Syllabus for Four Years B. Sc. Honours Courses in Physics

For students admitted in 1st year in session: 2012-13 to onwards.

The B. Sc. (Hons.) in Physics consists of the following theoretical and laboratory courses spread over four academic years: Part-I, Part-II, Part-III, Part-IV & carries a total of 3350 Marks.

(a) Courses of studies in Physics in Part-I

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH-101</td>
<td>Mechanics</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-102</td>
<td>Properties of matter and waves</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-103</td>
<td>Electricity and Magnetism</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-109</td>
<td>Physics Lab.-I</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-111</td>
<td>*Mathematics for Physics</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-121</td>
<td>*Chemistry-I for Physics</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>PH-131</td>
<td>*Statistics for Physics</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>Ph-141</td>
<td>English for Physics</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>Viva Voce</td>
<td></td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>28</td>
<td>700</td>
</tr>
</tbody>
</table>

*Indicates allied courses.

(b) Courses of studies in Physics in Part-II

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Unit</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH-201</td>
<td>Heat, Thermodynamics and Radiation</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-202</td>
<td>Optics</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-203</td>
<td>Mathematical Physics</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-204</td>
<td>Atomic and Molecular Physics</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-205</td>
<td>Computer Fundamentals and Numerical Analysis</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-209</td>
<td>Physics Lab.-II</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-210</td>
<td>Computer Programming Lab.</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>PH-221</td>
<td>*Chemistry-II for Physics</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>PH-229</td>
<td>*Chemistry-Lab. for Physics</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>Viva voce</td>
<td></td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>32</td>
<td>800</td>
</tr>
</tbody>
</table>

*Indicates allied courses.
(c) Courses of studies in Physics in Part-III

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH-301</td>
<td>Quantum Mechanics-I</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-302</td>
<td>Electrodynamics</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-303</td>
<td>Classical Mechanics and Relativity</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-304</td>
<td>Statistical Mechanics</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>PH-305</td>
<td>Solid State Physics-I</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-306</td>
<td>Nuclear Physics-I</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-307</td>
<td>Electronics</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-308</td>
<td>Physics Lab.-III</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-309</td>
<td>Physics Lab.-IV</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Viva voce</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>36</td>
<td>900</td>
</tr>
</tbody>
</table>

(d) Courses of studies in Physics in Part-IV

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH-401</td>
<td>Quantum Mechanics-II</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-402</td>
<td>Astronomy and Cosmology</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>PH-403</td>
<td>Plasma Physics</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-404</td>
<td>Solid State Physics-II</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-405</td>
<td>Digital Electronics</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-406</td>
<td>Nuclear Physics-II</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-407</td>
<td>Reactor Physics</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-408</td>
<td>Geophysics</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>PH-420</td>
<td>Physics Lab.-V</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>PH-421</td>
<td>Physics Lab.-VI</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Viva voce</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>38</td>
<td>950</td>
</tr>
</tbody>
</table>

Grand Total Credit = 134  Marks = 3350

Assessment of Student

Assessment of a student in a particular course will be based on marks obtained in (i) the particular course-end examinations (written examination in the case of a theoretical course and practical examination in the case of a practical field-work course). (ii) Class work in the form of tutorial tests and class attendance. The distribution of marks for a course will be as follows:

(a) Part-end examinations: 70%
(b) In-course work which will include
   (i) Tutorial (written)/ Practical tests 20%
   (ii) Class attendance 10%
Written Tutorial Examinations/Practical Tests
There will be a minimum number of tutorial tests spread over the entire academic year, each of at least one-hour duration in each course as prescribed below:

(a) For a 4 credit theoretical/practical/field work course: 3 written/practical tests
(b) For a 2 credit theoretical/practical/field work course: 2 written/practical tests

Class Attendance
A student with class attendance of less than 75% in any course will be debarred from appearing at the course-end examination of that particular course. Credits in the form of marks will be given to students attending classes over the minimum 75% mandatory requirement. Basis for awarding marks for class attendance will be as follows:

<table>
<thead>
<tr>
<th>% of Class Attendance</th>
<th>Marks allocated for 4 credit courses</th>
<th>Marks allocated for 2 credit course</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 % and above</td>
<td>10</td>
<td>5.00</td>
</tr>
<tr>
<td>85 % to less than 90 %</td>
<td>09</td>
<td>4.50</td>
</tr>
<tr>
<td>80 % to less than 85 %</td>
<td>08</td>
<td>4.00</td>
</tr>
<tr>
<td>75 % to less than 80 %</td>
<td>07</td>
<td>3.50</td>
</tr>
<tr>
<td>70 % to less than 75 %</td>
<td>06</td>
<td>3.00</td>
</tr>
<tr>
<td>65 % to less than 70 %</td>
<td>05</td>
<td>2.50</td>
</tr>
<tr>
<td>60 % to less than 65 %</td>
<td>04</td>
<td>2.00</td>
</tr>
<tr>
<td>Less than 60 %</td>
<td>00</td>
<td>00</td>
</tr>
</tbody>
</table>

Eligibility for Bachelor (Honours) Degree
A student who has
(a) secured at least GPA of 2.00 for theoretical and practical courses as well as viva voce in Part-I, Part-II and Part-III examination,
(b) secured at the end of Part-IV a CGPA of 2.25 will be deemed to have qualified for the Bachelor Degree (Honours) degree in the subject offered.

Award of Bachelor (Honours) Degree
(a) A successful candidate who has secured a minimum of 2.25 at the end of part-IV will be awarded a Degree of Bachelor of Science with Honours [cited as B. Sc. (Honours)] in the Faculties of Mathematical and Physical Sciences, Biological Science, and Social Science (for the department of Economics, and department of Geography and Environment only) and Degree of Bachelor of Arts with Honours [cited as B.A. (Honours)] in the Faculty of Arts and Humanities.

However, the Honours Degree to be awarded to a successful candidate in department of Government and Politics, department of Anthropology and department of Archaeology will be Bachelor of Social Science with Honours [cited as B. S. S. (Honours)], while that in Pharmacy will be Bachelor of Pharmacy with Honours [cited as B. Pharm. (Honours)].

(b) Students attaining a CGPA of 3.75 or above will be awarded a Bachelor (Honours) Degree with distinction and citation so be made in the transcript and certificate.
**Award of Bachelor (Honours) Degree**

Bachelor Degree (Pass) will be given to students under the following circumstances:

(a) A student with poor results defined by the situation where he fails to secure a minimum CGPA of 2.25 after the regular Part-IV final examination (that is, without taking any improvement examination) but succeeds in securing a CGPA between 2.00 and 2.35 after availing all chances of improvement will be eligible for Bachelor Degree (Pass).

(b) After completing three years of study and attaining a CGPA of 2.00 or higher a student may decide to discontinue the course and opt in writing for a Bachelor (Pass) Degree.

**Grading Scheme**

Based on the total marks obtained in the class attendance, tutorial and final examinations grading scheme will be as follows:

<table>
<thead>
<tr>
<th>Marks (%)</th>
<th>Letter Grade</th>
<th>Grade Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 % and above</td>
<td>A</td>
<td>4.00</td>
</tr>
<tr>
<td>75 % to less than 80 %</td>
<td>A</td>
<td>3.75</td>
</tr>
<tr>
<td>70 % to less than 75 %</td>
<td>A′</td>
<td>3.50</td>
</tr>
<tr>
<td>65 % to less than 70 %</td>
<td>B′</td>
<td>3.25</td>
</tr>
<tr>
<td>60 % to less than 65 %</td>
<td>B</td>
<td>3.00</td>
</tr>
<tr>
<td>55 % to less than 60 %</td>
<td>B′</td>
<td>2.75</td>
</tr>
<tr>
<td>50 % to less than 55 %</td>
<td>C′</td>
<td>2.50</td>
</tr>
<tr>
<td>45 % to less than 50 %</td>
<td>C</td>
<td>2.25</td>
</tr>
<tr>
<td>40 % to less than 45 %</td>
<td>D</td>
<td>2.00</td>
</tr>
<tr>
<td>Less than 40 %</td>
<td>F(Fail)</td>
<td>0</td>
</tr>
<tr>
<td>Incomplete</td>
<td>I</td>
<td>0</td>
</tr>
</tbody>
</table>
DETAILS OF COURSES IN B. Sc (Hons) 1ST YEAR

PH-101: MECHANICS 4 Credit (100 Marks)

1. **Vector Algebra**: Vector and scalar quantities; Vector addition and subtractions; Vector differentiation and integration; Gradient of a scalar, divergence and curl of a vector; Scalar and vector products and their significance; Gauss’s divergence theorem, Green’s theorem and Stokes theorems, Spherical polar and cylindrical coordinates; Surface and volume element, $\Delta$- and Laplacian operators in polar and cylindrical coordinates.

