Scheme of Studies for Batch 2022

FIRST YEAR

Fall				
Course Code	**Course Title**	**Th**	**Pr**	**Total**
CS-101	Introduction to Computer	2	1	3
CY-115	General Chemistry-I	2	1	3
HS-105 OR HS-127	Pakistan Studies OR Pakistan Studies (For Foreigners)	2	0	2
MT-100	Introduction to Mathematics	-	-	NC
MT-173	Calculus	3	0	3
PH-101	Mechanics & Properties of Matter	3	0	3
PH-102	Heat & Thermodynamics	2	0	2
PH-103	Physics Lab-I	0	1	1
	Total	**14**	**3**	**17**

Spring				
Course Code	**Course Title**	**Th**	**Pr**	**Total**
CY-116	General Chemistry-II	2	1	3
EL-255	Programming Language	2	1	3
HS-104	Functional English	3	0	3
HSK-1 OR HS-231	Chinese Language Or Turkish Language-I	-	-	NC
MT-227	Differential Equations	3	0	3
PH-104	Waves & Oscillations	2	0	2
PH-105	Electricity & Magnetism	3	0	3
PH-106	Physics Lab-II	0	1	1
	Total	**15**	**3**	**18**

SECOND YEAR

Fall				
Course Code	**Course Title**	**Th**	**Pr**	**Total**
CT-262	Introduction to Artificial Intelligence	2	1	3
EL-232	Electronics	3	1	4
HSK-2 OR HS-232	Chinese Language Or Turkish Language – II	-	-	NC
MT-272	Linear Algebra & Geometry	3	0	3
PH-202	Modern Physics	3	0	3
PH-207	Optics and Laser	3	0	3
ES-205 OR ES-209	Islamic Studies Or Ethical Behavior	2	0	2
	Total	**16**	**2**	**18**

Spring				
Course Code	**Course Title**	**Th**	**Pr**	**Total**
EL-238	Digital Electronics	3	1	4
EA-200	Community Service	-	-	NC
EA-214	Academic Writing	3	0	3
MT-331	Probability and Statistics	3	0	3
PH-203	Physics Lab-III	0	1	1
PH-204	Introduction to Material Science	3	0	3
PH-205	Classical Mechanics	3	0	3
	Total	**15**	**2**	**17**

THIRD YEAR

Fall				
Course Code	**Course Title**	**Th**	**Pr**	**Total**
EA-301	Business and Organizational Communication	3	0	3
PH-301	Quantum Mechanics-I	3	0	3
PH-303	Mathematical Physics-I	3	0	3
PH-304	Electromagnetic Theory-I	3	0	3

Spring				
Course Code	**Course Title**	**Th**	**Pr**	**Total**
MG-110	Fundamentals of Management	3	0	3
PH-307	Mathematical Physics-II	3	0	3
PH-309	Electromagnetic Theory-II	3	0	3
PH-311	Physics Lab-V	0	1	1

PH-310	Solid State Physics-I	3	0	3
PH-206	Physics Lab-IV	0	1	1
	Total	**15**	**1**	**16**

PH-403	Solid State Physics-II	3	0	3
PH-415	Statistical Mechanics	2	0	2
	Total	**13**	**1**	**14**

FOURTH YEAR

Fall				
Course Code	**Course Title**	**Th**	**Pr**	**Total**
##-###	Elective-I	3	0	3
PH-308	Quantum Mechanics-II	3	0	3
PH-312	Physics Lab-VI	0	1	1
PH-407	Physics Project	0	3	3
PH-409	Atomic and Molecular Physics	2	0	2
PH-417	Nuclear Physics	2	0	2
PH-418	Computational Physics	3	0	3
	Total	**13**	**4**	**17**

Spring				
Course Code	**Course Title**	**Th**	**Pr**	**Total**
##-###	Elective-II	3	0	3
##-###	Elective-III	3	0	3
##-###	Elective-IV	3	0	3
MG-481	Entrepreneurship	3	0	3
PH-407	Physics Project	0	3	3
	Total	**12**	**3**	**15**

Grand Total Credit Hours **132**

List of Elective Courses- Bachelor of Science (Physics) (BSPH)

(N) New Courses

Elective courses will be offered solely at the department's discretion.

S. No	Course Code	Title	Cr Hr. Theory	Cr Hr. Practical	Cr Hr. Total
1	PH-313	Cosmology and Theory of Relativity	3	0	3
2	PH-411	Applications of Space Physics	3	0	3
3	PH-419	Fundamentals of Medical Physics	3	0	3
4	PH-420	Nano Science and Nanotechnology	3	0	3
5	PH-421	Vacuum Science	3	0	3
6	PH-422	Plasma Physics	3	0	3
7	MY-402	Advance Materials	3	0	3
8	PH-423	Surface Science and Applications (N)	3	0	3
9	PH-424	Essentials of Health Physics (N)	3	0	3
10	PH-425	Microwave Systems (N)	3	0	3
11	PH-426	Essentials of Quantum Field Theory (N)	3	0	3
12	PH-427	Dielectric Materials (N)	3	0	3
13	PH-428	Renewable Energy Sources (N)	3	0	3
14	PH-429	Environmental Physics (N)	3	0	3
15	PH-430	Optoelectronic Devices (N)	3	0	3

First Year

PH-101 Mechanics and Properties of Matter

Vectors: Review of Vector Analysis, Gradient, Divergence, and Curl.
Motion in one and two dimensions: Motion in one- and two-dimensions, Motion under Constant Acceleration, Projectile Motion, Uniform Circular Motion Inertial and Non-Inertial Reference Frames.
Newton's Law: Newton's Laws of Motion and their applications, Time-dependent forces.
Newton's Law and Related Planetary Laws of Motion: Newton law of Gravitation, Kepler's Laws, Escape Velocity, and their applications.

Work and Energy: Work done by Constant and Variable Forces *Work-Energy theorem*, Power, Conservative and Neoconservative Forces.

System of Particles: Newton's Laws for a System of Particles, Conservation of Linear Momentum, Impulse, Momentum and Kinetic Energy in One- and Two- Dimensional Elastic and Inelastic Collisions.
Rotational Motion: Rotation about a Fixed Axis, *Dynamics of rotatory bodies, Angular Motion,* Parallel-axis Theorem, Torque and Newton's Law for Rotation, Angular Momentum for a System of Particles, Conservation of Angular Momentum, P recession of a Gyroscope, Static Equilibrium involving Forces and Torques, Determination of moment of inertia of various shapes, effects of Torque.
Properties of Matter: Elastic Properties of Matter, Poisson's ratio, the Relation between three types of elasticity, Fluid Statics, Variation of Pressure in fluid at rest and with height in the atmosphere, Coefficient of viscosity, fluid flow through a cylindrical pipe (Poiseuille's law)

Recommended Books:

Text book(s)

1. David Halliday, Robert Resnick, Jearl Walker, "*Fundamentals of Physics, Extended*" 12th edition, Wiley, 2021.
2. R. A. Freedman, H. D. Young, and A. L. Ford, "*University Physics with Modern Physics*", 15th edition, Pearson, 2019.

