Syllabus for Undergraduate Programm
Physics Discipline
Science & Humanities School
Bangladesh Army University of Engineering & Technology (BAUET)

Summary of the courses for B. Sc (Hons.) in Physics

Year-I Semester -I

Course No	Course Title	Hrs/Week	Credit Hrs.
PHY -1101	Mechanics & Properties of Matter	3-0	03
PHY-1103	Waves & Oscillation	3-0	03
PHY -1105	Mathematical Methods in Physics-I	3-0	03
PHY -1102	Physics Sessional - I	0-3	1.5
CHEM-1123	Physical Chemistry	2-0	02
CHEM-1124	Chemistry Sessional - I	0-3/2	0.75
MATH-1141	Mathematics-I	3-0	03
ENG-1133	Basic Skills Development in English	2-0	02
CSE-1123	Computer Fundamentals	2-0	02
CSE-1124	Computer Fundamentals Sessional	0-3/2	0.75
Total		**18-6**	**21.00**

Year-I Semester-II

Course No	Course Title	Hrs/Week	Credit Hrs.
PHY-1201	Atomic & Molecular Physics	3-0	03
PHY-1203	Electricity & Magnetism	3-0	03
PHY-1205	Heat & Thermodynamics	3-0	03
PHY-1202	Physics Sessional - II	0-3	1.5
CHEM-1223	Inorganic & Organic Chemistry	2-0	02
CHEM-1224	Chemistry Sessional – II	0-3/2	0.75
MATH-1241	Mathematics-II	3-0	03
CSE-1223	C – Programming	2-0	02
CSE-1224	C – Programming Sessional	0-3	1.5
Total		**16-7.5**	**19.75**

Year-II Semester -I

Course No	Course Title	Hrs/Week	Credit Hrs.
PHY-2101	Electronics-I	3-0	03
PHY-2103	Optics – I	3-0	03
PHY-2105	Mathematical Methods in Physics-II	3-0	03
PHY-2102	Physics Sessional – III	0-3	1.5
STAT-2123	Statistics	3-0	03
MATH-2141	Mathematics-III	3-0	03
CSE-2124	Database Sessional	0-3	1.5
ECON-2125	Principle of Economics	2-0	02
HSS-2131	Government & Sociology	2-0	02
Total		**19-6**	**22.00**

Year-II Semester -II

Course No	Course Title	Hrs/Week	Credit Hrs.
PHY-2201	Classical Mechanics	3-0	03
PHY-2203	Optics –II	3-0	03
PHY-2205	Statistical Mechanics & Radiation	3-0	03
PHY-2207	Theory of Relativity	3-0	03
PHY-2202	Physics Sessional – IV	0-3	1.5
MATH-2241	Mathematics-IV	3-0	03
CSE-2224	MAT LAB	0-3	1.5
BA-2225	Accounting	2-0	02
Total		**17-6**	**20.00**

Year-III Semester -I

Course No	Course Title	Hrs/Week	Credit Hrs.
PHY-3101	Electronics - II	3-0	03
PHY-3103	Electrodynamics-I	3-0	03
PHY-3105	Elementary Particle Physics	3-0	03
PHY-3107	Mathematical Methods in Physics-III	3-0	03
PHY-3109	Nuclear Physics – I	3-0	03
PHY-3111	Solid State Physics - I	3-0	03
PHY-3102	Physics Sessional – V	0-3	1.5
Total		**18-3**	**19.50**

Year-III Semester -II

Course No	Course Title	Hrs/Week	Credit Hrs.
PHY-3201	Electronics – III	3-0	03
PHY-3203	Electrodynamics-II	3-0	03
PHY-3205	Nuclear Physics – II	3-0	03
PHY-3207	Quantum Mechanics- I	3-0	03
PHY-3209	Solid State Physics – II	3-0	03
PHY-3202	Physics Sessional – VI	0-6	03
Option-1		3-0	03
Total		**18-6**	**21.00**

Students will have the option to select any one course from the following courses

PHY-3211	Geophysics	3-0	03
PHY-3213	Meteorology	3-0	03
PHY-3215	Renewable Energy	3-0	03

Year-IV Semester -I

Course No	Course Title	Hrs/Week	Credit Hrs.
PHY-4101	Advanced Electronics	3-0	03
PHY-4103	Nuclear Physics- III	3-0	03
PHY-4105	Quantum Mechanics –II	3-0	03
PHY-4107	Solid State Physics – III	3-0	03
PHY-4109	Radiation and Health Physics	3-0	03
PHY-4102	Thesis	0-6	03
Option-I		3-0	03
Total		**18-6**	**21.00**

Students will have the option to select any one course from the following courses

PHY-4111	Computational Physics	3-0	03
PHY-4113	Plasma Physics	3-0	03
PHY-4115	Spectroscopy	3-0	03
PHY-4117	X-ray Crystallography	3-0	03

Year-IV Semester -II

Course No	Course Title	Hrs/Week	Credit Hrs.
PHY-4201	Biophysics & Medical Physics	3-0	03
PHY-4203	Fiber Optics and Optical Fiber Communication	3.0	03
PHY-4205	Quantum Mechanics-III	3.0	03
PHY-4207	Reactor Physics	3.0	03
PHY-4202	Thesis	0-6	03
Option- I		3.0	03
Total		**15-6**	**18.00**

Students will have the option to select any one course from the following courses

PHY-4209	Material Science	3.0	03
PHY-4211	Methods of Experimental Physics	3-0	03
PHY-4213	Particle and High Energy Physics	3-0	03

Total Credit Hour – 162.25 Credit Hours
Total Credit Hours in Core Courses: 115.50 Credit Hours
Total Credit Hours in Basic Science & Computer Oriented Courses: 29.75 Credit Hours
Total Credit Hours in Humanities & Social Science: 8.0 Credit Hours
Total Credit Hours in Optional Courses: 9.00 Credit Hours

Term Wise Credit Hour Distribution

Year	Semester	Credit Hours				Total	
		Core Courses	**Basic Science & Computer Oriented Courses**	**Humanities & Social Science Courses**	**Optional Courses**	**Term Wise**	**Year Wise**
1st	1st	10.50	8.50	2.00 (English)	--	21.00	40.75
	2nd	10.50	9.25	--	--	19.75	
2nd	1st	10.50	7.50	4.00 (2.0-Govt & Sociology +2.0-Econ)	--	22.00	42.00
	2nd	13.50	4.50	2.00 (Accounting)	--	20.00	
3rd	1st	19.50	--	--	--	19.50	40.50
	2nd	18.00	--	--	3.00	21.00	
4th	1st	18.00	--	--	3.00	21.00	39.00
	2nd	15.00	--	--	3.00	18.00	
Total		**115.50**	**29.75**	**8.00**	**9.00**	**162.25**	**162.25**

Detailed Syllabus for B. Sc. (Hons.) in Physics

Year-I Semester -I

PHY – 1101: Mechanics and Properties of Matter
Credit 03: (3 hours/ week)

Section – A

1. **Motion in One and Two Dimensions:** One dimensional motion with variable acceleration and constant acceleration; Equation of motion in free fall; Projectile motion; Uniform circular motion; Tangential acceleration in circular motion.
2. **Particle Dynamics and Moment of Inertia:** Force; Newton's laws and their applications; Dynamics of uniform circular motion; Moment of inertia; Radius of gyration; Torque; Expression for moment of inertia; Calculation of moment of inertia of solids of different shapes.
3. **Conservation of Momentum and Collisions:** Center of mass and gravity; Linear momentum; Conservation of linear momentum; Impulse; Systems of variable mass; Cross-section; Conservation of linear momentum during collisions.
4. **Rotational Kinematics and Dynamics:** Relation with constant angular acceleration; 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.

Section – B

5. **Gravitation:** Kepler's laws; Newton's law of gravitation; Gravitational attraction; Gravitational potential and field; Determination of gravitational constant; Escape velocity; Motions of planets and satellites.
6. **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 σ; Bending of beams; Cantilever.
7. **Hydrostatic Pressure and Surface Tension:** Pressure; Change of pressure with elevation; Measurement of pressure; Surface tension; Molecular theory; Surface energy; Angle of contact; Pressure of a curved membrane; Excess pressure inside a soap bubble; Capillarity; Variation of surface tension with temperature.
8. **Hydrodynamics and Viscosity:** Concept of fluid flow; Bernoulli's equation; Equation of continuity and their applications; Viscosity; Co-efficient of viscosity; Stoke's law; Critical velocity; Poiseullies equation and its correction; Effect of temperature and pressure on viscosity.

Books Recommended:

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. *Brij Lal & N. Subrahmanyam*: Properties of Matter.

PHY – 1103: Waves and Oscillation
Credit 03: (3 hours/ week)

Section – A

1. **Free Vibration:** Harmonic motion; Mathematical representation; Boundary conditions; Vector representation; Velocity, acceleration and their phase relationship; Energy of a harmonic oscillator; Physical and torsional pendulum; Plasma vibration.
2. **Damped and Forced Vibration:** Damping forces; Types of damping; Logarithmic decrement; Relaxation time and quality factor (Q); Electromagnetic damping; Forced oscillator; Steady state and transient solutions; Variation of driving frequency; Examples of resonance.

3. **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.

Section – B

4. **Fundamentals of Waves:** Wave motion; Types of waves; Wave generation; Wave equation and solution; Energy, power and speed of traveling waves; Plane and spherical waves; Introduction to some wave phenomena in physics.
5. **Superposition of Periodic Motions:** Principle of superposition; Superimposed vibration of equal and different frequencies; Stationary waves; Beats; Combination of two vibrations at right angles; Lissajous figures.
6. **Sound Waves and Acoustics:** Sources; Propagation and speed of sound in fluid and solid media; Musical sound; Doppler's effect; Infrasonic and ultrasonic; Recording and reproduction of sound; General idea of acoustics.

Books Recommended:

1. *C.A. Coulson*: Waves
2. *A.B. Wood*: A Text book of Sound
3. *N.W. Molechlan*: Theory of Vibration
4. *D. Haliday, R. Resnick & K.S. Krane*: Physics Vol.1
5. *A. Beiser*: Main Streams of Physics

PHY – 1105: Mathematical Methods in Physics-I
Credit 03: (3 hours/ week)

Section – A

1. **Vector and Scalar:** Vectors; Scalars; Vector algebra; Laws of vector algebra; Unit vector; Rectangular unit vectors; Components of a vector; Scalar field; Vector field; Dot product; Cross product; Triple product; Reciprocal sets of vectors.
2. **Vector Differentiation:** Ordinary derivatives of vectors; Space curve; Continuity and differentiability; Differentiation formulae; Partial derivatives of vectors; Differentials of vectors; Differential geometry; Mechanics.
3. **Gradient, Divergence and Curl:** The vector differential operator del; Gradient; Divergence; Curl; Formulae involving del; Invariance.

Section – B

4. **The Divergence Theorem, Stock's Theorem and Related Integral Theorems:** Gauss's divergence theorem; Stock's theorem; Green's theorem in the plane; Related integral theorems; Integral operator form for del.
5. **Curvilinear Co-ordinates:** Transformation of co-ordinates, Orthogonal curvilinear co-ordinates; Unit vectors in curvilinear systems; Arc length and volume elements; Gradient, Divergence & Curl; Special orthogonal co-ordinate systems; Cylindrical co-ordinates and spherical co-ordinates.
6. **Vector Integration:** Ordinary integrals of vectors; Line integrals; Surface integrals; Volume integrals.

Books Recommended

1. *M.R. Spigel:* Vector Analysis and an Introduction to Tensor Analysis
2. *M.L. Khanna*: Vector Analysis
3. *M.D. Raisinghania*: Vector Calculus
4. *S.A. Sattar:* Vector Analysis
5. *B. Spain:* Tensor Calculus
6. *H. Lass:* Vector and Tensor Calculus

PHY – 1102: Physics Sessional – I
Credit 1.5: (3 hours/week)

1. Determination of the Young's modulus and rigidity modulus of a short wire by Searle's dynamic method.
2. Determination of the modulus of rigidity of a wire by statical method.
3. Determination of the moment of inertia of a fly wheel about its axis of rotation.
4. Determination of the value of 'g', acceleration due to gravity, by means of a compound pendulum.
5. Determination of the surface tension of water by capillary tube method.
6. Determination of the co-efficient of viscosity of a liquid by its flow through a capillary tube.
7. Determination of the surface tension of mercury and the angle of contact by Quincke's method.
8. Determination of the spring constant and effective mass of a given spiral spring and hence to calculate the rigidity modulus of the material of the spring.
9. To show the variation of viscosity of water with temperature.
10. Determination of the Young's modulus by flexure of a beam (bending method).

Books Recommended

1. *Giasuddin Ahma 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

CHEM – 1123: Physical Chemistry
Credit 02: (2 hours/ week)

Section – A

1. **Chemical Analysis:** Types of chemical analysis; Qualitative analysis, Quantitative analysis, Volumetric analysis; Types of titrations, Requirement of volumetric analysis; Acidemetry 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 lowering of vapor pressure elevation of boiling point and depression of freezing point; 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.

Section – B

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, k_c.