2. **Kinematics and Particle Dynamics**: Concept of motion and frame of reference; Equations of motion; Tangential and normal components of acceleration in a place; Projectile motion; Uniform Circular motion; Newton’s laws of motion; Concept of mass and force; Frictional forces and their laws.

3. **Work, Energy and Power**: Work done by constant and variable forces; Kinetic and potential energies; Work-energy theorem; Conservative and non-conservative forces; One dimensional forces depending on position only; two and three dimensional conservative systems; Principle of conservation of energy.

4. **Conservation of Linear Momentum**: Centre of mass; Motion of a system of particles and its linear momentum; Conservation of linear momentum for a system of particles; Application of the linear momentum principle in cases of rocket propulsion and collision phenomena.

5. **Rotational Kinematics**: Rotational motion; Rotational quantities as vectors; Rotation with constant angular acceleration; Relation between linear and angular kinematics of a particle in circular motion.

6. **Rotational Dynamics**: Torque and angular momentum; Kinetic energy of rotation and rotational inertia (moment of inertia); Rotational dynamics of a rigid body; Parallel and perpendicular axes theorems; Calculation of moment of inertia; Conservation of angular momentum.

**BOOK RECOMMENDED**

5. Sears, F.W.; Mechanics, Wave Motion & Heat; Addison Wesley Publishing Company.
1. **Gravitation**: Kepler’s laws; Newton’s Law of Gravitation; Gravitational attraction; Determination of Gravitational constant; Mass and density of the earth; Inertial and gravitational mass; gravitational field; Gravitational potential energy; Escape velocity; Energy and orbits; The acceleration due to gravity; Variations in ‘g’; Measurement of the acceleration due to gravity.

2. **Elasticity**: Stress; Plane stress; Examples of plane stress; Hydrostatic pressure; Strain; Hooke’s law; Stress-strain diagram; Elastic hysteresis; Elastic modulii; Internal elastic potential energy; Relations between elastic constants; Torsion; Coil spring; Determination of the elastic constants; The bending of beams; Cantilever.

3. **Hydrostatics and Surface Tension**: Hydrostatic pressure; Change of pressure with elevation; Pascal’s law; Hydrostatic paradox; Thrust on an immersed plane; Center of pressure; Equilibrium of floating bodies; Pressure gauges: Force against a dam; Surface tension; Surface energy; Pressure difference across a surface film; Minimal surfaces; Contact angle and capillarity; Measurement of the angle of contact; Experimental determination of surface tension; Factors affecting surface tension.

4. **Hydrodynamics and Viscosity**: Lines and tubes of flow; Equation of continuity; Bernoulli’s equation and its applications; Flow in a curved duct; Viscosity; Coefficient of Viscosity: Poiseuille’s law; Stoke’s law; Determination of coefficient of viscosity of liquids and gases; Variation of viscosity with temperature.

5. **Oscillations**: Harmonic motion: Simple harmonic motion (SHM); Energy consideration in SHM; Applications of SHM; Relation between SHM and uniform circular motion; combination of harmonic motions; Damped harmonic motion; Forced oscillations and resonance.

6. **Travelling Waves**: Equation of travelling waves; Speed of propagation of waves in a stretched string; Longitudinal waves in a bar; Plane waves in fluid; Transmission of energy by travelling waves; The superposition principle; Waves in a canal; Ripples; Fourier series; Group speed and phase speed.

7. **Stationary Waves**: Reflection and transmission at a junction; Reflection at a fixed end of a stretched string; Boundary conditions for no reflection; Normal modes and proper frequencies of a stretched string.

8. **Sound Waves**: Intensity and intensity levels; Loudness and pitch; Waves in three dimensions; Interference of spherical (sound) waves; Diffraction of sound waves; Radiation efficiency of a sound source; Beats; Combination of tones; Doppler effect and its applications.

**BOOKS RECOMMENDED**

1. Sears F.W.; Mechanics, Wave Motion and Heat; Addison Wesley Publishing Company.
5. Tewari, K. K.; Electricity and magnetism with Electronics; S. Chand and Company Ltd.
1. **Electric Field**: Electric charge; Coulomb’s law; Electric field; Point charge in an electric field; Dipole in an electric field; Electric flux; Gauss’s law and some of its applications.

2. **Electric Potential**: Potential and field strength; Potential due to a point charge, A group of point charges and a dipole; Electric potential energy; Calculation of field strength from potential; An insulated conductor; Electrostatic generator.

3. **Capacitors and Dielectrics**: Capacitor and capacitance –its calculations for different geometry; Dielectric and Gauss’s law; Parallel–plate capacitor with and without dielectric; Electric vectors; Energy stored in an electric field.

4. **Current and Resistance**: Current and current density; Drift speed of charge carrier, Resistance, resistivity and conductivity; Ohm’s law-resistivity an atomic view; Energy transfer in an electric circuit., Electromotive force and potential difference; Kirchhoff’s laws; Single loop and multi loop circuits; The potentiometer, ammeter, voltmeter and galvanometer; RC circuits.

5. **Magnetic Force**: Magnetic Induction and Magnetic effects of currents; Magnetizing force; Magnetic force on a charge and on a current; Torque on a current loop; Moving coil galvanometer; The Hall effect; The Ampere slaw and its applications; Magnetic effects of currents--The Biot-Savart law and its application.

6. **Electromagnetic Induction and Inductance**: Faraday’s law of electromagnetic induction; Lenz’s law; Motional emf; Self and mutual inductance and their applications; LR circuit, Energy stored in a magnetic field.

7. **Alternating Current**: The simple AC generator; Alternating voltage and current and their graphical representation; R.M.S. Value of an AC voltage applied to resistors, capacitors and inductors; AC current and voltage in series RL and RC circuits; LCR circuits; Power dissipation in an AC circuit; Transformer.

8. **Thermoelectricity**: Peltier effect; Seeback effect; Thermocouple.

9. **Circuit Analysis & Network Theorems**: Thevenin’s theorem; Superposition theorem; Maximum power transfer Theorem; Norton’s theorem; Transient currents.

**BOOKS RECOMMENDED:**

5. Sydney George Starling; Elementary Electricity.
6. B.L. Theraja; Basic Electronics Solid State; S. Chand and Company Limited.
PH-111: MATHEMATICS FOR PHYSICS

1. **Set Theory:** Algebra of sets; Union, Intersection and Cartesian product; Relations and functions; Elements of logic.

2. **Complex Numbers and Their Properties:** Complex numbers; De Moivere’s theorem and its applications; Hyperbolic functions and their relations to trigonometric functions.

3. **Analytic Geometry of Two and Three Dimensions:** General equations of second degree for two and three dimensions and reductions to standard form; General properties of conic sections.

4. **Introduction of Elementary Calculus:** Fundamental theorems of elementary calculus; Derivatives of elementary functions; Chain rule; Higher derivatives; Taylor series; Partial differentiation; Euler’s rule for partial differentiation of homogeneous functions, Maxima, Minima, L Hospital’s rule, Asymptotic and tangent normal of curves, Arc length and radius of curves.

5. **Integral Calculus:** Definite integral as limit of a sum; Indefinite integral and different tools of solution, Fundamental theorem of integral calculus; Indefinite integrals and different tools of solutions; Determination of length and area of plane curves and determination of volume obtained by revolution of plane curves.

6. **Differential Equations:** Solutions of linear differential equations; Solutions of second order differential equations.

**BOOKS RECOMMENDED**

1. Barnard and Child; Higher Algebra; S. G. Wasani for Macmillan India Ltd
2. Majumber and Saifullah Elements of Higher Algebra
3. Schaum’s Series Analytic Geometry
4. Askwith, H. Analytic Geometry of Conic Sections
5. Bacon, H.M. Differential and Integral Calculus
6. Ayers, F. (Schaum Series) Calculus
7. Ayers, F. (Schaum Series) Set Theory
8. J. T. Bell; Three Dimensional Geometry
1. **Thermochemistry**: Heats of reaction; Exothermic and endothermic reactions; Energy units; Sign convention; Heats of formation; Thermochemical laws; heats of combustion; Heats of solution; Problems relating to thermochemistry.