Reference Book(s)

1. Christina Earley, "*Properties of Matter*", Seahorse Publishing, 2022.Alauddin Khan, "*Properties of Matter, Waves, and Oscillations. An Introduction to Basic Mechanics"*, 1st edition, GRIN Verlag, 2021.

PH-102 Heat & Thermodynamics

Thermodynamic systems, Surrounding and Boundaries, Type of systems, Macroscopic and microscopic description of system, Properties and state of the substance, Extensive and Intensive properties, Equilibrium, Mechanical and Thermal Equilibrium, Processes and Cycles, Isothermal, Isobaric and Isochoric. Zeroth Law of Thermodynamics, Consequence of Zeroth law of Thermodynamics. The state of the system at Equilibrium, Temperature, Kinetic theory of ideal gas, Work done on an ideal gas, Internal energy of an ideal gas, Equipartition of Energy, Intermolecular forces, The Virial expansion, The Van der Waals equation of state, First law of thermodynamics and its applications to adiabatic, isothermal, cyclic and free

expansion. Reversible and irreversible processes, Second law of thermodynamics, Carnot theorem and Carnot engine, Heat engine, Refrigerators, Calculation of efficiency of heat engines. Thermodynamic temperature scale, Absolute zero, Entropy, Entropy in reversible process, Entropy in irreversible process. Entropy and second law of thermodynamics, Entropy and Probability, Thermodynamic potentials, Maxwell's relations, TdS equations. Energy equations and their applications, Intrinsic and mutual stabilities of single component system, Conditions of stabilities, The Le ChatelierBraun Principle, Phase transitions
(latent heat), First order Phase transition, Discontinuities of Volume and Entropy, Second Order Phase Transition, Low Temperature Physics, Joule-Thomson effect and its equations, Thermocouple, Seebeck's effect, Peltier's effect, Thomson effect, Statistical distribution and mean values, Mean free path and microscopic calculations of mean free path. Distribution of Molecular Speeds, Distribution of Energies, Maxwell distribution, Maxwell Boltzmann energy distribution, Internal energy of an ideal gas, Brownian Motion and Langevin equation, Qualitative description.

Recommended Books:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley, 9th ed. 2010.
2. M. W. Zemansky, "Heat and Thermodynamics", McGraw Hill, 7th ed. 1997.
3. M. Sprackling, "Thermal Physics" McMillan 1991.
4. B. N. Roy, "Principle of Modern Thermodynamics", Institute of Physics, London 1995.

PH-103 Physics Lab-I

Experiments on Mechanics, Heat and Thermodynamics will be conducted, encompassing topics namely, the Young's modulus, modulus of rigidity, acceleration due to gravity, pendulum, surface tension, moment of inertia, viscosity, specific heat, thermal conductivity, thermal coefficient and thermocouple. **Text book(s)**

1. Laboratory Workbook for Physics Lab-I **Reference Book(s)**

1. C.L. Arora, "*B.Sc. Practical Physics*", S Chand & Co Ltd, 2010.
2. Robert Lucas, "*Physics Virtual Laboratory*", CRC Press, 2022.

PH-104 Waves and Oscillations

Simple and Damped Simple Harmonic Oscillation: Mass-Spring System, Simple Harmonic Oscillator Equation, LC and LCR Circuit, Simple Pendulum, Quality Factor, Steady-State Behavior, Driven LCR Circuit.

Forced Damped Harmonic Oscillation: Transient Oscillator Response, Resonance. Coupled Oscillation: Spring-Coupled Masses, Coupled LC Circuits, Normal Modes, Atomic and Lattice Vibrations.

Transverse Waves: Transverse Standing Waves, General Time Evolution of a Uniform String, Phase velocity, and Group Velocity.
Longitudinal Waves: Spring Coupled Masses, Waves in an Elastic Solid. Sound and Acoustics: Sound Waves in an Ideal Gas, *Doppler Effect and its application.*

Standing and Travelling waves: Standing Waves in a Finite Continuous Medium, Traveling Waves in an Infinite Continuous Medium, Energy Conservation, Transmission Lines, Reflection, and Transmission at Boundaries, Fourier series and Fourier Transforms, Bandwidth, Plane Waves, Three-Dimensional Wave Equations, Electromagnetic waves, Laws of Geometric Optics, and Cylindrical Waves, Interference of waves by slits diffraction.

Recommended book(s) for the approved course .
Text book(s)

1. A. P. French, "*Vibrations and Waves*", CBS, 2017.
2. R. A. Freedman, H. D. Young, and A. L. Ford, "*University Physics with Modern Physics*", 15th edition, Pearson, 2019.

Reference Book(s)

1. P Alauddin Khan, "*Properties of Matter, Waves, and Oscillations. An Introduction to Basic Mechanics"*, 1st edition, GRIN Verlag, 2021
2. Joel Franklin, "*Mathematical Methods for Oscillations and Waves*", 1st edition, Cambridge University Press, 2020.

PH-105 Electricity and Magnetism

Electrostatic: Electric Charge, Conductors and Insulators, Coulomb's Law, Electric Fields due to a Point Charge, a Charge Distribution and Electric Dipole Electric Flux, Gauss' Law and its Applications.

Electric Potential: Potential due to a Point Charge, Electric Dipole and continuous charge distributions. The Relation between Electric Field and Electric Potential Energy.

Capacitor and Capacitance: Parallel Plate, Cylindrical and Spherical capacitors, Capacitors in Series and Parallel, Energy Stored in Capacitors.

DC Circuits: Electric Current and Current Density, Resistance and Resistivity, Ohm's Law, Power in Electric Circuits, EMF source, Resistances in Series and Parallel, Single and Multiloop Circuits, Circuit analysis rules *and theorem***,** RC Circuits, Charging and Discharging of Capacitor.

Magnetic Field and Magnetic Force: Crossed Electric and Magnetic Fields and their Applications, Magnetic Force on a Current-Carrying Wire, Torque on a Current Loop, Biot-Savart Law and its application, Ampere's Law, and its applications.

Electromagnetic Induction: Inductance, Faraday's Law of Induction, Lenz's Law, Self-Inductance, RL Circuits, Energy Stored in a Magnetic Field, Energy Density, Mutual Induction.

Alternating Fields and Currents: Alternating Currents *Circuit theory*, *Resonant circuits*, Power in AC Circuits, Transformers, *AC Bridges.*

Magnetism and Magnetic Material: Magnetic induction, magnetization, diamagnetism, Para-magnetism, Ferromagnetism, The Electron theory of magnetism, and the Hysteresis curve.