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

Books Recommended:

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

CHEM – 1124: Chemistry Sessional-I
Credit 0.75: (3 hours/ every alternative week)

Volumetric Analysis:

1. **Acidimetry and Alkalimetry (Neutralization titration):**
   (i) Preparation of approx (N/10) HCl, H_2SO_4 and CH_3COOH Solution.
   (ii) Preparation of standard solution.
   (iii) Determination of the strength of acid/base by using standard base/acid solution respectively.
2. **Oxidation- Reduction Titration:**
   (i) Determination of the amount of iron in grams per litre of the given ferrous sulphate solution by standard $KMnO_4$ solution.
   (ii) Determination of the amount of copper in grams per litre in a given copper sulphate solution by using standard $Na_2S_2O_3$ solution.

Books Recommended:

1. *A.I. Vogel*: Inorganic Qualitative Analysis
2. *Abdus Salam*: Babaharic Ajiba Rasayan
3. *Hazari and Das*: Babaharic Rasayan
4. *Hazari, Das & Dey*: Bislasheya O Babaharic Rasayan

MATH – 1141: Mathematics – I
Credit 03: (3 hours/ week)

Section – A

1. **Set Theory:** Sets and subsets; Set operations; Cartesian product of two sets; Relations; Order relation; Equivalence relations; Functions; Images and inverse images; Injective, subjective and bijective functions; Inverse functions.
2. **Real Number System:** Field and order properties; Natural numbers; Integers and rational numbers; Absolute value.
3. **Inequalities:** Arithmetic, geometric and harmonic mean; Weierstrass, Cauchy's and Chebyshev's inequalities.
4. **Summation of Algebraic Series:** Arithmetic, geometric series; Method of difference; Successive differences; Use of mathematical induction.

Section – B

5. **Theory of Equations:** Synthetic division; Number of roots of polynomial equations; Relations between roots and coefficients; Multiplicity of roots; Symmetric functions of roots; Descarte's rule of signs; Upper and lower limits; Transformation of equations; Solution of cubic and biquadratic equations; Difference equation.
6. **Complex Number System:** Field of complex numbers; Geometric representation; De Moivre's theorem and its applications; Gregory's series; Summation of trigonometric series; Hyperbolic functions; Spherical trigonometry.

Books Recommended:

1. *R.S. Agarwal*: Set Theory and Number System
2. *Bernard and Child*: Higher Algebra
3. *Hall and Knight*: Higher Algebra
4. *S. Lipschutz*: Set Theory and Related Topics

5. *Rahman & Bhattacharjee*: Higher Algebra and Trigonometry
6. *M. Ray & H.S. Sharma*: A Text Book of Higher Algebra

ENG – 1133: Basic Skills Development in English
Credit 02: (2 hours/week)

Section – A

1. **Word:** Word structure; Word formation; Pronunciation and word stress; Word meaning.
2. **Parts of Speech:** Types and function.
3. **Phrase:** Phrase structure and function; Clause and its structure; Punctuation; English sound system; Intonation; Art of speaking; Guideline for improving listening skill.
4. **Oral Communication Tasks:** Interview, dialogue, debate, reception of visitors.

Section – B

5. **Reading Strategies:** Scanning; Skimming; Readers' expectation and context in reading.
6. **Writing:** Approaches to writing (product approach and process approach).
7. **Modes of Writing:** Definition; Description; Narrative; Cause and effects; Art of good writing.
8. **Writing Tasks:** Précis; Paragraph and essay; Letters and application.

Books Recommended:

1. *Thomson & Martinet* : Cliffs TOEFL Guide.
2. *Greenall, Simon and Michael Swan* : Effective Reading: Reading Skills for Advanced Students. Cambridge University Press.
3. *R. L. Gordon* : Interviewing Strategy.
4. *A. S. Hornby* : Oxford Learner Dictionary.
5. *A. W. Heffernan* : Writing: A College Handbook.

CSE – 1125: Computer Fundamentals
Credit 02: (2 hours/ week)

Section – A

1. Basic digital electronics; Computer arithmetic; Number system; Decimal; Binary; Octal; Hexadecimal; Integer & floating point representation; Coding: BCD, ASC II; GRAY; EBCDIC etc-their representation & manipulation; Introduction to analog & digital system of electronics; Logic gates: AND, OR, NOT, NOR, NAND, XNOR; Truth Tables; Boolean Algebra; Combinational logic circuits; Half adder; Full adder.
2. **Computers Architecture & Peripherals:** Generation, types, size and capacity; Basic organization of computer: CPU; Arithmetic logic unit; Control unit; Main memory; Buses & peripherals; Different types of memory: RAM, ROM, PROM, EPROM, EEPROM, Bubble and core memory; Elementary ideas about memory management; Ports and peripherals; Serial & parallel communication; 1/0 devices-Bulk storage: DISK, CD, Types etc; Keyboard, monitor, mouse, joystick, scanner, OMR.
3. **Operating System:** Functions of operating system; Operating system architecture: command processor, scheduler, field manager & resource allocator, dispatcher; Ideas on batch processing, real time processing, multi-programming & multi-processing; Idea about DOS, WINDOWS & UNIX; Language processor: Editor, compiler & interpreter.

Section – B

4. **Idea About Computer Networks:** LAN, MAN, WAN; Different network topology; Idea about internet & WWW.
5. **Microprocessor:** Intel 8086.
6. **Basic Maintenance of Computer:** Voltage stabilizer, UPS, IPS, Surge protection, Maintenance of disk and storage media; Different utility of software for fault-diagnosis; Idea about computer viruses and anti-virus and their uses.
7. **Programming Languages:** Basic ideas of algorithm, Flow chart, PDL, Program structure; BASIC/FORTRAN language - Constant, variables, subroutines; 1/0 operations; Examples of development of physics programs.

Books Recommended:

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

CSE – 1126: Computer Fundamentals Sessional
Credit 0.75: (3 hours/ every alternative week)

Introduction to computer; Basic units of a computer; Hardware & software, Operating system; Word processing package; Spread sheet & analysis packages.

Year-I Semester – II

PHY – 1201: Atomic & Molecular Physics
Credit 03: (3 hours/ week)

Section – A

1. **Wave-Particle Duality:** Photoelectric effect; Einstein's photoelectric equation and its experimental verification; Photoelectric cells and their application; Compton effect; de Broglie waves; Experimental verification of particle waves: Wave and group velocities.
2. **Atomic Models:** Atomic models; Rutherford's nuclear atom; Atomic spectra; The Bohr model and the structure of atoms; Vector atom model; Atomic excitation; The Franck-Hertz experiment; The correspondence principle; Correction for nuclear motion; Hydrogen-like atoms.
3. **X-Rays:** Production and properties of X-rays; Continuous and characteristic X-rays; X-ray spectra; X-ray absorption; Moseley's law;

Section – B

4. **Quantum Mechanical Theory of Hydrogen Atom:** Schrödinger equation for the hydrogen atom and magnetic quantum numbers; Electron probability density; Spectrum of hydrogen.
5. **Electron Spin and Complex Atoms:** Spin angular momentum; Exclusion principle; Periodic table; Stern-Garlach experiment; Spin-orbit interaction; Fine structure; Total angular momentum of atoms; Atomic spectra (Helium, Sodium and Mercury); Zeeman effect.
6. **Molecular Spectra:** Molecular spectra of diatomic molecules; Rotational spectra; Vibrational-rotatinal spectra; Molecular quantum states; Dissociation of molecules; Heat of dissociation; UV- spectra; Ramman spectra.

Books Recommended:

1. *A. Beiser*: Concepts of Modern Physics
2. *H. Semat*: Introduction to Atomic & Nuclear Physics
3. *J.B. Rajam*: Atomic Physics
4. *Brij Lal & N. Subrahmanyam:* Atomic & Nuclear Physics
5. *B.L. Theraja*: Modern Physics

PHY – 1203: Electricity and Magnetism
Credit 03: (3 hours/ week)

Section – A

1. **Electrostatics:** Coulomb's law; Electric field; Calculation of E; A point charge in an electric field; A dipole in an electric field; Flux of the electric field; Gauss's law and its applications; Electric potential due to a point charge; Potential due to a dipole; Electric potential energy; Calculation of E from V.
2. **Capacitor and Dielectrics:** Capacitance; Calculation of capacitance; Dielectrics; Parallel plate capacitor with dielectric; Dielectrics and Gauss's law; Energy storage in an electric field.
3. **Current and Resistance:** Current and current density: Resistance; Resistivity; Conductivity; Ohm's law; Kirchhoff's laws and their applications.

Section – B

4. **Electromagnetic Induction:** Faraday's and Lenz's laws; Self and mutual induction; Solenoids; Growth and decay of current in the circuits of L, C and R combination; Moving coil instruments and galvanometers; Concept of electric generator and motors.
5. **Magnetic Fields and Interaction:** Magnetic force; Magnetic force on charge and current; Biot-Savart's law and its applications; Ampere's law and its applications; Magnetic effects of current.
6. **Thermoelectricity:** Thermoelectric phenomenon and relation; Thermoelectric power; Thermoelectric diagrams; Thermocouples.
7. **Alternating Current:** Power and power equations; L, C and R in AC circuits; Vector diagram and use of complex quantities; Polar representation of AC circuits; Resonance and anti-resonance circuits; Q-factors; Transformers; AC measuring instruments; AC bridge.

Books Recommended:

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
5. *J.P. Agarwal*: Circuit Fundamental and Basic Electronics

PHY – 1205: Heat and Thermodynamics
Credit 03: (3 hours/ week)

Section – A

1. **Thermometry:** Types of thermometer: Different scales of temperature; High and low temperature measurement; Platinum resistance thermometer; Thermo-couple; Seebeck effect; Thermoelectric thermometer.
2. **Kinetic Theory of Gas:** Kinetic theory of gas: Expression for the pressure of a gas; Derivation of gas equation; Mean free path; Andrew's Experiment; Van-der Waals equation of state; Critical constants.
3. **Transmission of Heat:** Thermal conductivity; Rectilinear flow of heat by Searle's method; Lee's methods for bad conductors and liquid; Spherical shell method; Cylindrical flow of heat; Thermal conductivity of glass and rubber.
4. **Specific Heat and Liquefaction of Gas:** Specific heat of liquid and solid; Newton's law of cooling; Heat capacities; Liquefaction of O_2, H_2 and air.

Section – B

5. **The First Law of Thermodynamics:** The energy equation; Isothermal and adiabatic changes; Thermal coefficients and their relations.

6. **The Second Law of Thermodynamics:** Reversible and irreversible processes; Carnot's cycle; Heat engines; Absolute scale of temperature; Theorem of Clausius; Entropy; Changes of entropy in reversible and irreversible process; Entropy of a perfect gas.
7. **Maxwell's Thermodynamical Relations:**Thermodynamic variables;Thermodynamical functions and their relations; Gibbs – Helmhotz epuation and Entropy; Joule- Thomson effect; Change of state; Clausius-Clapeyron equation; Phase equation & phase rule; Triple point; Gibb's phase rule and its applications; Heat of reaction; Heat of combustion; Heat of neutralization; Heat of vaporisation; Hess's law.

Books Recommended:

1. *F.W. Sears:* Heat and Thermodynamics
2. *M.W. Zemansky:* Heat and Thermodynamics
3. *T. Hossain:* Text book of Heat
4. *Brij Lal & N. Subrahmanyam:* Heat and Thermodynamics

PHY – 1202: Physics Sessional –II
Credit 1.5: (3 hours/week)

1. Determination of specific heat of a solid by the method of mixture with radiation correction.
2. Determination of specific heat of a liquid by the method of mixture.
3. Determination of specific heat of a liquid by the method of cooling.
4. Determination of thermal conductivity of a bad conductor by Lee's and Chorlton's method.
5. Determination of coefficient of thermal conductivity of a metal using Searle's apparatus.
6. Determination of the value of an unknown resistance.
7. Verification of the laws of series and parallel resistance by means of a post office box.
8. Determination of specific resistance of a wire using a meter bridge.
9. Determination of the end correction of a meter bridge.
10. Determination of Stefan's constant.

Books Recommended

1. *Giasuddin Ahmad, 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

CHEM – 1223: Inorganic and Organic Chemistry
Credit 02: (2 hours/ week)

Section – A

1. **Atomic Structure:** Elementary ideas on atomic structure; Electronic configuration of elements.
2. **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.
3. **Group Study of Elements:** Alkali metals; Alkaline earth metals; Helogens; Inert gases and transition elements.
4. **Chemical Bond:** Elementary different types of chemical bonding; Concept of hybridization; Molecular orbitals; Bond length and bind strength.

Section – B

5. **Aliphatic Compounds:** Nomenclature of organic compounds; Preparation and properties of alcohols; Halides; Aldehydes; Ketones and Carboxylic acids.
6. **Aromatic Compound:** Aromaticity; Orientations; Preparations and properties of Benzene, Phenol, Nitrobenzene and Aniline; Alicyclic and Heterocyclic compounds.