2. **Solution**: Various types of standard solution; preparation of standard solution; Titrimetry; Nernst distribution law; Deviations from distribution laws; Solvent extraction; Properties of non-volatile, non-electrolytic dilute solutions; Raoul’t’s law of vapour pressure lowering; Elevation of boiling point and depression of freezing point; Van Hoff’s law of osmotic pressure; Determination of molecular weight of substances using Raoul’t’s law; application of Van Hoff’s law for measuring molecular weight of monomers and polymers; Determination of molecular weight of gases and volatile liquids using ideal gas equation.

3. **Chemical Equilibrium**: Equilibrium states; Law of mass action; Equilibrium constants; variation of units for different types of reaction; examples; le Chatelier Principle and variables affecting equilibrium concentration; Specific example of each case; Calculation of equilibrium constants; Dissociative and associative reactions; Homogeneous and heterogeneous equilibria; Examples.

4. **Electrochemistry**: Electrolytic conduction; Generation of electricity involving chemical reaction; Examples; Faraday’s law of electrolysis; Faraday cell; Constant equivalent conductance; Specific conductance; Transport numbers; Mobility of hydrogen and hydroxyl ions; Electrochemical Cell; Reversible and irreversible cell; reactions and e.m.f. of standard cells.

5. **A Brief Introduction to Organic Chemistry**: Elements of organic chemistry; Orbital representation of aliphatic and aromatic hydrocarbons; Nomenclature, structural formula and important properties of simple organic compounds belonging to the following classes; Alkanes, amides, amino acids, proteins and carbohydrates.

6. **Elements of Biochemistry**: Cell sand tissue; structure and function; Ion and pH balance of the body fluid; Blood constituents; Metabolism of protein and carbohydrate; DNA, RNA.

**BOOKS RECOMMENDED**

1. Maron, S.M. and Lando, J.B.; Fundamentals of Physical Chemistry; Sultan Chand and Sons
2. Atkins, P.W. Physical Chemistry
3. Hoque, M.M. and Nawab, M.A. Physical Chemistry
4. Glasston, S. Physical Chemistry
5. Mortimer, C. Chemistry – A Conceptual Approach
6. Finar organic Chemistry
7. Lehninger Biochemistry
8. Stryer Biochemistry
1. Elements of Statistics
   
a. **Statistics**: Its nature and scope; Nature of statistical data; Attributes and variables; Discrete and continuous variable; Method of data collection; Tabulation; Graphs and diagrams.

   b. **Measures of Location**: Arithmetic mean; Geometric mean; Harmonic mean; Median; Mode; Quartiles; Deciles; Percentiles.

   c. **Measures of Dispersion**: Characteristics of an ideal measure of dispersion; Absolute measure; Relative measure; Range; Standard Deviation; Mean deviation; Quartile deviation; Coefficient of dispersion; Coefficient of variation; Skewness and kurtosis.

   d. **Regression and Correlation**: Relationship between variables; Fitting of simple linear regression; Simple correlation; Multiple correlation and multiple regression.

2. Elements of Probability: Meaning and definition of probability; Apriori and a posteriori probability; Experiment; Sample space and event; Theorems of total, compound and conditional probability; Random variables; Probability functions; Expectation of sum and products; Concepts of Binomial, Poisson’s and Normal distribution.

3. Sampling Technique: Simple random sampling; Stratified random sampling and systematic sampling.

4. Tests of Significance: Type -I, Type -II level of significance, size of the test, power of the test; Tests of means; Variance; Correlation coefficient and regression coefficient; Contingency table analysis.

5. Theory of Errors: Error; Causes of variation of measurements; Measurement of error; Distribution of error; Methods of estimation of error; Minimizing error, examples related to physics problems.

**BOOK RECOMMENDED**

5. Mostafa, M. G.; Methods of Statistics.
PH-141: ENGLISH FOR PHYSICS  
2 Credit (50 Marks)

1. **Grammar**: Review: Parts of speech; Articles; Verb patterns; Tenses; Voice; Narration; Prepositions; Sentences and its classifications; Transformations of sentences; Analysis of sentences; Synthesis of sentences; Group verbs; Common idioms and phrases; Glossaries.

2. **Writing**: Spelling: Rules of spelling; Word formation; difficult spellings; Punctuation; Common confusables; Writing definition of scientific terms; Writing paragraphs on instruments and devices; Writing physical phenomena; Writing theory; Writing reports.

3. **Speaking**: Pronunciation: General points of pronunciation; Difficult pronunciation; How to invite, ask questions, make request and give instructions; How to respond to queries, invitations and statements; How to thank, introduce, express gratitude, regret or appreciation; How to express different concepts: ability, possibility, futurity, necessity, obligation, assumption, regularity, continuity, arrangement, comparison, etc; Conversation with classmates; teachers, neighbors, and people in bus, train, plane etc.

**BOOKS RECOMMENDED**

4. Thompson and Martinet; A Communicative of English.
5. S. M. Zakir Hussain; A Passage to English Language; Ruhel Publications; Dhaka, 1996.
PH-109: PHYSICS LAB-1  

(A student will be required to perform two experiments in the final examination taking one from each group)

LIST OF EXPERIMENTS

GROUP-A

A1. Experiment with spring:
   a. To verify Hooke’s law for a spring.
   b. To determine the modulus of rigidity of the material of the spring.
   c. To observe the harmonic motion of the spring for different loads attached to it.

A2. To determine the acceleration due to gravity ‘g’ by means of a compound pendulum.

A3. To determine the acceleration due to gravity ‘g’ by Kater’s pendulum.

A4. To determine the surface tension of water by capillary rise method.

A5. To determine rigidity modulus of the material of a wire by dynamic method.

A6. To determine the coefficient of viscosity of water at room temperature.

A7. To determine the moment of inertia of a flywheel.

A8. To determine Young’s modulus of the material of a wire by Searle’s apparatus.

A9. To determine the surface tension of mercury by Quincke’s method and hence to determine the angle of contact.

GROUP-B

B1. To verify Ohm’s law by using a tangent galvanometer.

B2. To verify laws of series and parallel resistances by means of a P. O. Box.

B3. Experiment with sonometer:
   a. To draw $n - l$ and $n - \frac{1}{l}$ curves and hence to determine the unknown frequency of a tuning fork.
   b. To verify the laws of a stretched string from the $n - l$ curve.

B4. a. To determine the resistance of a Voltmeter.

   b. To determine the resistance of a galvanometer by half deflection method.

B5. To determine the horizontal component of the earth’s magnetic field and the magnetic moment of a bar magnet by magnetometer.

B6. To determine the internal resistance of a cell by using a potentiometer.
B7. To determine the frequency of a tuning fork by Melde’s experiment.

B8. To determine the end-corrections of a meter bridge and hence to determine the specific resistance of wire.

B9. To compare the e. M. F. s of two cells and hence to determine the E. M. F. of the cells by using a standard cell.

N.B.: In Addition to Above Experiments the Department May Include/Exclude Experiments.
DETAILS OF COURSES IN B. Sc (Hons) 2ND YEAR

PH-201: HEAT, THERMODYNAMICS AND RADIATION 4 Credit (100 Marks)

1. **Heat and Transfer of Heat:** Newton’s law of cooling; Heat capacities; Conduction; Thermal conductivity and thermal diffusivity; Rectilinear flow of heat; Radial flow of heat in a sphere or cylinder; Heat flow through a compound wall; Experimental measurements of thermal conductivity; Convection; Wiedemann-Franz law.

2. **Kinetic Theory of Gases:** Fundamental assumptions in kinetic theory; Pressure exerted by a perfect gas; The root mean square velocity; Concept of temperature; Explanation of gas laws; Evaluation of constants; Brownian movement; Degrees of freedom; Equipartition of energy; Molecular and atomic specific heat; Mean free path; Transport phenomena.

3. **Equation of State:** Equation of state of an ideal gas; Equation of state for real substances; Vander Waals equation; Heat of transformation; Virial equation.

4. **First law thermodynamics:** First law and some of its applications.