Recommended Books
Text book(s)

1. D.L. Sehgal, K.L. Chopra ,N.K. Sehgal, "*Electricity and Magnetism*", 2020 edition, Sultan Chand & Sons, 2020.

2. P. F. Kelly, "*Electricity and Magnetism*", 1st edition, CRC Press, 2021.
3. R. A. Freedman, H. D. Young, and A. L. Ford, "*University Physics with Modern Physics*", 15th edition, Pearson, 2019. **Reference Book(s)**
1. V. K. Sachan, "*Electricity and Magnetism*", KDP Print, 2020.

PH-106 Physics Lab-II

Experiments on Waves, Oscillation, Electricity and Magnetism will be conducted, encompassing topics namely, the components of magnetic fields, hysteresis curve, frequency responses of the series and parallel LCR circuits, linear density, unknown high resistance, capacities and current sensitivity, harmonic motion and travelling waves.

Recommended book(s) for the approved course .
Text book(s)

1. Laboratory Workbook for Physics Lab-II.

Reference Book(s)

1. C.L. Arora, "*B.Sc. Practical Physics*", S Chand & Co Ltd, 2010.
2. Ronald Laymon, Allan Franklin, "*Case Studies in Experimental Physics*", 1st edition, Springer, 2022

ES-105 Pakistan Studies

Historical and ideological perspective of Pakistan Movement, Two Nation Theory, Definition: Claim of Muslims of being a separate nation from Hindus, based upon cultural diversity, Significance: Cultural diversity and interests led to the demand of Pakistan – Lahore resolution, Creation of Pakistan, Factors leading to the creation of Pakistan, Quaid-e-Azam and the demand of Pakistan, Land of Pakistan, Geo-physical conditions, Geo-political and strategic importance of Pakistan, Natural resource, viz: mineral, water and power, Constitutional Process, Early efforts to make a constitution (1947-1956) problems and issues, Salient features of the constitution of 1956 and its abrogation., Salient features of the constitution of 1962 and its abrogation, Constitutional and political crisis of 1971, Salient features of the constitution of 1973, Constitutional developments since 1973 to date with special reference to the amendments to the constitutions, Contemporary issues in Pakistan, A brief survey of Pakistan Economy, An overview of current economic situation in Pakistan; problems, issues and future prospects, Social Issues, Pakistani Society and Culture-Broad features, Citizenship: national and international, Literacy and education in Pakistan: problems and issues, State of Science and Technology in Pakistan: A comparison with other countries with special reference to the Muslim world, Environmental Issues, Environmental pollution and its hazards: causes, and solutions, Environmental issues in Pakistan: government policies and measures and suggestions for improvement, Pakistan's role in the preservation of nature through international conventions / treaties, Pakistan's Foreign Policies, Evolution of Pakistan foreign policy-1947 to date, A brief survey of Relation with Neighbours, Super Powers & the Muslim World, Human Rights, Conceptual foundations of Human Rights, What are Human Rights?

Definition, origins & significance, Comparative analysis of Islamic and Western Perspectives of Human rights, UN System for protection Human Rights, UN Charter, International Bill of Human Rights – an overview, Implementation mechanism, Other important international treaties and conventions, The convention on the elimination of

all forms of discrimination against Women (CEDAW), International convention on the rights of child (CRC), Convention against torture (CAT), Other treaties and Convention, Pakistan's response to Human Rights at national and international levels, Constitutional Provisions, Pakistan's Obligations to international treaties and documents, Human Rights issues in Pakistan- a critical analysis, Pakistan's stand on violation of Human Rights in the international perspective.

Recommended Books:

1. Rafi Raza, Pakistan in Perspective 1947-1997
2. Sharif-ul-Mujahid, The Ideology of Pakistan
3. N. Sethi, The Environment of Pakistan
4. Ziring Lawrence, Pakistan in the Twentieth Century
5. Parvez Hoodbhoy, State and Education
6. Burke S. M. & Ziring Lawrence, Pakistan's Foreign Policy
7. Dr. Ishrat Hussain, Pakistan - The Economy of an Elitist State
8. Pakistan Almanac

ES-127 Pakistan Studies for Foreign Students (Alternate Course to ES105)

Land of Pakistan, Land & People, Strategic importance, Important beautiful sights, Natural resources, A brief Historical background, A brief Historical survey of Muslim community in the sub-continent, British rule & its impacts, Indian re-action, Two nation theory – Origin & development, Factors leading towards the demand of a separate Muslim state, Creation of Pakistan, Government & Politics in Pakistan, Constitution of Pakistan – A brief outline, Governmental structure – Federal & Provincial, Local Government Institutions, Political History – A brief account, Pakistan & the Muslim World, Relations with the Muslim countries, Language and Culture, Origins of Urdu Language, Influence of Arabic & Persian on Urdu Language & Literature, A short history of Urdu literature.

Recommended Books:

1. M. Ikram Rabbani, Pakistan Affairs, 8th Ed., 2005, Carvan Enterprises
2. Victoria Schofield, Old Roads - New Highways 50 years of Pakistan, 1997, Oxford University Press

MT–173 Calculus

Vectors: Review of vectors, Vector derivatives. Line and surface Integrals. Gradient of a Scalar. Complex Number: Argand diagram, De Moivre formula, roots of polynomial equations, curve and regions in the complex plane, standard functions, and their inverses (exponential, circular and hyperbolic functions).
Limits and Continuity: Bounds and bounded sets, Limit point of sets, Sequence, Convergence of sequences monotonic sequences, Function and their graph, limit of function and continuous functions.
Differential Calculus: Differentiation and Successive differentiation and its application; Leibnitz theorem, Taylor and Maclaurin theorems with remainders in Cauchy and Lagrange form, Taylor and Maclaurin series, L'Hopitals Rule, extreme values of a function of one variable using first and second derivative test, asymptotes of a function, curvature and radius of curvature of a curve, partial differentiation, exact differential and its application in computing errors, Multivariate functions, Maxima and Minima for multivariate functions, Maxima Minima under certain conditions (Language Multiplier).

Integral Calculus: Indefinite integrals and their computational techniques, reduction formulae definite integrals and their convergence, Beta and Gamma functions and their identities, double and triple integration with applications. (Area, Volume, centroid, inertia, arc length).

Vector Algebra: Scalar and Vector quantities, physical and geometrical meanings, Algebra of vectors, Scalar and Vector triple products.

Recommended Books:

1. "Engineering Mathematics", Anthony Croft, Robert Davison and Martin Hargeaves, Pearson Education Limited, 3rd Edition, 2001.
2. "Calculus", Thomas & Finney, 3rd Edition, Addison Wesley Longman, 2006.
3. "Engineering Mathematics", K.A. Stroud and Dexter J. Booth, 6th Edition, Industrial Press, 2007.
4. "Calculus and Analytical Geometry", Howard Anton, John Wiley & Sons Inc, 5th Edition, 1998.
5. "Complex Analysis for Mathematics and Engineering", John H. Mathews, Jones and Bartlett Publishers Inc. 5th Edition, 2006.