Book Recommended:

1. *S.Z. Haider*: Modern Inorganic Chemistry
2. *T. Moeller*: Modern Inorganic Chemistry
3. *E. Gilreath*: Fundamental Concepts of Inorganic Chemistry
4. *D.K. Seberra*: Electronic Structure and Chemical Bonding
5. *M. Ahmed & A. Jabbar*: Organic Chemistry
6. *I.M. Finer*: Organic Chemistry
7. *B.S. Bahl and A. Bahl*: Advanced Organic Chemistry
8. *Ahmed and Hossain*: Snatak Ajaiba Rasayan (Bangla)
9. *A.K.S. Ahmed*: Ajaiba Rasayan (Bangla)

CHEM – 1224: Chemistry Sessional – II
Credit 0.75: (3 Hours / every alternative week)

1. Detection of carbon, oxygen, nitrogen, sulphur and halogen in organic compound.
2. Identification of organic compounds containing different functional groups.

Books Recommended:

1. *A.I. Vogel*: Inorganic Qualitative Analysis
2. *Abdus Salam*: Babaharic Ajiba Rasayan
3. *Hazari and Das*: Babaharic Rasayan
4. *Hazari, Das & Dey*: Bislasheya O Babaharic Rasayan

MATH – 1241: Mathematics – II
Credit 03: (3 hours/ week)

Section – A

1. **Geometry in Two Dimensions:** General equation of second degree; Pair of straight lines; Reduction to standard form of conics; Circle; Parabola; Ellipse; Hyperbola.

Section – B

2. **Geometry in Three Dimensions:** Equation of plane in Cartesian coordinates of three dimension; Straight line; Sphere; Cylinder; Cone; Ellipsoid; Paraboloid and hyperboloid.

Books Recommended:

1. *R-E.H. Askwith*: Analytic Geometry of Conic Sections
2. *Khosh Mohammed*: Coordinate Geometry
3. *Rahman & Bhattacharjee*: Two & Three dimensional geometry
4. *C. Smith*: Analytic Geometry of Conic Sections
5. *C. Smith*: An Elementary Treatise Geometry
6. *Shanti Narayan*: Analytical Solid Geometry
7. *J.M. Kar*: Analytical Geometry
8. *B.D. Sharma*: Analytical Solid Geometry.

CSE – 1223: C – Programming
Credit 02: (2 hours/ week)

Section – A

1. **Elements of Computer Structures and Programming Languages:** Number system; Binary arithmetic; Principles of programming; Structured programming concepts; Programming algorithms and flow charts construction; Introduction of C programming language; Basic structure of C program.

Section – B

2. Writing, Debugging and Running programs using C; Variables; Arithmetic expressions; Data types; Operators and expressions; Control flow; Functions and program structures; Pointers and arrays; Structures; Input/output systems in C; Introduction to object oriented programming using C $^{++}$.

Books Recommended:

1. *E. Balagurusamy*: Programming in ANSI C
2. *Kerighan and Ritchie*: The C Programming Language
3. *H. Schildt*: Mastering Turbo C/C $^{++}$

CSE – 1224: C – Programming Sessional
Credit 1.5: (3 Hours/week)

Students will complete at least three projects with proper documentation as assigned by teacher, based on course **CSE-1253.**

Year– II Semester – I

PHY – 2101: Electronics-I
Credit 03: (3 hours/ week)

Section –A

1. **Circuit Analysis:** Network theorem – Nortan's theorem, Thevenin's theorem, Maximum power transfer theorem; Superposition theorem; Wave filter: high pass, low pass, band pass.

2. **Vacuum Tubes and Gas Filled Tubes:** Vacuum tube; Vacuum diode and its characteristics; Vacuum triode and its characteristics; Vacuum tube constants; and their relation; Gas filled tubes; Classification of gas filled tubes; Characteristics of cold-cathode diode; Thyratron; Application of thyratron.

3. **Atomic Structure:** Bohr's atomic model; Energy levels; Energy bands; Important energy bands in solids; Classification of solids and energy bands.

Section – B

4. **Semiconductor Physics:** 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; Applying voltage across-pn junction; V-I characteristics of pn-junction.

5. **Semiconductor Diode:** Semiconductor diode; Equivalent circuits; Semiconductor diode rectifiers; Half-wave rectifier; Full-wave rectifier; Efficiency of half-wave and full-wave rectifier; Nature of rectifier output; Ripple factor; Filter circuits; Types of filter circuits; Voltage stabilization; Zener diode as a voltage stabilizer.

6. **Transistors & Transistor Biasing:** Transistor; Transistor action; Transistor connections; Characteristics of CE, CB and CC connection; Transistor as an amplifier in CE arrangement; Transistors load line analysis; Operating point; Cut off and saturation points; Power rating of transistor; Faithful amplification; Transistor biasing; Methods of transistor biasing; Design of transistor biasing circuits; Mid point biasing.

Books Recommended:

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

PHY – 2103: Optics – I
Credit 03: (3 hours/ week)

Section – A

1. **Nature and Propagation of Light**: Light and electromagnetic spectrum; Energy and momentum; Speed of light; Doppler effect.
2. **Plane Waves and Plane Surfaces:** Refraction; Huygen's principle; Fermat's Principle.
3. **Spherical Waves and Spherical Surfaces**: Refraction and reflection at spherical surfaces; Refraction through lenses; Equivalent lens; Cardinal points.
4. **Defect of Images and Optical Instruments:** Aberrations; Spherical aberration at a single surface and in a lens; Reducing spherical operations; Coma, Astigmatism; Distortion; Chromatic aberrations; Reducing of aberrations; Microscope; Telescope.

Section – B

5. **Interference of Light:** Division of wavefront and amplitude; Young's experiment; Fresnel biprism; Fringes with quasi-monochromatic and white light; Fringes of equal inclination and thickness; Newton's rings; Michelson interferometer; Mach-Zehnder and Rayleigh interferometers; Michelson stellar interferometer.
6. **Diffraction:** Fresnel & Fraunhofer diffraction; Diffraction- single slit and double slit; Multiple slits diffraction phenomena; Diffraction gratings; Crystal diffraction; Bragg's law.
7. **Holography:** Diffraction from apertures and edges; Production of holograms; LASER properties; Emission and absorption coherence of radiation; General description and theory of LASER; Types of LASER and their application.

Books Recommended:

1. *R.S. Longhurst*: Geometrical & Physical Optics
2. *D. Halliday, R. Resnick, K.S. Krane*: Physics (Vol.-2)
3. *O. Svelto and D.O. Hanna*: Principle of Lasers
4. *F.A Jenkin and H.E. White*: Fundamentals of Optics
5. *G.B. Goodhar*: Introduction to Optics
6. *A. Ghatak*: Optics
7. *Brij Lal and N. Subrahmanyam*: A Text Book of Optics

PHY – 2105: Mathematical Methods in Physics – II
Credit 03: (3 hours/ week)

Section – A

1. **Matrices:** Types of matrices; Determinant of a square matrix; Matrix equivalence; The adjoint and inverse of a matrix; Orthogonal and unitary matrices; Linear dependence of vectors, Linear equations; Vector spaces, Linear transformations-similarity; Characteristic roots and vector diagonalisation of matrices.

2. **Tensor Analysis**: Definition; Co-ordinate transformation; Contravarient, covarient and mixed tensor; Kronecker delta; Invarients or scalar; Fundamental operations with tensors; Matric tensor; Crystoffel symbols.

Section – B

3. **Complex Variables:** Definition of complex number; argand diagram, Complex differentiation and derivatives; Analytic functions; Cauchy-Reimann equations; Cauchy's integral formula and its extension; Cauchy's theorem; Residues at a pole and at infinity; Residue theorems; Definite integrals.

Books Recommended:

1. *D.A. Pipce*: Applied Mathematics for Engineers & Physicists
2. *M.R. Spiegel*: Vector Analysis & an Introduction to Tensor Analysis
3. *M.R. Spiegel*: Complex Variables
4. *M.R. Spiegel*: Theory of Matrices
5. *H. Lass*: Vector and Tensor Calulus
6. *S.L. Ross*: Differential Equations
7. *B.D. Gupta*: Mathematical Physics

PHY – 2102: Physics Sessional – III
Credit 1. 5: (3 hours/week)

1. Determination of the focal length and hence the power of a convex/concave lens by displacement method with the help of an optical bench.
2. Determination of the refractive index of a liquid by plane mirror and pin method using a convex lens.
3. Determination of the angle of a prism.
4. Determination of the refractive index of the material of a prism.
5. Determination of the Cauchy's constants and the resolving power of a prism using a spectrometer.
6. Determination of the emf of a cell with a potentiometer.
7. To compare the emf of two cells with a potentiometer.
8. Determination of the internal resistance of a cell by a potentiometer.
9. Determination of the resistance of a galvanometer by half-deflection method.
10. To calibrate a meter bridge wire.
11. Studying the characteristics of a p-n-p transistor in CE connection.
12. Studying the characteristics of pn-junction.
13. Verification of the superposition theorem.
14. Verification of the maximum power transform theorem.

Books Recommended

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

STAT – 2123: Statistics
Credit 02: (3 hours/ week)

Section – A

1. **Statistics:** Meaning and scope; Variables and attributes; Collection and presentation of statistical data; Frequency distribution and graphical representation.
2. **Univariate Distribution:** Location; Dispersion and their measures; Skewness; Kurtosis and their measures; Moment and cumulates density function; Binomial, Poisson, normal distributions and their properties.

3. **Linear Regression:** Linear regression involving nonrandom variables; Principle of least squares; Lines of best fit; Residual analysis.
4. **Large Sample Test of Significance:** Basic ideas about sampling distribution; Population and sample; Tendency of normality of statistics; Standard errors of means; Variances and proportion; Test of significance in large sample; Comparison of means; Proportions and variances; Correlation and regression coefficients.

Section – B

5. **Theory of Probability & Probability Distribution:** Permutation and combination; Meaning of probability; Mathematical and statistical definition of probability; Sample space event (simple and compound); Marginal and conditional probability; Additive and multiplicative rules of probability; Boys theorem of probability and simple problems in probability; Random variable; Probability function; Probability density function; Distribution: marginal and conditional distribution; joint probability function; Marginal probability density function; Conditional probability density function. Mathematical expectation; Theorem of expectation; Characteristics function; Cumulants; Binomial; Poisson; Normal; Exponential.

Books Recommended:

1. *A.J.B. Anderson*: Interpreting Data
2. *M.G. Bulmer*: The Elements of Probability Theory
3. *W. Feller*: Introduction Statistics
4. *U. Yule and Kendall*: Introduction to Theory of Statistics
5. *D.V. Lindley*: Introduction to Probability and Statistics
6. *M.G. Mostafa*: Method of Statistics

MATH – 2141: Mathematics – III
Credit 03: (3 hours/ week)

Section – A

1. **Functions:** Domain; Range; Inverse function and graphs of functions; Limits; Continuity.
2. **Ordinary Differentiations:** Differentiability; Differentiation; Successive differentiation and Leibnitz theorem.
3. **Expansion of Functions:** Rolle's theorem; Mean value theorem; Taylor's Theorem.
4. **Maxima and Minima:** Maxima and minima of functions of one variable.
5. **Partial Differentiation:** Euler's theorem; Tangents and normals.

Section-B

6. **Indefinite Integrals:** Methods of substitutions; Integration by parts; Special trigonometric functions; Rational fractions.
7. **Definite Integrals:** Fundamental theorem of calculus; Properties of definite integrals; Evaluation of definite integrals.
8. **Improper Integrals:** Beta and gamma functions.
9. **Application of Definite Integral:** Length, area, volume and surface of revolution; Length of plane curves; Area and volume of solid revolution

Books Recommended:

1. *F.Ayres*: Calculus
2. *B.C. Das & B.N. Mukherjee*: Differential Calculus
3. *B.C. Das & B.N. Mukherjee*: Integral Calculus
4. *Kaplan*: Advance Calculus
5. *Muhammad & Bhattacherjee*: Differential Calculus
6. *Muhammad & Bhattacherjee*: Integral Calculus

CSE – 2124: Database Sessional
Credit 1.5: (3 Hours/week)

Section – A

1. **Database Concepts:** Files and databases; Database management systems; Data models.
2. **Relational Data Model:** Relations; Domains; Attributes and tuple; Anomalies; Functional dependency; First, second and third normal forms; Boyce-Codd normal form; Relational calculus based languages – SQL and QBE; Relational algebra and set operations.
3. **Relational Database Design:** Relational design criteria; Lossless decompositions; Decomposition algorithms, Synthesis; Algorithms.

Section – B

4. **Advanced Database Concepts:** Fourth and fifth normal forms; Object-oriented databases.
5. **Entity – Relationship (ER) Approach:** The ER model and its construct; ER modeling in logical database design; Transformation of the ER model to SQL; Distributed database design.
6. **The MAM Technique:** Fact type; Uniqueness constraint; Arity checking; General constraints; Conceptual schema transformations; Relational implementation.