5. **Entropy and Second Law of Thermodynamics:** Reversible and irreversible processes; Carnot cycle; Thermodynamic temperature scale; Entropy; Change of entropy in reversible and irreversible processes; Entropy and second law of thermodynamics; Principle of the increase of entropy; Maxwell’s thermodynamic relations; Thermodynamic potential functions; Joule-Thomson cooling effects; Refrigeration cycle; Change of phase.

6. **Third Law of Thermodynamics:** Nernst’s heat theorem; Phase rule and its uses; Third law of thermodynamics.

7. **Radiation:** Black body radiation; Emissive power and absorptive power; Kirchhoff’s law; Stefan-Boltzmann law; Wien’s displacement law; Rayleigh-Jeans formula; Planck’s radiation law; Solar constant; Temperature of the sun; Application of radiation laws.

**BOOKS RECOMMENDED**

5. Brijlal and Subrahmanyam, N.; Heat and Thermodynamics; S. Chand and Company Ltd.
**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.

**Diffraction (Fresnel Class):** 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.

**Diffraction (Fraunhofer Class):** Two classes of diffraction phenomena; Diffraction by a single slit; Diffraction by Circular aperture, Rayleigh’s criterion for resolution; Diffraction by a double slit; Plane diffraction grating; Dispersive and resolving power of a grating.

**Polarization:** Polarization of light; Polarizing Sheets; Polarization by reflection; Double refraction; circular Polarization; Nicol Prism; Polarizing Microscope; Optical activity.

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

**The Laser:** Fundamental Principles; Stimulated emission; Einstein’s relation; population inversion; Optical feedback; Types of lasers: Ruby, He-Ne, CO₂, Argon ion, dye, Semiconductor; Applications of laser.

**BOOKS RECOMMENDED**

1. Jenkins, F.A and White, H.E. Physics.
2. Halliday, D. and Resnick, R.; Physics; New Age International Ltd.
3. Longhurst, R.S. Geometrical and Physical Optics.
5. Hecht and Zajac Optics.
1. **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.

2. **Special Functions:** Gamma and beta functions. Bessel’s functions, Orthogonal functions, Lagendre, Bessels, Laguerre and Hermite polynomials, Fourier series and integrals, Fourier and Laplace’s transform. Inverse Laplace’s transform, Hypergeometric Functions.

3. **Theory of Matrices:** Different types of matrices and their definitions, Determinants of a square matrix, Adjoint and inverse of a square matrix, Solution of linear equations by matrix method; Similarity transformation.

4. **Theory of Complex Variables:** Complex functions, Analytic function, Harmonic functions, Cauchy Riemann equations, Cauchy’s integral theorem, Cauchy’s integral formulas, Lorentz theorem, Differentiation of complex functions, Residue theorem and evaluation of residues, Evaluations of definite integrals.

5. **Tensor Analysis:** Definition, contra variant and covariant tensors. Invariance of tensors, Addition, subtraction, multiplication of tensors, Differentiation of tensors.

**BOOKS RECOMMENDED**

1. H. T. M. Piaggio; An Elementary Treatise on Differential Equations and their Applications; CBS Publisher’s and Distributors.
2. Theory of Complex Variables; Schaum’s Outline Series; McGraw-Hill International.
5. B. D. Gupta; Mathematical Physics; Vikash Publishing House Pvt. Ltd.
6. B. S. Rajput and Yog Prokash; Mathematical Physics; K. K. Mittal Partner
7. Bukov; Mathematics for Physics.
8. G. F. Arfken; Mathematical Methods in Physics.
1. **Particle Properties of Waves:** Particles and waves in nature; Electromagnetic radiation; Photoelectric effect and its important features; Compton effect; Pair production and pair annihilation; Concept of light; Photons and gravity, black holes; X-rays: Production of continuous and characteristic X-rays; X-ray diffraction.

2. **Wave Properties of Particles:** De Broglie’s hypothesis; phase velocity and group velocities of matter waves; particle diffraction; Davission-Germer experiment; Uncertainty principle and its applications.

3. **Atomic Structure:** Thomson model of atom; alpha-particle scattering experiment and Rutherford mode; Nuclear dimensions, electron orbit; Atomic spectra-the Bohr atom, energy levels and spectra; Atomic excitation-Frank-Hertz experiment; Nuclear motion and reduced mass.

4. **Quantum Concepts and Detailed Atomic Structure:** Schrodinger equation-four quantum numbers; Normal Zeeman effect; Stern-Gerlach experiment; Electron Spin, fine structure and anomalous Zeeman effect; Pauli exclusion principle and the periodic table; Vector atom model-is and jj coupling; Many-electron atoms and atomic spectra.

5. **Molecular Physics:** Molecular bonds; Electron sharing; The H$_2$ molecular ion; the hydrogen molecule; Complex molecules; Rotational and vibrational energy levels; Electronic spectra of molecules; Types of spectra; Raman effect.

**BOOKS RECOMMENDED**

3. Weidner, R.T. and Sells R.L.; Elementary Modern Physics; Allyn and Bacon Inc.

2. **Programming with C++**: Principles of Object Oriented Programming; Basic Data Types, Choice and Decisions, Loops, Array and String, Pointer, Functions, Program Files and the Preprocessor, Class, Operator Overloading, Inheritance, Virtual Functions and Polymorphisms, Constructor and Destructors, Program Errors and Exception Handling, Class templates, input and Output Operations, Introduction to Standard Template Library etc.


**BOOKS RECOMMENDED**

1. ITL Education Solutions Limited  
   Introduction to Computer Science
2. ITL Education Solutions Limited  
   Introduction to Information Technology
3. M. Lutfar Rahman  
   Computer Fundamentals
4. Peter Norton  
   Introduction to Computers
5. E. Balagurusamy  
   Object-Oriented Programming with C++
6. Ivor Horton  
   Beginning C++: The Complete Language
7. Robert Lafore  
   Object-Oriented Programming in C++, 4/e
8. Herbert Schildt  
   Turbo C/C++ (The Complete Reference)
9. S. S. Sastry  
   Introductory Methods to Numerical Analysis
10. E. Balagurusamy  
   Numerical Methods.
1. **The Chemical Bonds:** Electronic theory of valency; Types of bonds; ionic bonds, covalent bond and coordinate covalent bond; Electronegativity; Metallic bond; Hydrogen bond; Vander Waal forces.

2. **Oxidation Reduction Reactions:** Oxidation number; the modern concept of acids, bases.

3. **Molecular Geometry and Covalent Bond:** Resonance; Hybrid orbitals; Valence shells; Electronic pair repulsion theory and molecular geometry; Molecular orbitals.

4. **Chemistry of Elements:**
   a. **Group III Elements:** General remarks: Occurrence; isolation and properties; Chemistry of boron.
   
   b. **Group IV Elements:** General remarks: occurrence, isolation and preparation of the metals as semiconducting materials.

   c. **Group V Elements:** General remarks; Occurrence, Preparation and properties; Allotropic forms; Binary compounds; Oxides and oxiacids.

   d. **Transition of Rare-earth Elements.**

**BOOKS RECOMMENDED**

1. Haider, S. Z.; Introduction to Inorganic Chemistry; S. Chand and Company Ltd.
2. Cotton and Wilkinson; Basic Inorganic Chemistry; John Wiley and Sons Inc.
6. Companion; Chemical Bonding.
LIST OF EXPERIMENTS

GROUP A

A2. Determination of the specific heat of a liquid by the method of cooling.
A3. Determination of the thermal conductivity of a good conductor by Searle’s apparatus.
A4. Determination of the thermal conductivity of a bad conductor by Lee’s method.
A5. Investigation of the variation of the resistance of a Copper wire with temperature and determination of its temperature coefficient of resistance.
A6. Investigation of the variation of the capacitive and inductive reactance’s with frequencies.
A8. Investigation of the characteristics of a junction diode.
A10. To use resistance thermometer in particular to measure (a) the room temperature and (b) the boiling point of a liquid.
A11. To measure a small thermoelectric e.m.f and its variation with temperature using a milli-ammeter and a standard resistance.
A12. To construct and calibrate a direct reading thermoelectric thermometer and to measure; (a) the room temperature (b) the body temperature (c) the boiling point of a saturated brine solution and (d) the melting point of solder.