MT-100 Introduction to Mathematics

Algebra:

Complex Number: Properties of complex numbers, conjugates, and modules. Geometrical representation of complex numbers a+ ib.

Quadratic Equations: Roots of a quadratic equation (real, distinct, equal, and imaginary roots). Formation of quadratic equation when the roots are given.

Cube Roots of Unity: Properties of cube root of unity.

Matrices: Properties, sum, difference, and multiplication of matrices. Cramer's rule, solution of linear equations of three unknowns.

Determinants: Properties, addition, subtraction and multiplication of determinants, sequence and series, arithmetic progression, standard forms of an A. P.; arithmetic means. Geometric progression, standard forms of a G. P., sum of Infinite geometric series, geometric means. Harmonic progression, harmonic means. Relation between H.M, A.M. and G.M.

Permutation and Combination: Recognition between permutation and combination cases, factorial n! 0! = 1 etc.

Binomial Expression: Expansion of type for positive integer of 'n'. Use of the general term and determine the middle term or terms of the expansion.

Partial Fraction: Resolve into partial fractions, proper fraction, improper fraction, when all factors of denominator are linear, but some are repeated. When denominator has repeated irreducible quadratic factors.

Functions: One-one function, onto function, even function, odd function, exponential function, trigonometric function, and logarithmic function.

Circular Measure: Understand the definition of radians and use the relationship between radians and degrees.

Trigonometric Functions: Basic functions e.g., sine, cosine, tangent etc. relation between them. Trigonometric identities sum and difference formulae, multiple angle formulae.

Differential Calculus:

Limits: Basic concepts; limit of form {(sin x)/ x} = I when x tends to zero. Exponent functions and type ax etc.

Differentiation: Differentiation of n product and quotient formula, trigonometric functions, exponents, and logarithmic functions. Differentiations, minima and maxima, tangent and normal, velocity and acceleration, rate of reaction etc.

Integral Calculus:

Basic Integration: Integrals of sum powers of ", trigonometric functions, exponent functions and logarithmic functions. Integration by parts: e.g. sin, e and log etc. Substitution method; understanding of integration form {f( )/f( )} and [f( )]n f ( ) etc. Standard Application of integration**:** Area, volume, velocity, and acceleration.

Coordinate Geometry:

Lines: Find length, mid-point, gradient of line segment, given the coordinates of end points. Different forms of equation of a line. Angle between two lines, distance of a point from a line.

Conic Sections:

Circle: Equation of circle using radius and coordinate of center, Tangents and normal. Parabola: Equation of parabola, Focus, Vertex, Directrix and intersection of parabola. Ellipse: Equation of ellipse, Eccentricity, Foci, Latus rectum, Major and minor axes. Hyperbola: Equation of hyperbola, Foci, Directrices, Eccentricity and Latus rectum etc.

MT-227 Differential Equations

1st Order Differential Equations: Basic concept; Formation of differential equations and solution of differential equations by direct integration and by separating the variables; Homogeneous equations and equations reducible to homogeneous from; Linear differential equations of the order and equations reducible to the linear form; Bernoulli's equations. Application in relevant Engineering: orthogonal trajectories: Numerical approximation to solutions; Solution in series. Euler method, Euler modified method, Runge Kutta method of order 4

2nd and Higher Order Equations: Special types of 2 nd order differential equations with constant coefficients and their solutions; The operator D; Inverse operator I/D; Solution of differential by operator D methods; Special cases, Cauchy's differential equations; Simultaneous differential equations; simple application of differential equations in relevant Engineering.

Partial Differential Equation: Basic concepts and formation of partial differential equations; Linear homogeneous partial differential equations and relations to ordinary differential equations; Solution of first order linear and special types of second and higher order differential equations; D' Alembert's solution of the wave equation and two-dimensional wave equations; Lagrange's solution: Various standard forms.

Laplace Integral& Transformation: Definition, Laplace transforms of some elementary functions, first translation or shifting theorem, second translation or shifting theorem, change of scale property, Laplace transform of the nth order derivative, initial and final value theorem Laplace transform of integrals. Laplace transform of functions tn F(t) and F(t)/ t, Laplace transform of periodic function, evaluation of integrals, definition of inverse Laplace transforms and inverse transforms, convolution theorem, solutions of ordinary differential using Laplace transform.

CS-101 Introduction to Computers

Structure and organization of Computers and Computer Systems, Computer Peripherals, Introduction to Software development process, Modular decomposition, Introduction to common Software packages and their applications, Programming languages and their comparative study, High level and low-level languages, Introduction to data communication, LAN and WAN, Introduction to operating systems. The practical work will base on the above course.

CY-115 General Chemistry-I

Atomic and molecular structure, States of matter, Atomic theory, Periodic Table, Periodicity Electromagnetic spectrum and radiant energy, Quantum mechanics, Bohr Atomic model, Orbitals, electron spin and electronic configuration ,Lewis Structures, Octet Rules, Ionic, Covalent and Metallic Bonding, Valence Bond and Molecular Orbital Theory, Resonance Forms, Electronegativity, polarity and dipole moments, Types of reactions, Balancing, Types of solutes (ionic and molecular); electrolytes Solubility rules, Molecular and ionic equations, Conversion of and conservation of matter and energy, Empirical and molecular formulae, Reactant and product calculations, yields, Characteristics and properties of gases, Gas laws, Ideal vs. Real gases, Kinetic-molecular theory Dalton's laws of partial pressures, Diffusion, effusion and Graham's Law, Liquefaction of gases. Liquids and Solids: Kinetic-molecular description of liquids and solids, Intermolecular forces and their effects on liquid properties, Bulk properties of liquids and solids, Vapor pressures and phase changes, Phase diagrams. Energy and chemical changes/reactions, Enthalpy and heats of reaction Hess's Law, calorimetry. Redox reactions, Electrochemical Cells, Electrode potential, Emf of the Cell, Standard Electrode Potentials, Electrochemical Series, Fuel Cells, Electrolytic Cells, Faraday's Laws of Electrolysis, Corrosion of metals, Prevention of Corrosion.