Recommended References:

1. *Henry F. Korth & Abraham Silberschatz*: Database System Concepts
2. *John S. Shepherd:* Database Management: Theory and Application
3. *John Martin:* Database Organization
4. *Ullman:* Principles of Database Management

ECON – 2125: Principle of Economics
Credit 02: (2 hours/week)

Section – A

1. **Introduction:** Definition and scope of economics; Basic concepts and tools used in economics; Economic problems scarcity and resources.
2. **Demand Supply and Market Concept of Demand and Supply:** Market equilibrium; Determinants of demand and supply-shifting of demand and supply curves; Application of demand and supply; Elasticity of demand and supply.
3. **Economics of Consumer Behavior:** Utility analysis; Paradox of value; Law of diminishing marginal utility; Indifference curve analysis; Budget constraint; Consumers equilibrium; Change in income and prices; Derivation of demand curves; Income and substitution effects; Consumers surplus.
4. **Economics of Firm-Production and Costs:** Production function; Law and diminishing return; Stage of production; Law of variable proportion; Short run and long run production and costs.

Section – B

5. **Introduction to Macroeconomics:** Definition: Macro-economic performance; Measuring national product and national income – GNP, NNP, NI: Personal disposable income; National and real GNP; Circular flow of income; Value added.
6. **Determination of National Income:** Concepts of aggregate demand and planned spending; Aggregate demand; Equilibrium output/income; Change in equilibrium output; Multiplier; Paradox of thrift.
7. **Money & Banking:** Definition and functions of money; Different kinds of money; Banking-Goldsmith banking; Commercial bank and the money stocks; Functions of central bank-money supply; Open market operations; High powered money.

Recommended References:

1. *S. Fisher, R. Dornbusch. & R. Schmalansee:* Economics
2. *Maddala and Miller:* Microeconomics, Theory and Applications
3. *Hyman:* Economics
4. *A. Roger Arnold:* Economics
5. *S.A.Samuelson, & W. Nordhaus:* Economics

HSS-2131: Government and Sociology
Credit – 02 (2 hours/ week)

Section: A

1. Government: Some basis concepts of government and politics: Functions, organs and forms of modem states and governments; Socialism, fascism, Marxism; U.N.O.; Government and politics of Bangladesh; Some major administrative systems of developed countries; Local self-government.

Section: B

2. Basic Concepts of Society: Community, group association, institution; Civilization and culture; Social structure and organization-relation and interaction.
3. Migration: Internal-rural urban and urban-rural inter-regional, push and pull factors of migration; International migration and its impact on the economy.
4. Rural Power Structure and Its Impact on Rural Economy: Exploitation, poverty, unemployment, landlessness, and migration.
5. Social Problems in Urban and Rural Areas: Unemployment, crime, political and social unrest; Poverty, beggary and vagrancy-causes and solutions.

Recommended References:

1. *Bhushan, B:* Dictionary of Sociology
2. *Elbert W.Stewart and James A.Glagnn:* Introduction to Sociology
3. *Horton, P. B. & C.L.Hunt:* Sociology
4. *Morris ginsberg:* Sociology
5. *Martin Slattery:* Urban Sociology
6. *Thomas R.Shannon and Others:* Urban problems in Sociological Perspectives
7. *William F.Ogburn and Meyer F.Nimkoff:* A Handbook of Sociology

Year – II Semester – II

PHY – 2201: Classical Mechanics
Credit 03: (3 hours/ week)

Section – A

1. Variational Principle and Lagrangian Formulation: Variational principle; Constraints; Generalized co-ordmates; D'Alambert's principle; Hamilton's principle; Langrange's equation from D'Alambert's principle; Langrange's equation from Hamilton's principle; Applications of Lagrange's equation.

2. The Two-Body Central Force Problem: Reduction to equivalent one body problem; Equations of motion and first integrals; Equivalent one-dimensional problem and classification of orbits; Differential equation for the orbit and integrable Power-Law potentials; The Kepler problem and inverse square law of force; Scattering in a central force field; Transformation of the scattering problem to laboratory co-ordinates.

Section – B

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; Conservation theorem; 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.

Books Recommend:

1. *G. Goldstein*: Classical Mechanics
2. *N.C. Rana & P.S. Joag*: Classical Mechanics
3. *S.L. Gupta, H.V Sharma & V Kumar*: Classical Mechanics
4. *K.C. Gupta*: Mechanics of Particle & Rigid Bodies

PHY – 2203: Optics – II
Credit 03: (3 hours/ week)

Section – A

1. **Coherence of Light**: Spatial and temporal coherence; Coherence time and coherence length; Coherence properties of ordinary and laser light.
2. **Polarization :** Definition; Plane, circular and elliptic polarization; Polarization by reflection; Brewster's law; Optical activity; Birefringence; Optical axis; Full-wave, half-wave and quater-wave plates; Nicol and Wollaston prisms; Disperson; Cauchy and Sellmeir formulae; Polarization by scattering; Rayleigh scattering; Scattering phenomena in the atmosphere; Faraday, Kerr and Pockels effects.
3. **Fiber Optics**: Core and cladding; Principle of light propagation through optical fibers; Numerical aperture; Step-index and gradient–index fibers; Optical fiber communications.

Section –B

4. **Multiple-beam Interference:** Multiple reflections from a plane-parallel plate; Fabry-Perot interferometer; Free spectral range and chromatic resolving power; Single and multilayer films; Mathematical treatment; Anti-reflection coatings; Interference filter problems.
5. **Fourier Optics:** Fourier transforms in two dimensions; Inverse transforms; Dirac delta function; Optical application; Convolution and convolution theorem; Fourier methods in diffraction theory; Lens as a Fourier transformer; Spectra and correlation; Interpretation of Parseval's formula; Auto-correlation and cross-correlation; Wiener-Khintehine theorem.

Books Recommend:

1. *E. Hecht*: Optics
2. *F.A. Jenkins and H.E. White*: Fundamentals of Optics
3. *Born and E. Wolf*: Principle of Optics
4. *Brij Lal and N. Subrahmanyam*: A Text Book of Optics

PHY – 2205: Statistical Mechanics and Radiation
Credit 03: (3 hours/ week)

Section – A

1. **Statistical Systems:** The scope of statistical physics; Macroscopic and microscopic states; Thermodynamic functions and their equilibrium conditions.
2. **Phase Space:** Phase space and phase trajectory; Density distribution in phase space; Liouville's theorem and its consequence; Postulates of classical statistical mechanics; Ensembles; Ensemble average; Microcanonical canonical and grand canonical ensembles; Use of the ensembles.
3. **Partition Function:** The evaluation of classical partition function; The semi-classical perfect gas components of the partition function; The Boatman partition function.

4. **Statistics and Thermodynamics:** Thermodynamic probability; Entropy; Statistical distribution function; Maxwellian-Boltzman statistics and its application.

Section – B

5. **Quantum Statistics:** Postulates of quantum statistical mechanics; Transition from classical statistics; Indistinguishability and quantum statistics; Exchange symmetry of wave function; Exchange degeneracy; Average value and quantum statistics; The density matrix.

6. **Quantum Mechanical Gases:** Fermi gas; Fermi-Dirac distribution; Fermi energy; Degenerate Fermi system; Heat capacity of free electron gas; Diamagnetism; Paramagnetism; Bose gas; Bose-Einstein distribution; Photon; Phonon; Bose-Einstein condensation; Thermodynamic properties of diatomic molecules; Nuclear spin effects in diatomic molecules.
7. **Radiation:** Kirchhoff's Law; Black body radiation; Stefan Boltzman's law; Rayleigh-Jean's law; Wein's radiation law and Planck's quantum law.

Books Recommended:

1. *F. Reif*: Fundamentals of Statistical & Thermal Physics
2. *L.D. Landau & E.M. Lifshitz*: Statistical Physics
3. *C. Kittel*: Elementary Statistical Mechanics
4. *A. Beiser*: Concept of Modern Physics
5. *Brij Lal*: Thermal and Statistical Physics
6. *S.L. Gupta*: Elementary Statistical Mechanics

PHY – 2207:- Theory of Relativity
Credit 03: (3 hours/ week)

Section – A

1. **Special Relativity:** Inertial systems; Michelson-Morley experiment and its explanation; Postulates of the special theory of relativity; Four vectors; Lorentz transformation; Length contraction; Time dilation; Velocity addition; Relativistic mass and energy, Galilean relativity; Newtonian mechanics, Twin paradox; Doppler effect and its application.
2. **Relativistic Mechanics:** Mass and momentum; Relativistic energy; Equivalence of mass and energy; Momentum energy four vector; Relativistic force law.

Section – B

3. **General Relativity:** Mach's principle; Principle of equivalence, Principle of general covariance; Principle of minimum gravitational coupling; Correspondence principle; Field equations of general relativity; Energy-momentum tensor; Maxwell's field equations; Schwarzchild solution; Experimental tests of general relativity; Particle in gravitational field; Gravitational field in relativistic mechanics; Curvilinear coordinates; Distance and time intervals in general relativity; Covariant differentiation; Motion of a particle in a gravitational field; The constant gravitational field; The gravitational field equations: The curvature tensor; The Einstein equations.

Books Recommend:

1. *R. D'Inverno:* Introducing Einstein's Relativity
2. *R. Resnick*: Introduction to Special Relativity
3. *P.G. Bergmann*: Introduction to the Theory of Relativity
4. *J.B. Hartle*: Gravity: An Introduction to General Relativity
5. *A. Beiser:* Concept of Modern Physics

PHY – 2202: Physics Sessional – IV
Credit 1.5: (3 hours/week)

1. Measurement of dispersive power of the material of a prism by spectrometer using a discharge tube.
2. Determination of the radius of curvature of a lens and wavelength of monochromatic light by Newton's ring.
3. Determination of the refractive index of a liquid by Newton's ring.
4. Determination the wavelengths of various spectral lines by spectrometer using plane diffraction grating.
5. Determination the specific rotation of a sugar solution by means of polarimeter.
6. Determination of the figure of merit of a galvanometer.
7. Determination of high resistance by the method of deflection.
8. Determination of the value of low resistance by the method of fall of potential.
9. Determination of wavelength of light by diffraction through a single slit.
10. Determination of wavelength of light by a biprism.
11. Determination of wavelength of light by plane diffraction grating.

Books Recommended

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

MATH-2241: Mathematics – IV
Credit 03: (3 hours/ week)

Section-A

1. **Differential Equations:** Definition and classifications of differential equations; Formation of differential equation.
2. **Solutions of First Order First Degree Equations:** Exact equation; Homogeneous equation; Linear and Bernoulli's equation.
3. **Higher Order Linear Differential Equations:** Higher order linear homogeneous and non-homogeneous equations with constant coefficients; Method of undetermined coefficients; Operator method; Method of variation of parameters.
4. **Linear Equation With Variable Coefficients:** Cauchy-Euler equation; Factorization of operators; Exact equation.

Section-B

5. **Total Differential Equation:** Integrability condition; Solution method for Pdx+Qdy+Rdz=0 and dx/P= dy/Q=dz/R; Formation of partial differential equations; Linearity of partial differential equations.
6. **First Order PDE:** Solution of first order linear partial differential equations; Lagrange's method.
7. **First Order Non-Linear PDE:** Cauchy's method of characteristics; Charpit's method; Jacobi's method.
8. **Second order PDE:** Linear PDE with constant coefficients; Equations with variable coefficients; Solution of linear hyperbolic equation; Monge's methods.
9. **Boundary value problem:** Solution of wave equation and heat equation.

Books Recommended:

1. *Ayres, F*: Differential Equations
2. *Dennemeyer,R*: Introduction to Partial Differential Equations
3. *Khanna, M. L*: Partial Differential Equations
4. *Sharma, B.D*: Partial Differential Equations
5. *T Myint U*: Partial Differential Equations

CSE–2224: MAT LAB
Credit 1.5: (3 hours/ week)

Students will solve the problems of the following topics by using MAT LAB:
Solution of algebraic and trigonometric equations; Graph of functions; Identifications and graphs of conics; Definite and indefinite integrals; Partial differentiation; Rolle's, Mean value and Taylor's theorem; Maxima and minima of functions; Curve tracing; Length, area and volume; Tangent and normal; Matrix algebra; Inverse matrix; Transformation of matrix; Solution of first order first degree ODE; First order higher degree ODE; Higher order linear homogeneous and non homogeneous ODE; Solution of first order PDE; Solution of second order PDE; Solution of boundary value problems (heat equation and wave equation).

BA – 2225: Accounting
Credit 02: (2 hours/week)

Section – A

1. Basic accounting principles; Double entry cystic; Journal; Ledger accounts; Trial balance; Cash book; Capital and revenue; Final accounts; Depreciation.

Section – B

2. Preparation of a cost sheet/statement of cost; Materials, overheads, wages and salaries; Reconciliation of cost and financial accounting.

Recommended References:

1. *Pyle and White:* Principle of Accounting
2. *Roger H. Hermanson; J.D. Edwards and Roy H. Garrison:* Financial Accounting.
3. *Brock and Plamer:* Cost Accounting – Principles and Applications.