GROUP B

B1. Determination of the refractive index of water and glycerine by pin method.
B2. Determination of the (i) refractive index and (ii) the dispersive power of the material of the prism by a spectrometer.
B3. Investigation of the principal types of optical spectra and to calibration of the spectrometer and hence to determination of the unknown wavelength.
B4. Determination of the Cauchy’s constant and the resolving power of a prism using a spectrometer.
B5. Determination of the thickness of a paper and a wire by means of interference fringes in air wedge.
B7. Determination of the unknown wavelength by using discharge tubes and diffraction grating.
B8. (A) Investigation of the voltage-current relationship for a simple ac inductive circuit and hence determination of the inductance.
   (B) Investigation of the voltage-current relationship for a simple ac capacitive circuit and hence determination of the capacitance.

N.B.: In Addition to Above Experiment the Department May Include/Exclude Experiments.
PH-210: COMPUTER PROGRAMMING LAB         2 Credit (50 Marks)

(A student will be required to solve two problems in the Final Examination- One Experiment from Each Group)

Group A: C++ Programming

1. Introduction to Computer and C++ programming.
2. Implementation of Branching. Looping Control Statements
3. Programming with Array and Strings.
4. Declaring and Defining Functions and Parameter Passing.
5. Programming with Classes and Objects.
7. Implementation of Operator overloading and Type Conversions.
8. Implementation of different types of Inheritance.

Group B: Programming for Numerical Analysis with Matlab

10. Introduction to Matlab programming: Plotting Scripting Functions and Symbolic Mathematics.
11. Implementation of the Solution of Linear Algebra and Nonlinear Algebraic Equations.
12. Implementation of Linear and Cubic-Spline Interpolation.
15. Implement of Numerical Integration-
   a. Trapezoidal Rule.
   b. Simpson's Rule.

BOOKS RECOMMENDED

1. E. Balagurusamy  Object-Oriented Programming with C++
2. Ivor Horton  Beginning C++: The Complete Language
4. Herbert Schildt  Turbo C/C++ (The Complete Reference)
5. E. Balagurusamy  Numerical Methods.
6. S. S. Sastry  Introductory Methods to Numerical Analysis
7. Rudra Pratap  Getting started with Matlab 7
8. Delores M. Etter and David C. Kuncicky with Dong Hill  Introduction to Matlab 6, 2/e

N.B.: In Addition to Above Experiment the Department May Include/Exclude Experiments.
PH-229: CHEMISTRY LABORATORY FOR PHYSICS 2 Credit (50 Marks)

LIST OF EXPERIMENTS

1. Calibration of volumetric glassware (pipette)
2. Determination of gram equivalent weight of magnesium.
3. Determination of Avogadro’s number.
4. Determination of:
   a) Molar volume of oxygen.
   b) Molecular weight of condensable vapor.
5. Experiment on preparation of sodium thiosulphate.
6. Experiment on preparation of ferrous ammonium sulphate.
7. Standardization of approximately 0.1N HCl by titration with standard 0.1N NaOH (acid-base to titration)
8. Determination of (a) ferrous and (b) ferric ion by oxidation with K₂Cr₂O₇ solution (oxidation-reduction titration)

N.B.: In Addition to Above Experiment the Department May Include/Exclude Experiments.
DETAILS OF COURSES IN B. Sc (Hons) 3RD YEAR

PH-301: QUANTUM MECHANICS-1 4 Credit (100 Marks)

1. **Physical Basis**: Failures of classical mechanics and emergence of quantum mechanics; Bohr atom and old quantum theory; Domain of quantum mechanics; Heisenberg uncertainty principle.

2. **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.

3. **Schrödinger’s Equation**: Time-dependent and time-independent Schrodinger’s equations; Significance of wave functions; Probability current density; Ehrenfest’s theorems; Time variation of expectation values.

4. **Problems in One-dimension**: Particles incident on a potential step and on a potential barrier; Particles in a finite and infinite square potential well; 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.

5. **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.

**BOOK RECOMMENDED**

7. Schiff, L. I.; Quantum Mechanics; McGraw Hill Company Limited.
PH-302: ELECTRODYNAMICS

1. **Electromagnetic Field Equations:** Maxwell’s modification of Ampere’s law; Equation of continuity; Maxwell’s equations; Energy in electromagnetic fields; Poynting vector.

2. **Propagation of Electromagnetic Waves:** Wave equations of $E$ and $H$ and their solutions; Propagation of electromagnetic waves in free space; Propagation of electromagnetic waves in isotropic nonconducting media; Propagation of electromagnetic waves in conducting media; Skin depth; Propagation of electromagnetic waves in ionized gases.

3. **Waves in Bounded Regions:** Boundary conditions on the field vectors; Reflection and refraction at the boundary of two nonconducting media (normal incidence and oblique incidence); Total internal reflection, Metallic reflection; Propagation between parallel conducting plates; Wave guides; Cavity resonators.

4. **Potentials, Fields and Radiation:** Scalar and vector potentials; Retarded potentials; Lienard-Wiechert potentials; Field of a moving point charge; Fields of and accelerated charge; Electric dipole radiation; Magnetic dipole radiation; Radiation fields of charges moving with low velocities; Radiation from an oscillating dipole; Radiation from a half-wave antenna; Radiation from a group of moving charges.

5. **Scattering:** Scattering cross section; Scattering by a free electron; Forced vibration; Scattering by a bound electron; Resonance scattering.

6. **Dispersion:** Normal and anomalous dispersion; Drude-Lorentz harmonic oscillator model; Resonance absorption by bound charges; The Drude free electron theory; Dispersion in gases; Dispersion in liquids and solids.

**BOOKS RECOMMENDED**

3. Corson D. R. and Lorrain, P.; Introduction to Electromagnetic Fields and Waves; CBS Publisher.
7. David J. Griffiths; Introduction to Electrodynamics; Prentice Hall of India.
PH-303: CLASSICAL MECHANICS AND SPECIAL THEORY OF RELATIVITY  

4 Credit (100 Marks)

1. **Review of Elementary Principles:** Mechanics of a system of particles; Constraints; D Alembert’s principle and Lagrange’s equations; Velocity dependent potentials and dissipation function.

2. **Variational Principles and Lagrange’s Equation:** Hamilton’s principle; Calculus of variations; Derivation of Lagrange’s equation from Hamilton’s principle; Extension of Hamilton’s principle to nonconservative and non-holonomic systems.

3. **The Two-Body Central Force Problem:** Reduction to equivalent one-body problem; Kepler’s law and classification of orbits; The Virial theorem; The differential equation for the orbit; Scattering in a central force field; Transformation of scattering problem to laboratory coordinates.

4. **Rigid Body Motion:** Space and body set of axes; Transformation matrix; Rotation matrix; Eulerian angles; Infinitesimal rotations; Components of angular velocity along body set of axes; Euler’s equation of motion for solving rigid body problems; symmetrical top.

5. **The Hamilton’s Equations of Motion:** Hamilton’s equations of motion; Derivation from variational principle; the principle of least action.

6. **Canonical Transformations:** The equations of canonical transformations, Legendre transformations; Invariance of Poincare’s integral; Lagrange and Poisson’s Brackets; Equations of motion in Poisson’s bracket notation.

7. **Special theory of Relativity:** Michelson and Morley experiment; Galilean transformations; Basic Postulates; Lorentz transformations; length contraction and time dilation.

8. **Relativistic Mechanics:** Four-dimensional interval; Time-like and space –like intervals; Moving clocks; Four-vectors; Four-velocity; Relativistic Lagrangian; Momentum and energy; Equivalence of mass and energy; Momentum-energy four vectors; Four-potential and Hamilton-Jacobi equation.

**BOOKS RECOMMENDED**

3. Resnick, R.; Introduction to Special Relativity; John Wiley and Sons.
6. Gupta, Kumar and Sharma; Classical Mechanics; Progati Prakashan.
1. **Statistical System:** Macroscopic and microscopic states; Thermodynamic functions and their equilibrium conditions.

2. **Ensembles:** Phase space; Lieuville's 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.

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

4. **The Condensed State:** Solids at low and high temperature; Debye’s interpolation formula; Thermal expansion of solids; Phonons; Quantum liquids with Bose-type spectrum; Quantum liquids with Fermi-type spectrum; the electronic spectra of metals; the electronic spectra of solid dielectrics.

**BOOKS RECOMMENDED**

3. C. Kittel; Thermal Physics.
5. Gupta, Kumar & Sharma; Statistical Physics.
6. Huamp; Statistical Physics.
1. **Crystal Structure**: The crystalline state of solids; Unit cell and Bravais lattices; Symmetry operations; Miller indices; Simple crystal structures; Diffraction of X-rays by crystals; Laue equations and Bragg law; Experimental diffraction methods-Laue method; Rotating crystal method and Power methods; Reciprocal lattice.