Recommended Books:

1. Atkins, P.W. Physical Chemistry, 7thed.; Oxford University Press, Oxford, 2003.

2. Hill J.W. Petrucci R. H. General Chemistry, 8thed.; Prentice Hall: New jersey, 2002.

3. Shriver, D.F. Atkins, P.W. Langford, C.H. Inorganic Chemistry, Oxford University Press, Oxford, UK, 1990

CY-116 General Chemistry-II

Properties of simple mixtures/solutions, Concentration terms, The thermodynamic description of mixtures, Partial molar quantities, The chemical potential of liquids, Ideal solutions, Raoult's law, The properties of solutions: liquid mixtures, elevation of boiling point, depression of freezing point, solubility, Osmosis and Osmotic pressure, solvent and solute activity, Vant Hoff's theory of dilute solutions, Colloids, Spontaneous chemical reactions and equilibrium, Properties of equilibrium state, Le Chatelier's Principle, the reaction quotient, Relationship between Kc and Kp, Heterogeneous equilibria, The nature of solubility equilibria, Distribution law, Application of the distribution law to the selected systems like solvent extraction, Extraction of metals from their ore, Investigation of complex ions, Chromatography. Zeroth, first and second laws of thermodynamics, state functions, thermodynamic reversibility and irreversibility, Work done and the change of internal energy during isothermal expansion of an ideal gas, Change of internal energy due to heat transfer at constant volume and constant pressure. Heat capacities of a gas at constant volume and constant pressure, Arrhenius and Bronsted theories of acids and bases, SelfIonization of water, pH scale, Kw, Strong and Weak Acids and Bases, Ka and Kb, Common Ion Effect in acid base Equilibria, Buffer Solutions, Solubility Equilibria, Lewis Acids and Bases, Hard and Soft Acids and Bases.The covalent bond, Hybridization, Stereoisomerism (optical/cistrans isomerism), Alcohols (oxidation, esterification, ether formation), Aldehydes & ketones (oxidation, reduction, hemiacetal and acetal formation, aldol condensation), Carboxylic acids (reduction, ester formation, acid anhydride formation, salt formation, amide formation), Amines, Metallic, Polymers (natural and synthetic), Biomaterials (composite, metallic, ceramics, polymeric & biological).

Recommended Books:

1. Hill J.W.; Petrucci R. H. General Chemistry, 8thed.; Prentice Hall: New jersey, 2002.

2. Solomons, T.W.G. Organic Chemistry, 5th ed.; John Wiley and Sons Inc. New York,1992.

3. Morrison, R.T.; Boyd, R. N. Organic Chemistry, 6th ed.; Prentice-Hall of India Pvt. Ltd, New Delhi, 1992.

EL-255 Programming Language

Turbo C Programming environment, Setting up the Integrated Development Environment, File used in C program development, The basic structure of C program, the printf() function, C building blocks, Variables, input/output operators, comments, Loops, the for loop, the while loop, the do while loop, decisions, the if statement, the if-else statement, the else-if construct, The switch statement, the conditional, operator, Functions, simple functions, functions that return a value, using arguments to pass data to a function, using more than one functions, Pre-processor directives, Arrays and Strings, Arrays, Referring to individual elements of the array, String, String functions, Multidimensional, arrays, Pointers, Pointer overview, Returning data from functions, Pointers and array, Pointers and Strings, Structure, Unions and ROM BIOS, Graphics functions and files.

SECOND YEAR

PH-207 Optics and Laser

Propagation of Light and Image Formation: Huygens' Principle, Fermat's Principle, Laws of Reflection and Refraction, Refraction at a Spherical Surface Thin Lenses, Newtonian Equation for a Thin Lens.

Matrix Methods in Paraxial Optics: Ray Transfer Matrices, Thick Lens, Significance of System Matrix Elements, Cardinal Points, optical instruments, Chromatic and Monochromatic Aberrations.

Superposition and Interference: Standing Waves, Beats, Phase and Group Velocities, Two-Beam and Multiple Beam Interference, Thin Dielectric Films, Michelson and Fabry-Perot Interferometers, Resolving Power, Free-Spectral Range.

Polarization: Linear, circular and elliptical polarization, Jones Matrices, Production of Polarized Light, Dichroism, Brewster's Law, Birefringence, Double Refraction, Electro-optic and magneto-optic effects.

Diffraction: Fraunhofer Diffraction from a Single Slit, Rectangular and Circular Apertures, Double Slit, Many Slits, Diffraction Grating, Dispersion, Resolving Power Blazed Gratings, Zone Plates, Rectangular Apertures.

Coherence and Holography: Temporal Coherence, Spatial Coherence, Holography of a Point object and Extended Objects.

Laser: Population Inversion, Resonators, Threshold, and Gain Energy Quantization in Light and Matter, Thermal Equilibrium and Blackbody Radiation, Non-laser Sources of Electromagnetic Radiation, Einstein's Theory of Light-Matter Interaction, Elements, operation, Characteristics, types and Parameters of Laser, Rate Equations Absorption, Gain Media, Steady-State Laser Output, Homogeneous Broadening, Inhomogeneous Broadening, Time-Dependent Phenomena. **Recommended Books:**

1. See Leang Chin, Huailiang Xu ,Shuai Yuan, "Fundamentals of Laser Optoelectronics", 2nd edition, WSPC, 2022.
2. C. A. Bennett, "Principles of Physical Optics", 2nd edition, John Wiley, 2022

PH-202 Modren Physics

Wave-Particle Duality: The consequences of black body radiation, Stefan Boltzmann, Wien's, and Planck's law, The quantization of energy, Photoelectric and Compton effect, Line spectra, quantum theory, de-Broglie hypothesis and its testing, Davisson Germier Experiment and J.P. Thomson Experiment, Wave behavior of particles and relation to the probability of particle, Wave packets, and particles, localizing a wave in space and time.

Atomic Physics: Bohr's theory, Frank-Hertz experiment, energy levels of electrons, atomic spectrum, Angular momentum of electrons, Vector atom model, Orbital angular momentum, Spin quantization, Bohr's Magnetron, X-ray spectrum (continuous and discrete) Moseley's law, Pauli's exclusion principle, and its use in developing the periodic table.

Basic Concepts of Radioactivity: Laws of Radioactivity, Half-Life, types of decay.

Special Theory of Relativity: Einstein's Postulates of special relativity and their consequences, The Lorentz transformation, Transformation of relativistic momentum, and energy.

Recommended Books:

1. R. A. Freedman, H. D. Young, and A. L. Ford, "*University Physics with Modern*

Physics", 15th ed. Pearson, 2019.
2. Kenneth S. Krane, "*Modern Physics*" 4th edition, Wiley, 2019.

PH-204 Introduction to Material Science

Structure of Crystalline Solids: The packing of atoms in 2-D and 3-D, unit cells of the hexagonal close packing (hcp) and cubic closed packing (ccp) structures, interstitial structures, density computation, lattices, and symmetry elements, indexing lattice directions and lattice planes, interplanar spacing, lattices and crystal systems in 3-D, symmetry, crystallographic point groups, and space groups.

X- ray diffraction: Generation of X-rays, Bragg's law and the intensities of Bragg reflections, Laue's Equation, Xrays diffraction methods, The Laue's Method, Rotating Crystal Method, Powder Method, Reciprocal Lattice,Imperfections in Solids.

Mechanical properties of solids: Types of stress and strain and its yield estimations, elastic deformation, plastic deformation, Young's modulus, shear modulus, Poisson's ratio, elastic strain energy, thermal expansion, Dislocations, and Strengthening Mechanisms, fracture mechanics, ductile fracture, brittle fracture, Griffith criterion, ductile fracture, the toughness of engineering materials, the ductile-brittle transition temperature, cyclic stresses and fatigue, creep.