YEAR – III SEMESTER – I

PHY-3101: Electronics – II
Credit 03: (3 hours/ week)

Section – A

1. **Transistor Amplifier:** 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.
2. **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.
3. **Feedback and Oscillator Circuits:** Feedback: Principles; Characteristics; Current and voltage feedback amplifiers; Positive feedback; Negative feedback; Oscillator: Condition for sustained oscillation; Phase-Shift; Wein-Bridge; Hartley; Colpitt's and Crystal and Relaxation oscillator.
4. **Solid-State Switching Circuits:** Switching circuit; Different types of switch; Multivibrators; Types of multivibrators; Transistor astable multivibrator; Transistor monostable multivibrator; Transistor bistable multivibrator; Differentiating circuit; Integrating circuit; Important applications of diodes; Clipping circuits; Applications of clippers; Clamping circuits; Basic idea of a clamper; Positive clamper; Negative clamper.

Section – B

5. **Electronic Devices:** FET: Junction field effect transistor (JFET); JFET drain and transfer characteristics; Enhancement MOSFET; Depletion MOSFET; Drain and transfer characteristics of Enhancement and depletion MOSFET.
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; Superhetrodyne FM receiver; AVC and AFC system.

Recommended References:

1. *James J. Brophy:* Basic Electronics for Scientists
2. *R. L.Boylestad, L. Nashelsky*: Electronic Devices & Circuit Theory
3. *J. Millman & A. Grabel*: Microelectronics
4. *V. K. Mehta*: Principle of Electronics
5. *G. K. Mithal*: Electronic Devices & Circuit
6. *G. K. Mithal*: Radio Engineering
7. *Dr.S.L.Gupta and Dr.V. Kumar:* Hand Book of Electronics

PHY - 3103: Electrodynamics-I
Credit 03: (3 hours/ week)

Section – A

1. **Electromagnetic Field Equations:**
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) Pointing'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 of 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) Multipole expansion of the potential due to a localized charge distribution; Dipole and quadrupole moments.
d) Field inside dielectrics; Boundary value problems involving dielectrics.

Section – B

3. **Propagation of Electromagnetic Waves in Isotropic Media:** Boundary conditions on the field vectors; Reflection and refraction of electromagnetic waves; Total internal reflection.
4. **Propagation of Electromagnetic Waves in Conducting Media :** Nature of metallic boundary conditions; Metallic reflection; Normal incidence; Oblique incidence; Propagation between parallel conducting plates; Propagation through ionized media; Wave guides; Cavity resonators.
5. **Propagation of Electromagnetic Waves in Crystalline Media:** Isotropic and anisotropic crystals; Light propagation in uni-axial crystals; Wave sun face; Internal and external conical refractions; Interference phenomenal in uni-axial and biaxial crystals; Isochromatic surface in uni-axial and biaxial crystals.

Recommended References:

1. *J. R. Reifz & F. J. Milford:* Foundations of Electromagnetic Theory
2. *W.K.H. panofsky & M. Philiphs:* Classical Electricity
3. *N. Tralli:* Classical Electromagnetic Theory

4. *D. R.. Corson & Lorrain:* Introduction to Electromagnetic Fields and Waves
5. *Joos:* Theoretical Physics
6. *R. W. Ditchburn:* Light
7. *H. A. Lorentz:* Theory of Electron
8. *B. K. Mathur:* Principles of Optics
9. *I. C. Stater & Frank:* Electromagnetism
10. *M. S. huq, A. K Rafiqullah & A K Roy:* Concept of Electricity and Magnetism
11. *J.D. Fackson* Classical Electrodynamics

PHY-3105: Elementary Particle Physics
Credit – 03 (3 hours/ week)

Section-A

1. **Building Blocks and Classification Schemes:** Prologue; Concept of a fundamental particle; The bore atom; Size-mass; Valence electrons; Isotopes; Periodic table; Binding energy; Nucleus.
2. **The Electron-A Familiar Particle:** Production; Charge; Mass; Spin; Magnetic moment; Angular momentum; The exclusion law; Size of the electron; the wave-particle problem; Relativistic effects; Heisenberg uncertainty principle; Chart of the particles stable against decay through nuclear forces; Organization and familiar features; The parameters; Mass particles antiparticles; Spin and statistics; Isotopic spin; Strangeness; Decay times.
3. **The Interactions:** Gravity; Electromagnetism; Strong nuclear force; Weak interaction; Discovery of $W^{\pm}$ and Z^0 bosons; Charged current reactions.

Section-B

4. **The Conservation Laws:** Conservation of mass-energy; Conservation of momentum; Conservation of angular momentum; Conservation of electric charge; Conservation of baryons and leptons; Conservation of strangeness; Conservation of parity; Conservation of isotopic spin.
5. **Leptons, Quarks and Hadrons:** Leptons; Electronic neutrinos; Further generations; Lepton decays and universality; Strongly interacting particles; Quarks; General properties of hadrons; pions and nucleons; Strange particles charm and beauty.

Recommended References:

1. *B. R. Martin G. Shaw:* Particle Physics
2. *L. B Okun:* α, β, γ,...Z, A Primer in Particle Physics
3. *Dan Green:* Lectures in Particle Physics
4. *L. J Tassi:* Elementary Particle Physics
5. *W. R. Leo, Spring verlag:* Techniques for Nuclear and Particle Physics Experiments
6. *Griffiths:* Introduction to Elementary Particles

PHY -3107: Mathematical Methods in Physics-III
Credit 03: (3 hours/ week)

Section – A

1. **Functions:** Bessel's functions; Legendre differential equations; Legendre and associated Legendre polynomials, Hermite differential equation and Hermite polynomials; Hypergeomatric functions; Fourier and Laplace transforms.
2. **Differential Equations:** Idea of differential equations and their solutions; Initial value problems; First order equations: Separable; Homogeneous; Exact and linear equations; Equation reducible to such forms; Application of first order equations (growth, decay, chemical reactions etc.).
3. **Linear Second Order Differential Equations**: Homogeneous equations with constant coefficients; Method of undetermined coefficients and variation of parameters.

Section – B

4. **Series Solutions of Second Order Differential Equations:** Linear second order differential equations with variable coefficients; Power series solution about an ordinary point; Regular singular point and the method of Frobenius.
5. **Partial Differential Equations:** Second order constant coefficient equations; Euler's equations; Separation of variables; Waves equations; Heat conduction and diffusion equations; Laplace's equation.

Recommended References:

1. *D.A. Pipce*: Applied Mathematics for Engineers & Physicists
2. *M.R. Spiegel*: Vector Analysis & an Introduction to Tensor Analysis
3. *M.R. Spiegel*: Complex Variables
4. *M.R. Spiegel*: Theory of Matrices
5. *H. Lass*: Vector and Tensor Calculus
6. *S.L. Ross*: Differential Equations
7. *B.D. Gupta*: Mathematical Physics

PHY – 3109: Nuclear Physics-I
Credit 03: (3 hours/ week)

Section – A

1. **The Nucleus:** Rutherford's alpha particle scattering and structure of the nucleus; Theories of nuclear composition; Proton-neutron theory of nuclear composition.
2. **Basic Properties of Nuclei:** Constituents of nuclei; Nuclear mass; Charge and size (mirror nuclei calculations); Nuclear density; Nuclear spin and angular momentum; Nuclear moments; Dipole magnetic moment; Magnetic moment expression; Electric moments (quadruple expressions); Nuclear binding energy; Mass defect; Parity and symmetry; Energy level; Liquid drop model; Bethe-Weizsacker semi-empirical mass formula.
3. **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; Beta disintegration; Conservation of nuclear energy during beta disintegration; Properties of γ-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.
4. **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.

Section – B

5. **Nuclear Fission and Fusion:** Introduction; Discovery of fission; Types of fission reactions; Mass distribution of emission products; Energy distribution of fission products; Neutron emission in nuclear fission; Fissile and fissionable nuclides; Fission energy; Theory of fission process; Explosive chain reaction and critical size; Controlled chain reaction; Nuclear reactor; Power of a nuclear reactor; Neutron balance in a reactor; Multiplication factor; Classification of reactors; Nuclear fusion; Stellar thermonuclear fusion reactions; Proton-Proton chain; Carbon-Nitrogen cycle; Controlled thermonuclear reactions; Conditions for controlled fusion; Hydrogen bomb; Cobalt bomb.
6. **Nuclear Reactions:** Discovery; Production and properties of neutron; Elastic and inelastic scattering; Q-value; Nuclear cross-section; Elementary kinematics; Electron scattering from a nucleus; Form factors; Compound nuclear model; Nuclear cross-section; Brit-Wigner resonance formula; Direct reaction; Butler's theory.
7. **Nuclear Force:** Non-exchange and exchange forces; Meson theory of nuclear force; One-Boson Exchange (OBE) potential; Paris potential; Nuclear stability condition; Symmetry and charge effects; Charge independence of nuclear force; Mirror nuclei and Coulomb energy.

Recommended References:

1. *A. Beiser:* Concepts of Modern Physics
2. *C. M. H. Smith:* A Text Book of Nuclear Physics
3. *I. Kaplan:* Nuclear Physics
4. *D. Halliday:* Introduction to Nuclear Physics
5. *Kenneth, s. Krane*: Introduction to Nuclear Physics
6. *A.M. Harunur Rashid*: Elementary Particle
7. *H.A. Enge*: Introduction to Nuclear Physics

PHY-3111: Solid State Physics – I
Credit 03: (3 hours/ week)

Section – A

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; Brillouin 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.

Section – B

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. **X-ray Photographs:** The production of X-ray; Powder cameras; Powder diffraction patterns; Measurement of powder photographs; Powder and film photographs; Rotation and oscillation photographs; Determination of cell dimension and space group; Collection of crystal structure data; Solid state and metallurgical applications.
6. **Imperfections 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.

Recommended References:

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-3102: Physics Sessional – V
Credit – 1.5 (3 hours/ week)

1. To find the vibration of the frequency of a tuning fork with the length of a sonometer (n-*l* curve) under given tension and hence to determine the unknown frequency of a tuning fork.
2. To verify the laws of transverse vibration of a stretched string by sonometer.
3. To verify the laws of transverse vibration of string and to determine the frequency of a turning fork by Melde's experiment.
4. "J" by callender and Barne's apparatus (with radiation correction).
5. Determine the electro-chemical equivalent of copper/silver with an ampere balance.
6. Calibration of an ammeter by potential drop method with the help of a potentiometer.
7. Calibration of a voltmeter by a potentiometer.
8. Determination of temperature co-efficient of the resistance of the material of a wire.
9. Determination of resistance per unit length of a meter bridge.
10. Determination of the boiling point of a liquid by a platinum resistance thermometer.

Books Recommended

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

Year – III Semester– II

PHY-3201: Electronics – III
Credit 03: (3 hours/ week)

Section – A

1. **Operational Amplifier :** Basic concepts on different amplifier (double ended input, single ended output) as the input stage of an op-amp; Differential and common mode operation; Common mode rejection ratio; Equivalent circuit; Ideal op-amp approximations; Inverting amplifier; Non-inverting amplifier; Adder; Substractor; comparator; Integrator; Differentiator (all analyses based on ideal approximation). Frequency response; Gain-bandwidth product; Active filters; Applications in millivolt meter and current-meter.
2. **Pulse Generators:** Multivibrators: Astable monostable and bistable; Schmitt trigger; Blocking oscillators and time-base generators.
3. **Pulse Shaping:** Pulse parameters; Linear waveshaping: RC integrator and RC differentiator; Non-linear waveshaping: Clipping and clamping.
4. **Integrating Circuit and Applications:** Fabrication of integrated circuits; Operational amplifiers; Active filters; Comparators and control; Mathematical operations, Oscillation; Thin film deposition techniques; Capacitors and resistors.

Section – B

5. **Binary Number & Codes:** Different number systems: Binary numbers; Decimal numbers; Octal numbers; Hexadecimal numbers; Number base conversion; Binary Number: 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.
6. **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.
7. **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.

Recommended References:

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 - 3203: Electrodynamics-II
Credit 03: (3 hours/ week)

Section – A

1. **Radiation From Non-Static Charges:** Radiation from an oscillating dipole; Radiation from a half-wave antenna; Radiation from a group of moving charges.
2. **Radiation From an Accelerated Charge:** Lienard and Wicehart potentials; Field of a charge in uniform motion; Fields of an accelerated charge; Radiation fields of charges moving with low velocities.
3. **Radiation, Scattering & Dispersion:** Forced vibration; Scattering by an individual free electron; Normal and anomalous dispersion; Scattering by a bound electron; Absorption of radiation by an oscillator; Rayleigh scattering; Thomson scattering; Resonance scattering.

Section – B

4. **Elements of Magnetostatics:** Calculation of the vector potential for current carrying loop; Boundary value problems in magnetostatics.
5. **Wave Guides:** Solution of the wave equation in a cylindrical and rectangular waveguide; TE, TM and TEM modes and their differences; Cut-off frequencies; phase and group velocities in a waveguide.
6. **Relativistic Electrodynamics:** Lagrangian formulation of electrodynamics; Covariant formulation of electrodynamics.