2. **Crystal Bonding**: Interatomic forces and crystal bonding; Ionic crystals-Calculation of electrostatic energy, Madelung constant & Bulk modulus; Covalent crystals; Crystals of inert gases-Vander Waals & Repulsive interactions; metal crystals and hydrogen bonded crystals.

3. **Lattice Vibrations and Thermal Properties**: Vibrations of monatomic linear lattice; Vibrations of diatomic linear lattice; Phonon; Phonon momentum; Enumeration of normal modes; Lattice specific heat; Einstein and Debye models; Lattice thermal resistivity; Normal and Umklapp processes.

4. **Free Electron Fermi Gas**: Energy levels and density of states in one dimension; Free electron gas in three dimensions; Heat capacity of the electron gas; Electrical conductivity and Ohm’s law; Hall effect; Thermal conductivity of metals; Wiedemann-Franz law.

5. **Dielectric Properties**: macroscopic electric field; Local electric field at an atom; Static dielectric constant; Electronic, ionic and Orientational polarizabilities; Clausius- Mossotti relation; Pyro, piezo and Ferroelectricity.

**BOOKS RECOMMENDED**

1. Kittel, C.; Introduction to Solid State Physics; Wiley India.
5. Saxena, Gupta & Sexena; Fundamentals of Solid State Physics; Pragati Prakashan.
6. Aschroft & Mermin; Solid State Physics.
1. **Nuclear Properties:** Constitution of the nucleus; Nuclear radius; Mirror nuclei; Coulomb displacement energy; Mass defect; Binding energy; Semi-empirical mass formula; Angular momentum; Spin, Parity and Symmetry; Magnetic dipole moment and electric moments.

2. **Radioactivity:** Stable and unstable nuclei; Natural and artificial radioactivity; Radioactive decay law; Successive radioactive transformations; Radioactive equilibrium; Radioactive dating.

3. **Alpha Decay:** Types of decays; Alpha decay properties; Fine structure; Measurement of alpha-particle energies; Geiger-Nuttal law and Theory of alpha decay.

4. **Beta Decay:** Introduction; Conservation of energy; Conservation of angular momentum; neutrino hypothesis; measurement of disintegration energies; Fermi theory of beta decay and selection rules.

5. **Gamma Decay:** Properties of gamma rays; Interaction and absorption of gamma rays; measurements of gamma-ray energies and life-times of excited states; internal conversion.

6. **Stopping and Detecting Nuclear Radiations:** Stopping power, range and strangling for charged nuclear particles; Stopping of neutrons; Gas-filled counters; Geiger-Müller counter; Solid state counter; Scintillation counter; neutron detection; Counting statistics.

7. **Accelerators and Sources of Atomic Particles:** Van de Graff accelerator; Cyclotron; Betatron; Proton synchrotron; Neutron sources.

8. **Nuclear Reactions:** Nuclear reaction and chemical reaction, Reaction dynamics; The Q-value equation and threshold energy; Neutron and neutron flux; Fission and fusion processes; Fission energy and Thermonuclear energy.

**BOOKS RECOMMENDED:**

7. H. M. Sen Gupta; Nuclear Physics.
8. A. M. Harun-or-Rashid; Nuclear Physics.
1. **Electronic Devices and Circuits**: Semiconductors; PN junction; Semiconductor diode; Transistors configurations and characteristics; Load lines; Hybrid parameters; Transistor biasing; FET: junction field effect transistor (JFET); JFET drain and transfer characteristics; Enhancement MOSFET; Depletion MOSFET; Drain and transfer characteristics of Enhancement and Depletion MOSFET.

2. **Power Rectification and Filter Circuits**: Half-wave rectifier; Full-wave rectifier; filter circuits; Capacitor filter; L-section filter; Pi-section filter; Zener diode; voltage stabilization.

3. **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.

4. **Transistor Amplifier**: Classifications 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.

5. **Feedback and Oscillators**: Negative feedback: voltage feedback; current feedback; Oscillators: Positive feedback; RC oscillators (phase shift and wein bridge oscillators); Resonant circuit oscillators (LC and crystal oscillators); Relaxation oscillators.

6. **Modulation and Detection**: Types of modulation; AM modulation; modulation factor; Analysis of amplitude modulated wave; Plate modulated class C amplifier; Grid bias modulation; Demodulation; Linear diode detection; Linear envelop detection; Discriminator circuit.

7. **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; Superheterodyne receiver; FM receiver; Superheterodyne FM receiver; AVC and AFC system.

8. **Basic Operational Amplifier**: Ideal Op-amp; Inverting and non-inverting Op-amp; Adder and subtractor; Integrator; Differentiator.

9. **Integrated Circuit Technology**: Integrated Circuit; IC Fabrication: Purification and preparation of silicon wafer; Epitaxial growth; Oxidization; Photolithographic process; Isolation diffusion; Base and Emitter Diffusion; metallization; Encapsulation; Formation of integrated circuit elements; Transistors, capacitors and resistors for integrated circuits; Sheet resistance.

**BOOK RECOMMENDED**

1. James J. Brophy; Basic Electronics for Scientists; McGraw-Hill Company Limited.
2. Jacob Millman and Arvin Grabel; Microelectronics; McGraw-Hill Company Limited.
4. V. K. Mehta; Principles of Electronics; S. Chand and Company Limited.
5. B. L. Theraja; Basic Electronics Solid State --S. Chand and Company Limited.
8. Dr. S. L. Gupta and Dr. V. Kumar; Hand Book of Electronics; Pragati Prakashan.
LIST OF EXPERIMENTS

1. Determination of the logarithmic decrement of a ballistic galvanometer and hence determining its critical damping resistance.
2. Determination of the absolute capacitance of a condenser.
3. Determination of the self-inductance of a cell by Rayleigh’s method.
4. For a series LRC circuit, determine the following (a) The phenomenon of resonance (b) The effect of variation of R on the frequency response curve (c) The effect of variation of L/C ratio on the frequency response curve.
5. To construct a full-wave bridge rectifier and observe the filtering action of capacitors.
6. To study the output and transfer characteristics of a p-n-p (or n-p-n) transistor in common emitter circuit.
7. To construct of a T.R.F. receiver and to explore the functions of the various components of the receiver.
8. To study the characteristics of a vacuum triode valve and to determine the plate resistance $r_p$, mutual conductance $g_m$ and amplification factor $\mu$.
10. Determination of the resistance of an inductive coil and loss factor of a capacitor by voltmeter measurements.
11. Construction of a transistor radio transmitter.
12. Construction of a two stage R-C coupled transistor voltage amplifier.
13. Polarization of light by 4 plates and investigation of intensity of polarized light (I) as a function of the position of the analyzer and (ii) also as a function of the angle between the optic axis of the 4 plate and that of the analyzer.
14. To study the characteristics of a junction diode.
15. To study the characteristics of a p-n-p transistor in common emitter circuit.

N.B.: In Addition to Above Experiment the Department May Include/Exclude Experiments.
PH-310: PHYSICS LAB–IV 4 Credit (100 Marks)

(A student has to do two experiments in the final Examination)

LIST OF EXPERIMENTS

1. Experiment with a cathode ray oscilloscope
   (a) Synchronizing the time base of an oscilloscope.
   (b) Calibration of a cathode ray tube for both d.c. and a.c. sources.
   (c) Measurement of an unknown frequency using Lissajou’s figures.
2. To study the characteristics of GM tube and find the resolution time of the GM tube.
3. To demonstrate the random nature of the emission of $\gamma$-particles from radioactive source and to introduce statistical methods of predicting and interpreting the results of radioactive measurements.
4. (a) To study the temperature dependence of a noble metal (Platinum).  (b) To study the temperature dependence of a semiconductor and to find the energy gap of the semiconductor.
5. To determine the inter planer distance ‘d’ and index an of X ray powder diffraction photograph and hence determine the cell constant “a”.
6. To determine of specific rotation of sugar solution using a polarimeter and to find the concentration of an unknown solution.
7. Determination of $e/m$ of an electron by Helmholtz coil.
8. Charging and discharging of condensers and studying their various characteristics.
    (b) Detection and elementary identification of principal nuclear radiations.
    (c) Demonstration of the directional emission from a radioactive source.
10. Determination of the current voltage characteristics of an ionization chamber and the range of alpha particles.
12. Measurement of thermal and electrical conductivity of metals and verification of the Wiedemann-Franz law.
14. Exploration of the magnetic field along the axis of a solenoid and measurement of the self inductance of the solenoid coil.