Structure of Polymer: Polymer basics, polymer identification, polymer molecules, additional polymerization, step growth polymerization, measurement of molecular weight, thermosetting polymers and gels, rubbers and rubber elasticity, configuration and conformation of polymers, the glassy state and glass transition, determination of Tg effect of temperature and time, mechanical properties of polymers, case studies in polymer selection and processing, materials selection, biopolymers, structural polysaccharides, hard materials, biomedical materials.

Recommended book(s)

1. W. D. Callister, D. G. Rethwisch "Fundamentals of Materials Science and Engineering: An Integrated Approach", Wiley, 5th edition, 2018.

Reference Book(s)

1. Yip-wah Chung, Monica Kapoor, "Introduction to Materials Science and Engineering", 2nd edition, CRC Press, 2022

PH-205 Classical Mechanics

Linear Motion: The Law of Conservation of Energy, *motion under a constant force*, *motions under variable force,* Energy, The Calculus of Variations, Hamilton's principle.

Central Conservative Forces: Reduced mass, Conservation theorems, *first integral of the Motion*, *Equation of Motion*, Orbits in a central field, *Centrifugal Energy and Effective Potential*, Planetary Motion, *Orbital Dynamics*.

Rotating Frames: Angular Velocity, Particle in a Uniform Magnetic Field, Apparent Gravity, Coriolis Force, Larmor Effect

The Two-Body Problem: Centre of mass and Relative Co-ordinates, The Centre of mass Frame, Elastic Collisions, CM and Lab Cross-sections.

Many-Body Systems: Center of mass, linear momentum, Angular Momentum, Central Internal Forces, elastic collision of two particles kinematics of elastic collision, inelastic collision, Scattering Cross-sections, Mean Free Path, Rutherford Scattering. **Rigid Bodies:** Basic Principles, Rotation about an Axis, Perpendicular

Components of Angular Momentum, Principal Axes of Inertia, Calculation of Moments of Inertia, Effect of a Small Force on the Axis, Instantaneous Angular Velocity, Rotation about a
Principal Axis, Euler's Angles.

Lagrangian Mechanics: Generalized Co-ordinates, Holonomic Systems, Lagrange's Equations, Precession of a Symmetric Top, Pendulum Constrained to Rotate about an Axis, Charged Particle in an Electromagnetic Field, The Stretched String.

Small Oscillations and Normal Modes: Introduction to Oscillatory Motion, Simple Harmonic Oscillator, Harmonic Oscillations in two-dimensions, Phase Diagrams, General Case of Coupled Oscillations, Eigenvectors and Eigenfunctions, Normal Co-ordinates, Small Oscillations of Particles on String.

Hamiltonian Mechanics: Hamilton's Equations, Conservation of Energy, Ignorable Co-ordinates, General Motion of the Symmetric Top, Liouville's Theorem, Symmetries and Conservation Laws, Galilean Transformations.

Recommended book(s)

1. Stephen T. Thornton, Jerry B. Marion, "*Classical Dynamics of Particles and Systems*", 6th edition, Cengage Learning, 2022.
2. T. M. Helliwell, V. V. Sahakian, "*Modern Classical Mechanics*", 1st edition, Cambridge University Press, 2021.

EL-232 Electronics

Conduction in Solids: Introduction, mechanics of conduction, mobility. Bohr's model for the elements, energy level diagrams for solids, conductors, intrinsic and extrinsic semiconductors, electron-hole pairs in an intrinsic semiconductor, distribution of electron and hole in conduction and valence bands, recombination, and lifetime.

Semiconductors and Diodes: Donor and acceptor impurities, zero biased, forward biased and reverse biased junction diodes, junction diode current equation, depletion barrier width and junction capacitance, diffusion capacitance, Zero and Avalanche break down, Hall effect, Fabrication of pn junction, diodes.

Electron Emission Devices: Types of electron emissions, thermionic diode, volt ampere characteristics, Child Langmuin Power Law, Gas filled diode, Thermionic triode, Parameters and characteristics, Tetrode, Pentode, and beam power tubes, Parameters, and characteristics.

Simple Diode Circuits and Applications: Mathematical and graphical analysis of diode circuits, The ideal and non ideal diodes, Piecewise linear models, Analysis of piecewise linear models of vacuum tube and junction diodes, The half wave rectifier. The inductance filter, the inductance capacitance filter circuits, Zener and gas diode, Voltage regulator circuits, Clamping and DC restorer circuits, Voltage doubler circuits, Clipping and limiting circuits.

Bipolar and Field Effect Transistors: Transistor biasing and thermal stabilization, The operating point, Bias stability, Collector to base bias, Fixed bias, Emitter feedback bias, Stabilization for the self biased circuits, Field effect transistors, Basic principles and theory, Types, FET characteristics, Different configurations-common gate, Common source and common drain, The FET, small signal model, Parameters, Biasing of the FET.

Amplifier Circuits: Introduction "h" parameters, Hybrid model for transistor, Elementary treatment, Low frequency transistor amplifier circuits, Stage cascaded LF.

EL-238 Digital Electronics

RTL and DTL circuit, Transistor-transistor logic, Integrated injection logic, MOS and CMOS, Fan in and fan out, Open collector TTL Gate, Tri state TTL gates, Schottky TTL and emitter coupled logic, non saturated logic, Combinational circuit design, A/D and D/A conversion. The practical work will be based on the above course.

CT-262 Introduction to Artifical Intelligence

Introduction: Introduction to Artifical Intelligence (AI), Branches of Artifical Intelligence(AI), Development stages of Intelligent machines,searching techniques

Machine Learning: Introduction to Machine Learning. Training and test data, object features, object detection

Knowledge Representation: Knowledge and its components, levels and type of knowledge, Knowledge representation techniques, Frame, Scripts, and Semantic Networks, Implementation of knowledge representation PROLOG

Expert System: Fundamental of Expert System, Component of Expert System, Development cycle of Expert, Design stages and Pro-type of Expert system

Natural Language Processing: Basic text processing, information Extracting, Natural Language understanding Problems, Natural language understanding techniques.

Applications: Game playing-Heuristic Search Algorithm and Turing Test.

Recommended Books:

1. Marcus, G & Davis, E. Rebooting A: Building Arificial Intelligence We Can Trust. Pantheon, 2022.
2. Mihel, M. Aniicial intelligence: guide for thinking humans, Farrar, Straus and Giroux, 2019.

MT-331 Probability& Statistics

Statistics: Introduction, Types of data & variables, presentation to data, object, classifications, Tabulation, Frequency distribution, Graphical representation, Simple & Multiple Bar diagrams, Sartorial & Pie-Diagram, Histogram, Frequency Polygon, Frequency Curves & their types.

