Deformations; Creep; Fatigue; Hardness Testing; Hardness Scales.

3. **Liquid crystals:** Structure and Classifications of Different Phases; Orientation Order; Magnetic Effects; Optical Properties; Introduction to Theories of Liquid Crystalline Phases; Glass; Glass Transition Temperature.

4. **Diffusion in Solids:** Classification of Diffusion; Diffusion Mechanism; Steady-State & non steady state Diffusion; factors that influence diffusion, other diffusion path.

5. **Magnetic Materials:** Types of Magnetism and their Origins; Langevin theory for Para-magnetism; Curie-Weiss law, Diamagnetic Material; Ferromagnetism; Magnetic Domain and Bloch Wall; Anti-ferromagnetism; Neel's Theory; Ferrimagnetism and Structure of Ferrites and Garnets; Uses of Various Magnetic Materials.

6. **Introduction to Nano-materials:** Nano particles, Nanotubes and Nanowires, Carbon nanotubes, Quantum dot and nano composites, Nano-crystals - Synthesis, Characterization and Applications.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | W. Brostow | **:** | Science of Materials |
| **2.** | E. Abdrson | **:** | Fundamentals of Solar Energy Conversion |
| **3.** | A. V. Narlikers | **:** | Introduction to Superconductivity |
| **4.** | Van-Vlack, L.H. | **:** | Elements of Materials Science and Engineering |
| **5.** | Kumar, D., Jain, S. K. and Bhargava, A. K. | **:** | Material Science and Manufacturing Processes |
| **6.** | Starfield, M. J. and Shvager A. M. | **:** | Introductory Materials Science |
| **7.** | Longman | **:** | Introduction to Magnetic Materials |

## PHY-409 Physics Lab-V 4.0

### NUCLEAR, HEALTH AND REACTOR PHYSICS

1. To determine the plateau of a Geiger-Mueller counter and hence to find its operation voltage.
2. To determine the dead time of a Geiger-Mueller counter.
3. Determination of the linear absorption coefficient and mass absorption coefficient of Aluminum using a $^{137}Cs$ radioactive source and verification of the inverse square law of gamma radiation.
4. Determination of the current voltage characteristics of an ionization chamber and the range of alpha particles.

### DIGITAL ELECTRONICS

5. To construct the basic gates using diodes and Transistors and also verity its truth table and cheek the corresponding Boolean algebra.
6. To study a half adder and full adder circuit using IC logic gates.
7. To construct NOR and NAND gates.

### OTHERS

8. To determine the temperature coefficient of the resistance of the material of a wire.
9. To verity Stefan's law and hence to determine Stefan's constant.
10. To find the value of e/m for an electron by Helmholtz coil.

**Books Recommended:**

| | **Authors** | | **Books** |
|---|---|---|---|
| **1.** | Giasuddin Ahmad and, Md. Shahabuddin | **:** | Practical Physics for Degree Students |
| **2.** | C.L. Arora | **:** | B.Sc. Practical Physics |
| **3.** | Harnam Singh | **:** | B.Sc. Practical Physics |
| **4.** | Kalimuddin | **:** | B.Sc. Practical Physics |
| **5.** | Giasuddin Ahmad and, Md. Shahabuddin | **:** | Practical Physics for Degree Students |
| **6.** | C.L. Arora | **:** | B.Sc. Practical Physics |
| **7.** | Harnam Singh | **:** | B.Sc. Practical Physics |
| **8.** | Kalimuddin | **:** | B.Sc. Practical Physics |

## PHY-410 Physics Lab-VI 4.0

### MODERN PHYSICS AND SOLID STATE PHYSICS

1. To calibrate the frequency dial of a signal generator with the help of line frequency by forming Lissajous' figures on an oscilloscope screen.
2. To determine the velocity of sound by acoustic transducer.
3. To verity the Faraday laws of induction.
4. To calibrate a polarimeter and hence to determine the specific rotation of a sugar solution by means of a polarimeter.
5. Determination of the self-inductance of a cell by Rayleigh's method.
6. To verify Biot-Savart law and Tangent law.
7. To determine the threshold frequency for photo-electric effect of a photo-cathode and the value of the Planck's by using a photo-electric cell.
8. Determination of Unitary Structure Factor using X-ray Diffraction Data.
9. To determine horizontal component of the earth magnetic field and the magnetic moment of a magnet by employing Magnetometer.
10. To determine the thermal conductivity of a bad conductor by Lee's method.

| **Books Recommended:** | | | |
|---|---|---|---|
| | **Authors** | | **Books** |
| **1.** | Giasuddin Ahmad and, Md. Shahabuddin | **:** | Practical Physics for Degree Students |
| **2.** | C.L. Arora | **:** | B.Sc. Practical Physics |
| **3.** | Harnam Singh | **:** | B.Sc. Practical Physics |
| **4.** | Kalimuddin | **:** | B.Sc. Practical Physics |
| **5.** | Giasuddin Ahmad and, Md. Shahabuddin | **:** | Practical Physics for Degree Students |
| **6.** | C.L. Arora | **:** | B.Sc. Practical Physics |
| **7.** | Harnam Singh | **:** | B.Sc. Practical Physics |
| **8.** | Kalimuddin | **:** | B.Sc. Practical Physics |

## PHY-411 Viva 2.0