N.B.: In Addition to Above Experiment the Department May Include/Exclude Experiments.
PH-401: QUANTUM MECHANICS-II                                      4 Credit (100 Marks)

1. **Basis of Quantum Theory**: Postulates of quantum mechanics; Operators; Wave functions; Eigen-values; Eigen-value equations; Expectation values; Matrix representation of operators, wave functions and eigen-value equations; Hilbert space; Dirac’s Bra and Ket notations; Eigen-values and their corresponding eigen-vectors of a matrix; Diagonalization of a matrix.

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; Eigen-values and eigen functions of orbital angular momentum operators; Spin angular momentum; Total angular momentum operators; Eigen-values and eigen functions 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; Important applications.

**BOOKS RECOMMENDED**

1. R. L. White; Basic Quantum Mechanics; McGraw-Hill Company.
2. A. K. Ghatak; Introduction to Quantum Mechanics; McMillan India Limited.
3. A. M. Harun-ur-Rashid; Quantum Mechanics; The University of Dhaka.
1. **Introduction:** Modern astronomy; Astronomical coordinates; Rough scales of the astronomical universe; Contents of the universe.

2. **Stars:** Properties of stars; Formation of stars; the end states of stars; white dwarfs, neutron stars; The sun as a star, Surveying the solar system; the interior of the sun; The sun’s outer layers; The source of energy of the sun.

3. **Galaxies:** Formation and classification of galaxies; Cosmic rays; The milky way system; Spiral structure; Density wave theory; Active galaxies; Peculiar galaxies and quasars; Clusters of galaxies.

4. **Expansion of the Universe:** Red shifts; Hubble’s law regarding expansion of the universe; Age of the universe.

5. **Big Bang Theory and Cosmology:** Static cosmological models; Expanding cosmological models and the Big bang theory; The early universe; The universe and the subatomic; Life and intelligence in the universe.

**BOOKS RECOMMENDED:**

1. Shu, F. H.; The Physical Universe; An Introduction to Astronomy.
2. Smith, E. V. P. and Jacobs, K. C.; Introduction to Astronomy and Astrophysics.
3. Kutner, M. L.; Astronomy; Physical Prospective.
6. Hawking, S. W.; A Brief History of Time; Bantam Books.
7. Snow, T. P.; The Dynamic Universe; West Publishing Company.
1. **Introduction:** 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**

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

2. **Band Theory of Insulators and Semiconductors**: A simplified model of an insulator and intrinsic semiconductors; Improved model of an insulator and intrinsic semiconductors; Models for an impurity semiconductor; Hall effect in semiconductors.

3. **Magnetism**: Origin of magnetism; Diamagnetism; Paramagnetism; Ferromagnetism; Weiss theory of ferromagnetism; Nature and Origin of Weiss molecular field; Concept of Domains and hysteresis; Antiferromagnetism; Ferrimagnetism, Ferrites.

4. **Superconductivity**: Basic properties of superconductors; Meissner effect; Type-I and Type-II Superconductors; Thermodynamics of superconductivity; London equation; BCS theory; Tunnelling and Josephson effect; High-Tc superconductors.

5. **Excitons, Photoconductivity, Luminescence and Defects in Solids**: Excitons; Photoconductivity in crystals; Traps; Space charge effects, point defects in solids: Lattice vacancies; Schottky defects; Frenkel defects; Diffusion; Colour centres.

**BOOKS RECOMMENDED**

1. Dekker, A. J.; Solid State Physics; McMillan India Company.
2. Kittel, C.; Introduction to Solid State Physics; Wiley India.
5. Chikazum; Physics of Magnetism.
1. **Numbers**: Different number systems: Binary numbers; Decimal numbers; Octal numbers; Hexadecimal numbers; Number base conversion.

2. **Binary Codes**: Weighted codes: The 8421 code; Other 4-bit BCD codes; The parity bit; The Gray code; Hamming code; Error detection and correction; The ASCII code; Code conversion.

3. **Boolean Algebra and Logic Gates**: Laws and theorems of Boolean algebra; Boolean functions; Simplification of Boolean functions; De Morgan’s theorems; Digital Logic Gates: AND gate; OR Gate; NOT gate; NOR gate; The universal building block; XOR and XNOR gates; TTL circuits.

4. **Simplifying Logic Circuits**: Minterm and maxterm; SOP and POS circuits; Algebraic simplification; Map method: Truth table to Karnaugh maps; Simplifications; Tabulation method: Determination and selection of Prime-Implicants.

5. **Arithmetic Circuits**: Complements: The r’s and (r-1)’s complements; Subtraction with r’s and (r-1)’s complements; Adders: Half-adder and Full-adder; Binary parallel adder, Decimal adder, BCD adder; Subtractors: Half-subtractor and full subtractor; Binary Multiplier.

6. **Flip-Flops**: SR latches: Transistor latch; NAND and NOR latch; Clocked SR flip-flop; D-type flip-flop: Unclocked and clocked D flip-flop; JK flip-flop: Edge-triggered JK flip-flop; Jk master-slave flip-flop; Multivibrators.

7. **Counters and Registers**: Ripple counter, Design of synchronous counter, Parallel Counter; Combination counter; BCD shift registers; Decoders: BCD- to decimal decoder; Demultiplexers; Encoders; Multiplexers.

8. **D/A and A/D Conversion**: Variable-resistor network; Binary ladder, D/A converter; D/A accuracy and resolution; A/D converter, A/D accuracy and resolution; Advanced A/D techniques.

9. **Memory Devices**: Semiconductor memory technologies; Memory addressing; ROM architecture; Types of PROMS and EPROMS; RAM architecture; Static and dynamic RAM; DRAM; SDRAM; Magnetic Core and bubble memory Cache memory.

**BOOKS RECOMMENDED**

4. Tocci; Digital Systems, Principles and Applications; Prentice Hall of India Pvt. Ltd.
1. **The Deuteron Problem:** The Experimental data; The ground state of the deuteron; Excited state of the deuteron; Electric quadrupole moment and deuteron wave function; radius of deuteron.

2. **Two Body Problems:** neutron-proton scattering at low energy; Spin dependence of neutron-proton scattering; Phase shift; Effective range theory in n-p scattering; Neutron-proton scattering at intermediate and high energies; Ortho- and para hydrogen and coherent scattering of low energy neutrons.

3. **Nuclear Force:** General properties and characteristics; Exchange forces; Yukawa proposal; Messon theory of nuclear forces.

4. **Interaction of Nuclei with Electromagnetic Radiation:** Introduction; Multiple radiation and selection rules; The probability of multiple emission and absorption; Radiative transition in the two body problem; Internal conversion; Translation between low – laying states of nuclei; Transition involving highly excited states.

5. **Nuclear Models:** Shell model- single particle shell model; introductory collective model.

6. **Nuclear Reactions:** Nuclear cross-section; Breit-Wigner dispersion formula for an s-state; compound nucleus; Elastic and inelastic processes; Direct reactions; introductory optical model for nuclear reaction.

7. **Neutron Chain Reactions:** Fission chain reaction, neutron cycle and four-factor formula; Nuclear reactors; homogeneous and inhomogeneous reactor systems.

8. **Elementary Particles:** Fundamental interactions, Unification of forces, Particle-antiparticle, classification and general properties; Quantum number and their conservation; Idea of quarks; Gluons Colour.

**BOOKS RECOMMENDED**

1. Preston, H. A.; Physics and Nucleus.
2. Blatt and Weisskopf; Theoretical Nuclear Physics; Angel Publishing Company.
3. Enge, M. A. Introduction to Nuclear Physics; New Age International Ltd.
5. Elton, L. R.; Introductory Nuclear Theory.
7. Liverhant, S. E.; Elementary Introduction to Nuclear Reactor Physics.

2. **Neutron:** Discovery; Sources of neutrons; Properties of neutrons; Neutron reaction; Slow neutron reaction; Neutron cross section; Microscopic and Macroscopic cross sections; Determination of cross section; Mean free path; Attenuation of Neutrons; Neutron flux; Reaction rate; Classification of neutron according to energy; Energy dependence of neutron cross section; Fission cross section.