Measures of Central Tendency and Dispersion: Statistics Averages, Median Mode, Quartiles, Range, Moments, Skew ness & Kurtosis, Quartile Deviation, Mean Deviation, Standard Deviation, Variance & its coefficient, Practical Significance in related problems.

Curve Fitting: Introduction, fitting of a first- and second-degree curve, fitting of exponential and logarithmic curves, related problems. Principle of least squares, Second order Statistics & Time series not in bit detail.

Simple Regression &Correlation: Introduction, Scatter diagrams, Correlation & its Coefficient, Regression lines, Rank Correlation & its Coefficient, Probable Error (P.E), Related problems.

Sampling and Sampling Distributions: Introduction, Population, Parameter & Statistic, Objects of sampling, Sampling distribution of Mean, Standard errors, Sampling & Non-Sampling Errors, Random Sampling, Sampling with & without replacement, Sequential Sampling, Central limit theorem with practical significance in related problems.

Statistical Inference and Testing of Hypothesis: Introduction, Estimation, Types of Estimates, Confidence interval, Tests of Hypothesis, Chi-square distribution/test, one tails & two tails tests. Application in related problems.

Probability: Basic concepts, Permutation & Combination, Definitions of probability, Laws of probability. Conditional probability, Baye'snile.Related problems in practical significance.

Random Variables: Introduction, Discrete & Continuous random variables, Random Sequences, and transformations. Probability distribution, Probability density function, Distribution function, Mathematical expectations, Moment Generating Function (M.G.F.), Markove random walks chain/ Related problems.

Probability Distributions: Introduction, Discrete probability distributions, Binomial Poisson, Hyper geometric & Negative binomial distributions. Continuous probability distribution, Uniform, Exponential & Normal distributions & their practical significance.

Recommended Books:

1. Advance Engineering Mathematics Erwin Kreyszig
2. Mathematical Statistics Hogg & Craig
3. Introduction to Statistics Walpole
4. Exploring Statistics Larry J. Kitchens

MT-272 Linear Algebra & Geometry

Linear Algebra: Linearity and linear dependence of vectors, basis, dimension of a vector space, field matrix and type of matrices (singular, non- singular, symmetric, non- symmetric, upper, lower, diagonal tri-diagonal matrix), Rank of a matrix using row operations and special method, echelon and reduced echelon forms of a matrix, determination of consistency of a system of linear equation using rank, transitions matrix.

Euclidean Spaces and Transformation: Geometric representation of vector, norm of vector, Euclidean inner product, projections and orthogonal projections, Euclidean n spaces n properties Cauchy-Schwarz inequality, Euclidean transformations, apply geometric transformations to plane figure, composition of transformations. Application of linear Algebra: Leontief Economic models, Electrical Networks, Scaling, translation, rotation, and projection etc.

Eigen values & Eigen Spaces : Interpret eigenvectors and eigenvalues of a matrix in terms of transformation it represents, convert a transformation into a matrix eigen value problem, find the eigenvalues and eigenvectors of order not more than 3×3 matrices algebraically, determine the modal matrix for a given matrix, reduce a matrix to diagonal (form and Jordan form, state the Cayley-Hamilton theorem and use it to find powers and the inverse of a matrix, understand a simple numerical method for finding the eigenvectors of a matrix, use appropriate software to compute the eigenvalues and eigenvectors of a matrix, Define quadratic form and determine its nature using eigenvalues.

Solid Geometry: Coordinate Systems in three dimensions. Direction cosines and ratios, vector equation of a straight line, plane and sphere, curve tracing of a function of two and three variables, Surfaces of revolutions. Transformations (Cartesian to polar &cylindrical).

Recommended Books

1. Elementary Linear Algebra Howard Anton Seventh Edition
2. Calculus & Analytical Geometry Howard Anton Fifth Edition 3. Elementary Linear Algebra Bernald Kolman Seventh Edition

THIRD YEAR

PH-301 Quantum Mechanics-I

Review of Basic Concepts: *Young's double-slit experiment,* de-Broglie's hypothesis, wave-particle duality, *statistical in the interpretation of matter waves, probability density,* wave packets. **Mathematical Foundation:** *Linear vector space*, *Hilbert space* and wave function, quantum operators, Linear operators, and their properties, Eigen values, Eigen Functions, Dirac notation, expectation values, Hermitian operators and their properties, Commutator algebra, Heisenberg uncertainty principle and superposition, Heisenberg and wave mechanics.

Postulates of Quantum Mechanics Basic postulates of quantum mechanics, the state of the system, observable and operators, the time evolution of the system state, time development of state function, expectation values, and conservation laws, Stationary state, time-dependent and independent Schrodinger equation.
Applications of The Quantum Postulates: Bound and unbound states**,** free particle, transmission and reflection at a step, barrier penetration (tunneling), infinite and finite potential well (up to 3D), the harmonic oscillator (up to 3D), solving the Eigenvalues of the harmonic oscillators by the polynomial method, central potential, angular momentum, *Eigen functions of angular momentum, eigenvalues of orbital angular momentum, operators L2 and Lz, spherical harmonics. Stern Gerlach experiment, symmetry principles,* Pauli spin matrices, spin angular momentum.

Recommended book(s)

1. Nouredine Zettili, "Quantum mechanics: concept and application", 3rd edition, Wiley, 2022.
2. Richard L Liboff, "Introductory Quantum Mechanics", 4th edition, Addison- Wesley, 2022.
3. N. Zettili, "Quantum Mechanics: Concepts and Applications", John Wiley, 2nd ed. 2009.
4. D.J. Griffiths, "Introduction to Quantum Mechanics", Addison-Wesley, 2nd ed. 2004.
5. R. Liboff, "Introductory Quantum Mechanics", Addison-Wesley, 4 ed. 2002.

PH-303 Mathematical Physics

Bessel Functions, Neumann Functions, Hankel Functions, Spherical Bessel Functions, Legendre Functions, Associated Legendre Functions, Spherical Harmonics, Hermite Polynomials. Introduction to important PDEs in Physics (wave equation, diffusion equation, Poisson's equation, Schrodinger's equation), general form of solution, general and particular solutions (first order, inhomogeneous, second order), characteristics and existence of solutions, uniqueness of solutions, separation of variables in Cartesian coordinates, superposition of separated solutions, separation of variables in curvilinear coordinates, special functions, integral transform methods, Green's functions, Review (polar form of complex numbers and de Moivre's theorem, complex logarithms and powers), functions of a complex variable, Cauchy-Riemann conditions, power series in

a complex variable and analytic continuation with examples, multi-valued functions and branch cuts, singularities and zeroes of complex functions, complex integration, Cauchy's theorem, Cauchy's integral formula, Laurent series and residues, residue integration theorem, definite integrals using contour integration.