Recommended References:

1. *J. R. Reitz & F. J. Milford:* Foundations of Electromagnetic Theory
2. *W.K.H. Panofsky & M. Philiphs:* Classical Electricity
3. *N. Tralli:* Classical Electromagnetic Theory
4. *D. R.. Corson & Lorrain:* Introduction to Electromagnetic Fields and Waves
5. *Joos:* Theoretical Physics
6. *R. W. Ditchburn:* Light
7. *H. A. Lorentz:* Theory of Electron
8. *B. K. Mathur:* Principles of Optics
9. *I. C. Stater & Frank:* Electromagnetism
10. *M. S. huq, A. K Rafiqullah & A K Roy:* Concept of Electricity and Magnetism
11. *J.D. Fackson* Classical Electrodynamics

PHY-3205: Nuclear Physics-II
Credit 03: (3 hours/ week)

Section – A

1. **Interaction of Charged Particles and Radiation with Matter:** Ionisation; Multiples scattering: Stopping power; Range determination; Energy loss of electrons and other charged particles; Straggling; Bremsstrahlung; Interaction of electromagnetic radiation with matter; Positronium; Pair production and pair annihilation; Radiation length.
2. **Nuclear Detectors:** Gas-filled counters; Geiger-Muller counter; Solid state counter; Scintillation counter; Counting statistics; Detection of charged particles; Photons and Neutrons; HPGe detector.
3. **Accelerators and Sources of Atomic Particles:** Van de Graff accelerator; Cyclotron; Betatron; Proton synchrotron; Neutron sources; Linear accelerator.

Section – B

4. **Alpha-particle Emission:** Alpha instability; Measurement of energy of alpha-particle and nuclear size; Alpha particle capture; An astro-physical application; Geiger-Nuttal law; Theory of alpha decay and selection rules; Gauge-energy curves.
5. **Beta Decay:** Introduction; Different types of β-decay; Conservation of energy; Conservation of angular momentum; Neutrino hypothesis; Measurement of disintegration energies; Fermi theory of beta decay and selection rules; Range-energy relationship for β-particle; Orbital electron; Capture; Positron emission.
6. **Gamma Radiation:** Interaction and absorption of gamma rays; Measurements of gamma-ray energies and lifetimes of excited states; Internal conversion; Energy measurement; Pair spectrometer; Theory of gamma emission; Mossbauer effect.

Recommended References:

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
8. *G Suresh, Feroz Ahmed and L.S Kotheri:* Physics of Nuclear Reactor
9. *Kenneth, S. Krane:* Introductory Nuclear Physics
10. *I. Kaplon:* Nucleus Physics

PHY-3207: Quantum Mechanics-I
Credit 03: (3 hours/ week)

Section – A

1. **The Origins of Quantum Theory:** Experimental observation (black body radiation, atom model, photoelectric effect etc.) and difficulties in classical theory; Quantization of physical quantities; Basic postulates of quantum mechanics.
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. **The Schrödinger Wave Equation:** The development of wave function and its interpretation; Normalization of wave function; Probability and current densities; Expectation values of dynamical variables; The Ehrenfest theorem.

Section – B

4. **Fourier Techniques and Momentum Representation:** Fourier analysis of wave function; Fourier integral theorem; Parse Val's formula; Coordinate and momentum representation of wave function; Significance; Schrödinger equation in momentum representation; Momentum wave function for free particle and particle in a box; Box normalization; Dirac delta normalization.
5. **Operators:** Eigenfunctions and eigenvalues of operators; Expansion in eigenfunctions; Orthogonality of eigenfunctions; Commuting operators and observables; uncertainty relations.

Recommended References:

1. *K. Ziock:* Basic Quantum Mechanics
2. *P. T. Matthews:* Introduction to Quantum Mechanics
3. *S. L. Powell & D Crascmann:* Quantum Mechanics
4. *L. Pauling & B Wilson:* Quantum Mechanics
5. *V. Rojansky:* Introduction to Quantum Mechanics
6. *Gupta, Kumar, Sharma* Quantum Mechanics

PHY-3209: Solid State Physics-II
Credit 03: (3 hours/ week)

Section – A

1. **Classification of Solids and Crystal Lattice:** Covalent bond; Hydrogen bonded crystals; Directed bonds; Lattice vibrations and enumeration of normal modes: Infrared absorption; Specific heat of solids.
2. **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.
3. **Free Electron Theory:** Energy levels and density of states; Heat capacity of free electron gas; Free electron scattering by single atom; Electrical conductivity and Ohm's law; Thermal conductivity of metals; Wiedemann-Franz Law.

Section –B

4. **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.
5. **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.
6. **Magnetism:** Origin of magnetism; Classification of magnetic materials; Diamagnetism, Paramagnetism and ferromagnetism; Ferromagnetic domain; Bloch Wall hysteresis loop; Magnetic anisotropy; Antiferromagnets and ferrites.

Recommended References:

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- 3202: Physics Sessional VI
Credit 1.5: (3 hours/ week)

1. Determination of mutual inductance for varying distances between the coils.
2. Determination of absolute capacity of condenser.
3. Charging and discharging of a capacitor.
4. Determination of self-inductance by Anderson's method.
5. Plotting the characteristic curve for diode valve.
6. Drawing of characteristic curves of a triode valve and determination of triode parameters.
7. Plot the thermo emf temperature (callibration curve) for given thermo-couple and hence to determine the thermo-electric power.
8. Determination of neutral temperature for a given thermocouple.

Optional Courses:

PHY-3211: Geophysics
Credit – 03 (3 hours/ week)

Section – A

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.

Section – B

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 oscillation.
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.

Recommended References:

1.	*F. D. Stacey:*	Physics of the Earth
2.	*G.D. Garland:*	Introduction to Geophysics: Mantle, Core and Crust
3.	*F.S Grant and G.F. West:*	Interpretation Theory in Applied Geophysics
4.	*D.S. Parasnis:*	Principle of Applied Geophysics

5. *F.M. Telford; L.P. Geldart*
R.E. Sheriff. D. A. Keyes: Applied Geophysics

PHY-3213: Meteorology
Credit 03: (3 hours/ week)

Section – A

1. **Basic Physics of the Atmosphere:** Composition, classification and structure of the atmosphere; Application of the laws of radiation and thermodynamics; Virtual temperature; Geopotential and geopotential height; Lapse rates; Atmospheric diagrams; Moisture variables; Potential temperature and equivalent potential temperature.

2. **Cloud and Precipitation Physics:** Cloud formation; Cloud water content; Formation of could droplets; Condensation nuclei; Rain drop growth by collision and coalescence; Growth of ice crystals; Growth of hail.

3. **Atmospheric Dynamics:** Equations of motion for rotating fluids; Substantial derivative, Geostrophic and thermal wind equations; Relationship of wind to pressure and temperature; Vorticity and divergence; Heat momentum and water balances for the general circulation; Movement of long waves; Phase speed; Group speed and energy propagation; Types of energy; Total potential; Unavailable and available energy; The observed creation; Conversion between types and destruction of energy. Eckman spiral; Cyclone decay; Gravity and Lee waves-Air-Turbulence; Static stability and instability.

4. **Synoptic Meteorology:** Production and transformation of air masses; Depressions and fronts; Frontal characteristics and slope; Constant height and constant pressure analysis; Jet stream.

Section – B

5. **Radiation:** Solar output; Earth input; Planetary energy balance; Plank's law; Stefan Boltzmann law; Wien's law; Kirchhoffs law; Energy balance of surface and atmosphere; Plate-glass models and atmospheres; Radiative/convective equilibrium; Energy balance of clear and cloudy atmosphere transfer; Lone and band absorption.

6. **Tropical Meteorology:** The ITCZ; Low latitude disturbances; Easterly waves; Tropical cyclones; The monsoon; Types of cumulonimbus convection; Cumulonimbus models.

7. **Air-Sea Meteorology:** Wind and waves; Aero-dynamic roughness; The thermocline; Langmuir cells; Oceanic thermal interia; Sea fog; Organizations and structure of marine meteorological service.

8. **Satellite Meteorology:** Satellite orbits; Visible and infra-red imaginary; Surface temperature measurements; Use of satellite measurements in forecasting.

Recommended References:

1. *Cels:* Introduction to Meteorology
2. *Haltiner & Martin:* Dynamical Meteorology
3. *Dirtrich:* General Oceanography
4. *Hidy-The Winds:* The origin and behaviour of Atmospheric motion
5. *Greedy :* The Atmospheric Physics
6. *Fleagle & Businger*: Introduction to Atmospheric Physics
7. *Hess,S.L:* Introduction to Theoretical Meteorology
8. *Holton,S.L:* Introduction to Dynamical Meteorology
9. *Rogerse, R.E.:* A Short Course in Cloud Physics
10. *Houghton J.T.* The Physics of Atmosphere
11. *Wallace Hobbs:* Atmospheric Science: An Introduction
12. *Mason, B.J.:* The Physics of Clouds, P.H.P. 1971
13. *Paltridge & Platt:* Radiative Process in Meteorology and **C**limatology: Elsevier, 1976
14. *R.S. Scarer*: Cloud Atlas
15. *H. H. Lamp:* Climate: Past, Present, and Future
16. Bayers : General Meteorology

PHY – 3215: Renewable Energy
Credit – 03(3 hours/ week)

Section – A

1. **Introduction:** World energy requirement and reserve solar radiation; Solar constant; Measurement of solar radiation; Solar geometry azimuth; Declination day length; Solar time; Solar radiation on tilted surface.
2. **Radiation Characteristics of Materials:** Absorbance emitance, reflectance of selective surfaces; Transmissive optical materials.
3. **Basic Elements of Heat Transfer:** Modes of heat transfer; Radiation law and radiation heat transfer coefficient; Heat transfer coefficient for natural and forced convection.
4. **Solar Collectors and Flat-Plate Collectors:** Energy balance; Temperature distribution; Collector overall heat transfer coefficient; Collector deficiency factor; Heat removal factor and flow factor; Collector design and performance: Concentrating collectors. Concentration ratio; Thermal and optical performance; Imaging and non-imaging concentration of various types.
5. **Utilization of Solar Thermal Energy:** Energy storage; Solar heating design; Passice application.

Section – B

6. **Wind Energy:** Wind power; Wind power system: transmission, generation and control: Wind mill.
7. **Photovoltaics:** Solar cell; Principle of operation; Reflection absorption; Generation, separation and collection of carriers; Efficiency and efficiency limiting factor; Influence of the illumination level on efficiency; Type of solar cells; Crystalline amorphous; Thin films.
8. **Photovoltaic Modulus:** Operation: Standard modules; Series and parallel connection of cells; Hot spot formation; Stand-alone photovoltaic systems; System without storage battery; DC to AC conversion.
9. **Energy Storage:** Process loads and solar collector output; Energy storage in solar process system; Water storage packed; Bed storage; Phase change energy storage; Chemical energy storage.
10. **Other Non-Conventional Energy:** Biomass; Sources of biomass method of obtaining energy; Water power; Tidal power.

Recommended References:

1. *E. E. Anderson:* Fundamentals of Solar Energy Conversion
2. *Fisk and Anderson:* Introduction to Solar Technology
3. *B S. Magal* Solar Power Engineering
4. *R. C Neville:* Solar Energy Conversion Solar cell
5. *J.Duffie* A Solar Engineering to Thermal Process
6. *G. D Rai:* Solar Energy Utilization
7. *D Rapp:* Solar Energy

Year – IV Semester – I

PHY-4101: Advanced Electronics
Credit 03: (3 hours/ week)

Section – A

1. **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.
2. **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.
3. **Counters and Registers:** Ripple counter; Design of synchronous counter; Parallel counter; Combination counter; BCD shift registers; Decoders: BCD- to decimal decoder; Demultiplexers; Encoders; Multiplexers.
4. **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.

Section – B

5. **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.
6. **T.V:** Black and white and colored**;** Camera - their functions**.**
7. **Micro-Wave and Satellite Communications:** Klystron tubes and magnetron tubes as oscillators and amplifiers; Visibility zone; Channels; Servo-control systems.
8. **Microprocessor:** General purpose and special purpose microprocessor; Bit slice microprocessor; Internal organization of 8086, 80x86 microprocessor; Pins and signals; Instructions; Addressing modes; Stack; Subroutine; Interrupt and interrupt service routine.

Recommended References:

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-4103: Nuclear Physics-III
Credit 03: (3 hours/ week)

Section – A

1. **Two-Nucleon System - the Deuteron:** Central potentials; Ground state of the deuteron; Normalisation of the deuteron wave function; Non-existence of excited states; Tensor force; Magnetic and quadrupole moments of the deuteron.
2. **Two-Nucleon System – Scattering:** N-P and P-P scattering at low and high energies; Spin dependence of N-P scattering; Phase shift; Scattering length and effective range theory; Coherent scattering of thermal neutrons.
3. **Neutron Physics:** Sources of neutrons; Interactions of neutrons with matter; Thermal neutrons; Cross-section for neutron induced reactions; Scattering; Absorption and activation cross-sections.

Section – B

4. **Nuclear Shell Model:** Shell-model; Single particle potentials; Wave function and energy levels; Magic numbers; Prediction of spin and magnetic moments; Schmid values and lines; L-S coupling and j-j coupling.
5. **Collective Model:** Rotational energy spectrum and nuclear wave function for even-even nuclei and for odd-odd nuclei; Beta and gamma vibrations in nuclei.
6. **Optical Model:** Optical potential energy; Averaged cross section; Optical model at low energy; Phenomenological optical model.