3. **Nuclear Reactors:** Classification of Reactors according to the mean energy of neutrons causing fissions; Classification of Reactors according to the material used; Classification by Structure; Classification of Reactors according to the purpose; **Basic Components of a Nuclear Reactor:** Reactor Core, Cladding, Coolant, Moderator, Control rod or control system, Blanket, Reflector, Reactor Vessel, Shielding, Reactor building.

4. **Nuclear Fission:** Classification of fissile; Fissionable Materials; The mechanism of fission; Practical fission fuels; Products of fission; Yields and Mass Distribution of Fission Products; Energy Distribution of Fission Fragments; Energy Release from Fission; Neutron Yield and Neutron Production Ratio; Prompt and Delayed Neutrons; Energy Distribution of Fission Neutrons; Reactor power; Fuel burn up; Fuel consumption.

5. **Moderation or Slowing Down of Reactor Neutrons:** Neutron Moderation by Elastic Scattering; Collision kinematics; Differential elastic scattering cross section; Isotropic scattering; Scattering angles in L and C.M Systems; Angular and energy distribution; Forward scattering in the L System; Average energy loss per collision and average cosine of scattering angle; Average logarithmic energy decrement; Description of the dynamics of elastic collision in terms of lethargy; Transport mean free path and transport cross section; Slowing down power and moderating ratio; Slowing down time; Slowing down density; Resonance escape probability; The effective resonance integral.

6. **Neutron Diffusion:** Neutron Transport Equation: Basic Definitions, Assumptions; Derivation of Transport Equation; Meaning of neutron diffusion; Fick’s Law, Equation of Continuity, One Speed Diffusion equation; Steady-State Diffusion equation, Boundary conditions, Solution of Diffusion equation for different geometry. The thermal diffusion length; The exponential piles. The diffusion length for a fuel moderator mixture; Multi-region problem; Fast Neutron Diffusion and Fermi Age Equation;
7. **Neutron Chain Reaction:** Introduction; Neutron cycle and Multiplication Factors; Four factor formula; neutron leakage and critical size; Six Factor Formula; Nuclear reactors and their classifications; Homogenous and heterogeneous reactor system; Effect of heterogeneous arrangement on $\eta$, $p$, $f$, and $\varepsilon$.

8. **The Reactor Critical Equation:** Introduction; Diffusion equation applied to a thermal reactor; **One-group reactor equation; Solution of one-group reactor equation:** For the Slab reactor, For a spherical reactor, For an infinite cylindrical reactor, For a rectangular parallelepiped reactor, For a Finite Cylindrical reactor, Minimum critical volume of a reactor, Maximum to average fluxes and power, One-group Critical equation, Criticality Calculations: The group Diffusion Method, Two-group Critical equations, Modified on-group critical equation, Critical equation for continuous Slowing Down, Thermal Neutron Diffusion, Critical equation and reactor buckling; The non-leakage factor; Criticality of large thermal reactors; Critical size and geometrical buckling; Effect of reflector; Reflected reactors; Reflector Savings.

9. **Reactor Control:** Control and reactor kinetics; Fission Product Poisoning, $^{135}$Xe poisoning, $^{149}$Sm poisoning, Control rod worth, Cylindrical rod, Burnable poisons, Effects of temperature on reactor kinetics; General feature of reactor control.

**BOOKS RECOMMENDED**
1. Liverhant, S. E.; Elementary Introduction to Nuclear Reactor Physics.
2. Glasstone, S. and Edelund M. G.; Elementary of Nuclear Reactor Theory; CBS Publishing and Distributions.
PH-408: GEOPHYSICS        2 Credit (50 Marks)

1. **The Solar System:** The planets; Meteorites and their composition; Cosmic ray exposures of meteorites; The pointing-Robertson effect; Compositions of Terrestrial planets.

2. **Rotation and Figure of the Earth:** Figure of the earth; Precession of the equinoxes; The Chandler wobble; Tidal friction and the history of the Earth-Moon system; Fluctuation in rotation and the excitation of the wobble.

3. **The Gravity Field:** Gravity as a gradient of the geopotential; the satellite geoid; Crustal structure and the principle of isostasy; Earth tides.

4. **Seismology and the Internal Structure of the Earth:** Seismicity of the earth; Elastic waves and seismic rays; Travel time and velocity depth curves for body waves; Internal density and composition; Free oscillations.

5. **Geomagnetism:** The magnetism of the earth; Fundamental equations; measurement of the magnetic field; Method of Gauss; Saturation induction magnetometer; Proton precession magnetometer, Alkali vapour magnetometer.

6. **The Earth’s Internal Heat:** the geothermal flux; Thermal conduction in the mantle; Temperatures in the interior of the earth; Energy source for the geomagnetic dynamo.

7. **Radioactivity and the Age of the Earth:** The pre-radioactivity age problem; Radioactive elements and the principle of radiometric dating; Age of the earth and meteorites; dating the nuclear synthesis.

**BOOK RECOMMENDED**

1. F. D. Stacey ; Physics of the Earth ----- John Wiley and Sons, New York
3. F. S Grant and G.F. West; Interpretation Theory in Applied Geophysics.
4. D. S. Parasnis; Principles of Applied Geophysics; Chapman and Hall.
LIST OF EXPERIMENTS

1. a) (i) To construct stabilized power supply and observe the effect of variation of voltage on output.
   (ii) To observe the effect of variation of input voltage on output.
   (iii) To plot a graph of input vs. output voltage and hence to calculate the percentage of error.
   
   b) To construct a square wave Generator using the constructed 9 volts stabilized power supply and to demonstrate its operation.

2. To fabricate and test a phase shift Oscillator using a transistor and
   a) To measure the frequency of oscillation;
   b) To compare the measured value of frequency with that of the calculated value;
   c) To observe the effect of using two RC sections instead of three.

3. To verify Stefan’s law and hence to determine Stefan’s constant.

4. To study the JEFET Characteristics.

5. To design, construct and analyze inverting and noninverting high gain Operational high gain Operational Amplifier using 741 Linear IC and hence.
   a) To measure the input resistance of the inverting voltage amplifier
   b) To measure the output resistance of the non-inverting voltage amplifier.

6. To design, construct and test a high-pass Active Filter using 747 linear integrated circuits and
   a) To determine where the high response rolls off to – 3 dB.
   b) To plot a response curve showing frequency vs. Voltage gain.

7. (a) To demonstrate the operation and characteristics of a TTL Logic gate (AND gate) and to show how it can be used to perform the Logic functions.

   (b) To demonstrate the operation and characteristics of a CMOS logics gates and to show how it can be used to perform the logic functions.

N.B.: In Addition to Above Experiment the Department May Include/Exclude Experiments.
LIST OF EXPERIMENTS

1. To construct an Audio frequency Amplifier and
   (i) To observe distortion.
   (ii) To measure the output and input impedance and
   (iii) To measure the power gain.
   (iv) To plot its frequency response curve.

2. To study the SCR Characteristics.

3. To study the UJT Characteristics.

4. To design, construct and test a low pass active filter using 747 linear integrated ckt and
   (i) To determine in what low frequency range filtering occurs.
   (ii) To plot a graph of frequency vs Voltage gain.

5. (a) To design, Test and evaluate an IC Amplifier operated as a square-wave (Free-running square
    wave) oscillator.

   (i) To measure the output voltage
   (ii) To determine whether the frequency oscillation is dependent on the supply voltage and to
        determines the voltage range for oscillation.
   (iii) To determine whether the frequency oscillation is dependent on the supply voltage and to
        determines the voltage range for oscillation.
   (iv) To design, construct and evaluate sine Wave Oscillator using linear IC and

   (b) i) To record the output wave shape at the maximum distorted peak output \( V_{out} \).
        ii) To calculate the frequency of oscillation.
        iii) To calculate the output impedance.

6. (a) To determine the operation and characteristics of diodes AND Nor gate (Using discrete
     components)

       (b) To determine the operation characteristics of a typical discrete component transistor Logic gate.

7. (a) To demonstrate the operation and characteristics of set –reset (latch) Flip-flop.
     (b) To demonstrate the operation and characteristics of a D-type Flip-flop and a storage Register.

N.B.: In Addition to Above Experiment the Department May Include/Exclude Experiments.