Recommended References:

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
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-4105: Quantum Mechanics-II
Credit 03: (3 hours/ week)

Section – A

1. **One Dimensional Problem With Schrödinger Equation:** Free particle in quantum mechanics; Particle in a potential (step, square well, etc.) barrier; Reflection and transmission co-coefficients; Energy levels calculation; Tunneling through a potential barrier; Linear harmonic oscillator.
2. **The Schrödinger Equation in Three Dimensions:** Separation in Cartesian and polar coordinates; Central force problem; The free particle and free particle in a box; Three dimensional square well potential and harmonic oscillator.
3. **The Hydrogen Atom:** Schrödinger equation for hydrogen atom; Solution in spherical coordinates; Energy levels; Spherical harmonics.

Section – B

4. **Operators and Matrices:** Linear operators kets and bras; Eigenvalues and eigenkets; Expansion in eigenkets; Completeness and orthogonality of eigenkets; Representation of and operator; Commuting operators; Projection hermitian and unitary operators; Diagonalization of a matrix.
5. **Matrix Formulation of Quantum Mechanics:** State vectors; Linear vector spaces; Hilbert space; Orthonormal system; Matrix representation of state vectors and operators; Change of representation; Simple harmonic oscillator.
6. **Dynamical Behaviour of a Quantum System:** Schrödinger; Heisenberg and interaction pictures.

Recommended References:

1. *K Ziock:* Basic Quantum Mechanics
2. *P. T. Matthews:* Introduction to Quantum Mechanics
3. *S L Powell & D Crascmann:* Quantum Mechanics
4. *L Pauling & B Wilson:* Quantum Mechanics
5. *V Rojansky:* Introduction to Quantum Mechanics
6. *Gupta, Kumar, Sharma* Quantum Mechanics

PHY-4107: Solid State Physics- III
Credit 03: (3 hours/ week)

Section – A

1. **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.
2. **Optical Phenomena in Solids:** Colour of crystals; Weakly and tightly bound excitons; Photoconductivity; Traps; Crystal counters.
3. **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.

Section – B

4. **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.
5. **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.
6. **Photoconductivity and Luminescence:** Historical survey; Photo conducting materials; Electron transition in photoconductors; General mechanism; Photosensitivity; Capture cross section; Simple model of photoconductor; Exciton; Absorption; Trapping and its effect; Luminescence; Models of Luminescence; Comparison with experiment; Thallium activated alkali halides; Electron luminescence.

Recommended References:

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- 4109: Radiation and Health Physics
Credit – 03 (3 hours/ week)

Section- A

1. **Interaction of Radiation With Matter:** Beta Rays; Range-energy relationship; Mechanisms of energy loss (Ionization and Excitations; Bremsstrahlung); Alpha rays; Range-energy relationship; Energy transfer; Gamma rays; Exponential absorption; Interaction mechanisms; Neutrons; Production; Classification; Interaction; Scattering; Absorption; Neutron activation.
2. **Radiation Dosimetry:** Units; Absorbed dose; Exposure; Exposure measurement; The free air chamber; Exposure measurement; The air wall chamber; Exposure dose relationship; Absorbed dose measurement; Brag-Gray principle; Kerma; Source Strength; Specific gamma ray emission; Internally deposited radioisotopes; Corpuscular radiation; Effective half-life; Total dose; Dose commitment; Gamma emitters; MIRD method; Neutrons.
3. **Biological Effects of Radiation:** Dose-response characteristics; Direct action; Indirect action; Radiation effects; Acute effects; Delayed effects; Risk estimates; BEIR III; Relative Biological Effectiveness (RBE) and Quality Factor (QF); Dose equivalent; The Sievert (and the Rem); High energy radiation.
4. **Radiation Protection Guides:** Organizations that set standards; International Commission on Radiological Protection; International Atomic Energy Agency; International Labour Organization; International Commission on Radiological Units and Measurements; National Council on Radiation Protection and Measurements; Philosophy of radiation protection; Basic radiation safety criteria; Effective dose equivalent; Exposure of individuals in the general public; Exposure of populations; Medical exposure; Allowable Limit of Intake (ALI); Inhaled radioactivity; Derived air concentrations (DAC); Gastrointestinal tract; Combined exposure; Basis for radiation safety regulations; Calculation of MPC in drinking water based on dose to critical organ; Concentration in drinking water based on comparison with radium; Airborne radioactivity; Maximum permissible concentrations for non occupational exposure.

Section- B

5. **Health Physics Instrumentations:** Radiation detectors; Particle counting instruments; Gas-filled particle counters; Ionization chamber counter; Proportional counter; Geiger counter; Quenching a Geiger counter; Resolving time; Measurement of resolving time; Scintillation counters; Nuclear spectroscopy; Cerenkov detector; Semiconductor detector; Dose-measuring instruments; Pocket dosimeters; Film badges; Thermoluminescent dosimeter; Ion current chamber; Neutron measurements; Detection reactions; Neutron reactions; Neutron counting with a proportional counter; Long counter; Proton recoil counter; Neutron dosimetry.
6. **External Radiation Protection:** Basic principles; Techniques of external radiation protection; Time; Distance; Shielding; X-ray shielding; Beta ray shielding; Neutron shielding.
7. **Internal Radiation Protection:** Internal radiation hazard; Principles of control; Control of the source; Confinement; Environmental; Control of man; Protective clothing; Respiratory protection; Surface contamination limits; Waste management; High level liquid wastes; Intermediate and low level liquid wastes.
8. **Criticality:** Criticality hazard; Nuclear fission products; Criticality; Multiplication factor; Four factor formula; Nuclear reactor; Reactivity and reactor control; Fission product inventory; Criticality control.

Recommended References:

1.	*Herman Cember:*	Introduction to Health Physics
2.	*Fayez Ahmed Khan:*	Physics for Radiotherapy
3.	*R.E. Lapp and H.L Andrews:*	Nuclear Radiation Physics
4.	*A.Martin and S.A. Harbison:*	An Introduction to Radiation Protection

Optional Courses

PHY-4111: Computational Physics
Credit 03: (3 hours/ week)

Section- A

1. **Introduction:** Physics and Computational Physics.
2. **Overview of Use of Computation in Classical and Quantum Physics:** Introduction to computer algorithms and languages.
3. **Basic Numerical Methods:** Interpolations and approximations; Differentiation and integration; Zeroes and extremes of a single-variable function; Classical scattering; Iterative procedures for special functions; Discritization; Numerical quadrature; Random number generators.
4. **Numerical Methods for Matrices:** Basic Matrix operations; Linear equation systems; Zeroes and extremes of a multivariable function; Eigenvalue problem; The Faddev-Leverrier method; The Lanczos algorithm and the many-body problem; Random matrix.
5. **Ordrnary Differential Equations:** Initial-value problems; the Euler and Picard methods; the Runge-Kutta method; Boundary-value and eigenvalue problems; Linear equations and Sturn-Liouville problems; The one dimensional Schrodinger equation; Numerov's algorithm for the radial Schrodinger equation.

Section- B

6. **Partial Differential Equations:** Partial differential equation in physics; Separation of variables; Discretization of the equation; The matrix method for differential equations; Initial value problems.
7. **The Monte Carlo Method:** Introduction; Monte Carlo integration; Monte Carlo for the Ising model; Monte Carlo simulation of a monatomic gas; Renormalization with Monte Carlo simulation; Variational quantum Monte Carlo simulation; Green's function Monte Carlo simulations; Path-integral Monte Carlo simulation; Quantum lattice model.
8. **Symbolic Computing:** Symbolic computing systems; Basic symbolic mathematics; Computer calculus; Linear system; Non-linear system; Differential equations; Computer graphics.
9. **High-Performance Computing:** The basic concepts; High-performance computer systems; Parallelism and parallel computing; Data parallel computing; Distributed computing and message passing.

Recommended References:

1. *Tao Pang:* An Introduction to Computational Physics.
2. *I. M. Thijssen:* Computational Physics
3. *Harvey Gould and Jan Tobochnik:* An Introduction to Computer Simulation Methods (part 1 and part 2)
4. *S. Wolfram:* The Mathematica Book.
5. *D. M Cook and others:* A Comparison of Several Symbol, Manipulating Programs, Part I and II.

PHY – 4113: Plasma Physics
Credit 03: (3 hours/ week)

Section – A

1. **Introduction:** Occurrence of plasma in nature: Definition; Concept of temperature; Debye shielding; The plasma parameter; Criteria of plasma; Application of plasma physics.
2. **Single Particle Motions:** Uniform E and B field; Non-uniform B and E fields; Time varying B and E fields; Adiabatic Invariants.
3. **Plasma as Fluids:** Relation of plasma physics to ordinary electromagnetic theory; The fluid equation of motion; Fluid drifts perpendicular to B; Fluid drifts parallel to B; The plasma approximation.
4. **Waves in Plasmas:** Representation of Waves: Group velocity; Plasma oscillations; Electron plasma waves; Sound waves; Ion waves; Validity of the plasma approximation; Comparison of ion and electron waves perpendicular to B; Electromagnetic waves with B-O, perpendicular to and parallel to B; Hydromagnetic waves: Magnetosonic waves and CMA diagram.
5. **Diffusion and Resistivity:** Diffusion and mobility in weakly ionized gases; Decay of a plasma by diffusion; Steady state solutions; Recombination and diffusion across a magnetic field; Collisions in fully ionized plasma; The single fluid MHD equations; Diffusion in fully ionized plasma; Solutions of the diffusion equation and Bolun diffusion and neoclassical diffusion.

Section – B

6. **Equilibrium and Stability:** Hydro-magnetic equilibrium; Diffusion of magnetic field into a plasma; Classification of instabilities; Two sream instability; Resistive drift waves and the Weibel instability.
7. **Kinetic Theory:** The meaning of (V); Equations of kinetic theory; Derivation of the fluid equations; Plasma oscillations and Landau damping; Physical derivation of Landau damping and Van Kampen modes; Ion Landau damping and Kinetic effects in a magnetic field.
8. **Nonlinear Effects:** Sheaths; Ion acoustic shock waves; The ponderomitive force; Parametic instabilities; Plasma echoes: nonlinear Landau damping and equations of nonlinear plasma physics.

Recommended References:

1. *Francis F Chen:* Plasma Physics
2. *James E Drummond:* Plasma Physics
3. *Thomas Howard Stix:* The Theory of Plasma waves
4. *Ronal C. Davidson:* Methods in Nonlinear Plasma Theory

PHY-4115: Spectroscopy
Credit – 03 (3 hours/ week)

Section – A

1. **The Scattering of X-rays:** Scattering by a pair of electrons; Scattering of X-rays by gasses and liquids; X-ray emission and absorption spectra; Dipole; Forbidden and satellite lines; Non-diagram lines; Energy level diagrams.
2. **Physical Processes of X-ray Absorption:** Chemical effects in X-ray spectra; Fine structure of absorption edges XANES and FXAFS and their applications.
3. **Experimental Techniques of X-ray Spectroscopy:** Bragg and double crystal spectrometers; Focussion spectrographs; Methods of detection and measurement.

Section – B

4. **Nuclear Magnetic Resonance Spectroscopy:** Chemical shift; Dipolar interaction; Spin interaction; Magnetic equivalence; Experimental techniques and applications.
5. **Mossbauer Spectroscopy:** Isomer shifts; Quadruple splitting; Nuclear Zeeman splitting; Experimental techniques and applications.
6. **Photoelectron Spectroscopy:** Main features of photoelectron spectra; Experimental methods; Atomic photoelectron spectra; Molecular photoelectron spectra applications.

Recommended References:

1. *L. U. Azaroff:* X-ray Spectroscopy
2. *D. K. Agarwal:* X-ray Spectroscopy
3. *A. H. Compton & S. K. Allison:* X-rays in Theory and Experiment
4. *C. Bonnele & C. Mande:* Advances in X-ray Spectroscopy
5. *R. Chang:* Basic Principles of Spectroscopy

PHY- 4117: X-ray Crystallography
Credit 03: (3 hours/ week)

Section – A

1. **Geometry of Crystalline State:** Crystal classes and systems; Bravais lattices; Symmetry elements; Point group and space group.
2. **Diffraction of X-ray by Crystals:** Diffraction of X-ray; Electrons and neutrons by crystals; Laue equations and Bragg equation; Structure factors; Symmetry of X-ray diffraction pattern; Reciprocal lattice.
3. **Experimental Technique of X-ray Diffraction:** Powder method; Laue, oscillation/rotation and Eissenberg methods; Diffractometers; Interpretation of diffraction photographs: Corrections of experimental data; Lorentz and polarization factors; Temperature factor; Absorption correction.

Section – B

4. **The Fourier Series:** Fourier coefficients; Fourier and difference Fourier synthesis; Convolution; Electron Density; Diffraction and Fourier transform.
5. **Determination of Space Group:** The symmetry of X-ray photographs; Systematic absences; Intensity statistics; Moment tests.
6. **Determination of Crystal Structure:** The Patterson function; Sharpened Patterson; Harker line and section; The heavy atom method; Inequality relationship; Sign relationships and phase relationships.
7. **Refinement of Crystal Structure:** Different Fourier method and the method of least squares.

Books Recommended:

1. *MM Woolfson:* X-Ray Crystallography
2. *H Lipson & W Cochran:* Crystalline State. Vol III
3. *M. J. Burager:* X-Ray Crystallography
4. *L Azaroff:* Elementary X-Ray Crystallography
5. *H Lipson & Taylor:* Fourier Transforms and X-Ray Diffraction
6. *M. M. Woolfson:* Direct Methods in Crystallography
7. *Stout & Jensen:* Practical Structure Determination

Year-IV Semester-II

PHY-4201: Biophysics and Medical Physics
Credit – 03 (3 hours/ week)

Section- A

1. **Properties and Structure of Macromolecules:** Atomic and molecular forces; Nucleic acids (DNA, RNA); Methods of replication; Aminoacids.
2. **The Cell Membrane:** Properties of membrane; Transport and diffusion of ions and molecules through the cell membrane; Basic physics of membrane potentials; Measurement of membrane potentials; Membrane model.
3. **Basic Enzyme Behavior:** Michelis Manten mechanism and MWC model.
4. **Neuromuscular Physics:** Overview of the central nervous system; Origin of resting and action potentials in neurons and muscle fibes; Propagation of action potentials through neuromuscular system; Huxley-Hodgkin theory; Neurotransmitters.
5. **Physics of the Cardiovascular System:** Introductory concepts; Bernoulli's principle applied to cardiovascular system; Generation of Korotkoff sound and indirect measurement of blood pressure.

Section- B

6. **Physics of the Heart:** Electrical activity of heart; ECG/EKG measurement; Typical waveforms and physiological origins of the major peaks in the wave form; Artificial pacemaker.
7. **Imaging Techniques:** Nature; Production and detection of ultrasounds; A-scan; B-scan; M-scan; CT; MRI and gamma camera; Clinical applications.
8. **Image Processing and Analysis :** Digital image fundamentals; Image smoothing; Restoration and enhancement; Image segmentation and pattern recognition.
9. **Nuclear Medicine:** Principle; Choice of radionuclide and radiopharmaceuticals; Technetium generator; Imaging and function test of thyroid, gland, liver, spleen, kidney, lungs, brain, heart, and bone.
10. **X-rays and Radiation Therapy:** Production and clinical applications of X-rays; Principles of radiation therapy, Radiotherapy treatment planning; Isodose curve; Simulator; Teletherapy; Brachytherapy.

Recommended References:

1. *B.H. Brown and R.H Small wood:* Medical Physics and physiological Measurements
2. *J.R Cameron and J. Skofronick:* Medical Physics
3. *B.H. Brown and R.H Small wood, D.C Barber,P V Lawford and D R Hose:* Medical Physics and Biomedical Engineering
4. *Cromwell:* Biomedical Instrumentation and Measurement
5. *Guyton :* Textbook of Medical Physiology
6. *P Sprawls:* Physical Principle of Medical Imaging
7. *Refael C.Gonzale, R.E. woods:* Digital Image Processing
8. *W.E Hande:* Medical Physics of Radiation Physics

9.	*Johns and Cunnighum:*	Physics of Radiology
10.	*Cesareo, R. et al:*	Nuclear Analytical Techniques in Medicine
11.	*H. Chember:*	Introduction to Health Physics

PHY-4203: Fiber Optics and Optical Fiber Communication
Credit – 03 (3 hours/ week)

Section – A

1. **Introduction:** Historical Development; Basic optics for optical; Plane circularly and elliptically polarized waves; Reflection at a plane of interface; Total internal reflection; Concept of coherence and diffraction of Gaussian beams.
2. **Basic Characteristics of Optical Fiber:** The numerical aperture the coherent bundle; Attenuation in optical fibers; Pulse dispersion in step index optical fiber; Loss mechanism absorption and radiative loss pulse dispersion in graded index optical fiber; Effect of the material dispersion of the optimum profile; Calculation of material dispersion in pure and doped silica.
3. **Fabrication of High Silica Optical Fibers:** MCVD process; Tube diameter control; Hydroxyl impurity reduction; Deposition temperature; Fiber drawing diameter control; Strength; Surface treatment; Dust particle in the furnace; Humidity and primary coating.

Section – B

4. **Sources for Optical Fiber Communication:** Communication requirements; Laser fundamentals; Semiconductor laser; Absorption and emission in semiconductor; Optical gain in a semiconductor; Gain forward based p-n junction; Laser oscillation and threshold current; Laser diode characteristics; LED characteristics.
5. **Detectors and Design Considerations for Optical Fiber Communication:** Principle of optical detection; PIN photodetector: Its responsibility and quantum efficiency; APDs; Design considerations for optical communication system; Analog and digital modulation; Noise in detection process; Bit error rat; System design and maximum transmission distance due to attenuation.
6. **Optical Fiber Amplifiers and Integrated Optics:** Optical amplification; Semiconductor laser amplifier; Fiber amplifier; Rare earth doped fiber amplifier; Kaman and Brillouin fiber amplifier; Integrated optics; Some integrated optical devices; Beam splitters; Directional couplers and switches; Modulator.
7. **Application and Future Developments of Optical Fibers:** Public network applications; Military applications: Civil; Consumer and industrial applications; Optical sensor system; Computer applications and local area networks.

Recommended References:

1.	*Ajoy Ghatak and K Thyagarajan:*	Introduction to Fiber Optics
2.	*T Izawa and S Sudo:*	Optical Fibers, Materials and Fabrication
3.	*John M. Senior:*	Optical Fiber Communications, Principle and Practice

PHY-4205: Quantum Mechanics-III
Credit 03: (3 hours/ week)

Section – A

1. **Angular Momentum:** Angular momentum and its matrix representation.
2. **Symmetry in Quantum Mechanics:** Space and time displacements; The group concept; Rotation; Angular momentum and unitary group; Combination of angular momentum states and tensor operators; Space inversion and time reversal; Dynamical symmetry.
3. **Approximation Methods:** WKB approximation method; Time independent and time-dependent perturbations; Density of states and transition probability; Applications; Zeeman effect and Stark effect.

Section – B

4. **Theory of Scattering:** Scattering of particles by spherically symmetric potentials; Partial waves phase shifts; General formulation of scattering theory; Born's approximations.
5. **Identical Particles:** Symmetric and antisymmetric wave functions; The exclusion principle; Spin and statistics; Spin matrices.

Recommended References:

1.	*K. Ziock:*	Basic Quantum Mechanics
2.	*P. T. Matthews:*	Introduction to Quantum Mechanics
3.	*S. L. Powell & D Crasemann:*	Quantum Mechanics
4.	*L Pauling & B Wilson:*	Quantum Mechanics
5.	*V Rojansky:*	Introduction Quantum Mechanics
6.	*Gupta, Kumar, Sharma:*	Quantum Mechanics

PHY – 4207: Reactor Physics
Credit 03: (3 hours/ week)

Section – A

1. **Nuclear Reactions by Neutrons:** Neutron cross section and its determination; Energy dependence of neutron cross sections; Fission cross section.
2. **Diffusion and Slowing Down of Neutron:** Thermal neutron diffusion; Diffusion length and diffusion equations; Fast neutron diffusion and Fermi- Age equation; Energy distribution and cross section of thermal neutrons; The slowing down of neutrons; Transport mean free path and scattering cross section; Critical equation and reaction buckling.
3. **Reactor Theory:** The steady state; Multiplication factor; The four factor formula; Neutron leakage and critical size; Calculation of K for homogenous reactors; Classification of reactors; Research reactors; Swimming pool water boiler; Power and Breeder reactors; Heterogeneous reactors; Calculation of K for heterogeneous reactors.

Section – B

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 factures of reactor control; Effect of temperature on reactivity; Design of the control system and reactor operation; Fission product poisoning; Burnable poisons.

Recommended References:

1.	*J.R. Lamarsh:*	Introduction to Nuclear Engineering
2.	*J. R. Lamarsh:*	Introduction to Nuclear Reactor Theory
3.	*S. E. Liverhant:*	Elementary Introduction to Nuclear Physics
4.	*R. L. Murray:*	Introduction to Nuclear Engineering
5.	*S Glasstone & A Sensonske:*	Nuclear Reactor Engineering

Optional Courses:

PHY – 4209: Material Science
Credit – 03 (3 hours/ week)

Section – A

1. **Different Materials:** Engineering materials; Types of metals and alloys; Glassy metals; Non-metallic materials; Ceramics polymers; Composite materials and refractories.
2. **Renewable Energy Materials:** Biomass; Sources of biomass methods of obtaining energy; Wind energy; Water power; Tidal power; Solar cell; Principle of operation (reflection, absorption, generation, separation and collection of carriers efficiency); Types of solar cells (crystalline, amorphous, thin films).
3. **Material Processing:** Sample preparation; Grinding; Polishing annealing; Normalizing; Quenching etching solid state reaction; Sintering etc.

Section – B

4. **Crystal Structure, Crystal Growth and Thin Films:** Metallic crystals and their structure and packing factors; Nucleation; Homogeneous and heterogeneous nucleation; Growth modes and techniques; Sputtering; CVDLPE; MBE; MOCVD liquid crystals.
5. **Characterization of Materials:** Introduction; TGA determination of weight loss and decomposition products; DSC specific loss of heat capacity; measurements and determination of thermo chemical parameters; DTA determination of melting point; X-ray; Crystallite size analysis; Determination of lattice parameters; Principle of metallurgical microscope-SEM-TEM.
6. **Surface Physics:** Definition of surface; Description of surface structure; The TLK (Terrace Ledge Kink) model; Notation for surface structure; Vieinal surface; Real surfaces; Relaxation's reconstruction's defects; Surface states.

Recommended References:

1. *W. Brostow:* Science of Materials
2. *E. Abdrson:* Fundamentals of Solar Energy Conversion
3. *D. Rapp:* Solar Energy
4. *R. C. Neville:* Solar Cell: Solar Energy Conversion
5. *A. V. Narlikers*: Introduction to Superconductivity

PHY-4211: Methods of Experimental Physics
Credit – 03 (3 hours/ week)

Section – A

1. **Optical and Spectroscopy Instruments:** Phase contrast and Polarising microscope; Spectro-Photometers; Optical transmittance; Reflectance and absorption co-efficients;

2. **Electrical Measurements:** Potentiometer; High impedance voltmeters; Oscilloscope; DC Amplifier; Frequency meter and counter; Four point probe; Hall probe.
3. **High and Ultra-high Vacuum:** Production and measurement of high and ultra high vacuum; Rotary pump; Diffusion pump. Ion pump; Turbo pump; Pirani Gauge; Penning and ionisation gauges.

Section – B

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

Recommended References:

1. *Marton and Marton:* Methods of Experimental Physics Vol. 2
2. *J. Yarwood, Chapman and Hall:* High Vacuum Techniques
3. *Diefenderfer:* Principles of Electronic Instrumentation
5. *J. Brophy. N.Y:* Basic Electronics for Scientists
5. *Kings lake:* Applied Optics Vol. IV
6. *F.A. Jenkins and H.E White:* Fundamentals of Optics

PHY-4213: Particle and High Energy Physics
Credit – 03 (3 hours/ week)

Section – A

1. **Basic Concepts:** Particle and antiparticle; Particles and interactions; Basic particles; Mass, energy and momentum in Einstein's mechanics; Relativistic wave equation; Hole theory and the positron; Feynman diagram; Particle exchange; Weak and strong interaction; Mediators of interactions; Bosons.
2. **Non-Conservation of C, P, T and CP:** Charge conjugation and Parity; C, P, T and CP violation; Muon decay asymmetries; The CP puzzle; Left handed neutrions and right handed anti-neutrinos; Neutral kaons; CP violation in K and B systems.
3. **Cosmology and Astrophysics:** How old is the universe? The Big-bang explosion; Expanding of the universe; What is the universe made of?; The drak matter mystery; Formation of elements and early

universe; Oscillating universe; The Hubble expansion; The cosmic microwave background radiation; Radiative element dating.

Section – B

4. **Passage of Radiation Through Matter:** The cross section; Energy loss of heavy particles by collisions; Cerenkov radiation; Bremsstrahlung; Radiation length; Back scattering; The interaction of Photons; Radiation safety in high energy physics.
5. **Experimental Methods:** Accelerators; Linacs and synchrotrons; Fixed-target machines and colliders; Secondary beams; Particle interactions with matter; Short-interaction nuclei; Ionization energy losses; Radiation energy losses; Interactions of photons in matter; Particle detectors; Time resolution; Scintillation counters; Measurement of position; Measurement of momentum particle identification; Energy measurements; Calorimeters; Discovery of the J/ψ (3097); The Brookhaven experiment; The SLAC experiment; The Belle experiment at KEK.

Recommended References:

1. *B. R. Martin G. Shaw:* Particle Physics
2. *L. B Okun:* α, β, γ,...Z, A Primer in Particle Phvsics
3. *Dan Green:* Lectures in Particle Physics
4. *L. J Tassi:* Elementary Particle Physics
5. *W. R. Leo, Spring Verlag:* Techniques for Nuclear and Particle Physics Experiments
6. *Griffiths:* Introduction to Elementary Particles