Recommended Books:

1. G. Arfken, H. J. Weber, and F. E. Harris, "Mathematical Methods for Physicists", Academic Press, 7th ed. 2012.
2. K. F. Riley, M. P. Hobson, S. J. Bence, "Mathematical Methods for Physicists", Cambridge University Press, 2006.
3. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley, 8th ed. 1999.

PH-304 Electromagnetic Theory-I

The Dirac Delta Function: Review of Vector Calculus, *Curvilinear Co-ordinates,* The Dirac Delta Function, vector calculus using the example of Dirac Delta function.

Electrostatic: *Coulomb's Law, electric field, divergence and curl of the electric field, electric potential*, *work, and energy in electrostatic, conductors.*

Potential: *Poisson's equation*, Laplace's equation in one, two, and three dimensions, boundary conditions and uniqueness theorems, conductors and second uniqueness theorems, the method of images, multipole expansion.

Electric Field in Matter: Polarization, dielectrics, the field of the polarized object, bound charges with physical interpretation, electric displacement, Gauss's law in the presence of dielectrics, and linear dielectrics.

Magnetostatics: Lorentz force law, Biot-Savart Law and its application, the divergence and curl of the magnetic field, Ampere's law *and its application* magnetic vector potential, boundary condition, multipole expansion off vector potential.

Magnetic Field in the Matter: Magnetization, diamagnets, paramagnets, ferromagnets, torques, and forces on magnetic dipoles, the field of the magnetized object, bound current with physical interpretation, auxiliary field H, Ampere's law in magnetized materials, linear and non-linear media, magnetic susceptibility and permeability.

Recommended Books:

1. David J. Griffiths, "*Introduction to Electrodynamics*", 4th edition, Cambridge University Press, 2017.
2. Matthew N.O. Sadiku, "*Elements of Electromagnetics*", 7th edition, Oxford University Press, 2018.

Reference Book(s)

1. A. B. Bhattacharya, Atanu Nag, "*Physics: Introduction to Electromagnetic Theory*", 1st edition, Khanna Publishing House, 2021.

PH-206 Physics Lab-IV

Experiments in electromagnetism, and solid-state physics, Quantum Physics will be conducted, encompassing topics namely, the solar cell, band gap analysis, resonators, fine structures, energy conversion analysis and Michelson interferometer for the study of magnetic properties.

Recommended Books

1. Laboratory Workbook for Physics Lab-IV
2. M.A. Wahab, "*Solid State Physics: Structure and Properties of Materials*",3rd edition, Narosa Publishing House, 2021.
3. David J. Griffiths, "*Introduction to Electrodynamics*", 4th edition, Cambridge University Press, 2017.

PH-309 Electromagnetic Theory-II

Electrodynamics: Electromotive force, Ohm's law, motional emf, electromagnetic induction, Faraday's law, inductance, energy in magnetic fields, Maxwell's correction in Ampere's Law, and Maxwell's equations with boundary conditions. **Conservation Law:** The continuity equation, Charge conservation, Poynting's theorem and energy conservation, Newton's third law in electrodynamics, Maxwell's stress tensor, Conservation of momentum, angular momentum.

Waveguide: Basic concepts of waves, the wave equation, reflection, and transmission, polarization, electromagnetic waves in vacuum, matter, and conductors, the frequency dependence of permittivity, waveguides, types of waveguides the coaxial transmission line.

Radiation: Dipole Radiation, the basis of the radiation reaction.

Potential and Fields: Scalar and vector, Potentials, Gauge transformations, Lorentz force law, and potential form.

Relativistic Electrodynamics: Relativistic Electrodynamics, the field tensor, electrodynamics in tensor notation, relativistic potentials.

Recommended Books:

1. David J. Griffiths, "Introduction to Electrodynamics", 4th edition, Cambridge University Press, 2017.
2. Pierluigi Zotto, Massimo Nigro, "Problems in General Physics Electromagnetism", Società Editrice Esculapio, 2022.

Reference Book(s)

1. A. B. Bhattacharya, Atanu Nag, "Physics: Introduction to Electromagnetic Theory", 1st edition, Khanna Publishing House, 2021.

PH-310 Solid State Physics-I

Diffraction of X-rays through Crystal: *Crystal structure*, Diffraction of X-rays from periodic structures; *Geometrical form* of Bragg's law, Reciprocal lattice, Ewald construction and Brillouin zone, Fourier Analysis of the Basis.

Lattice Vibration: Quantization of Lattice Vibrations, Phonon momentum, inelastic scattering by phonons, Lattice Vibrations for Mono-atomic and diatomic basis, Optical Properties in the Infrared Region, Lattice heat Capacity.

Free Electron Theory of Metals: Classical model, Einstein Model, Enumeration of normal modes, Density of state in one, two or three dimensions, Debye model of heat capacity, Comparison with experimental results, thermal conductivity and resistivity, Umklapp processes, Classical free electron theory of metals, energy levels and density of orbitals in one dimension, effect of temperature on the Fermi–Dirac distribution function, properties of the free electron gas.

Application of Free Electron Theory of Metals: electrical conductivity and Ohm's Law, thermal and electrical conductivity of metals and their ratio, motion of free electrons in magnetic fields, cyclotron frequency, static magneto conductivity and Hall Effect along with applications. **Recommended Books:**

1. .A. Wahab, "*Solid State Physics: Structure and Properties of Materials*",3rd edition, Narosa Publishing House, 2021.
2. Siegfried Hunklinger, Christian Enss, "*Solid State Physics",* De Gruyter, 2022.

Reference Book(s)

1. E. Fred Schubert, "*Physical Foundations of Solid-State Devices*", 2022.

EA- 301 Business & Organizational Communication

Business Communication Foundations: Definition of business, organization and communication, Goals, patterns, principles, channels, tools, levels, Qualities (7 C's) and process of communication, Forms and functions of organizational communication,
Communication barriers, Feedback and its types, Listening & Understanding Nonverbal Communication, International and cross-cultural communication,
Communication Technologies and Techniques: Tools for digital communication, Etiquettes and ethics of using communication technologies
Communicating in Teams: Improving your performance in Teams (team communication, group dynamics, Etiquette in team settings), Making your meetings more productive (preparing for meetings, leading and participating in meetings, Meeting Notice, Agenda and minutes, Meeting simulation
Business Writing: Planning Audience Cantered Business Messages & Applying the three step Writing Process, Letter and Memos (Structure and elements) Practice in writing letters and memos, Three Types of Business Messages, and situations: Routine/Neutral/Positive/Good news and Goodwill messages, Negative/Bad News messages, Persuasive messages.
Employment Communication: Resume/CV, Job application (solicited and unsolicited) Writing Proposals and Reports: Finding and Communicating Information, Communicating Information Through Visuals, Writing effective Proposals, Short Reports (analytical and informational reports, memo, and letter reports), Formal Reports (structure and organization) **Recommended**
Books:

1. Business Communication Today (8th Edition) by Courtland L. Bovee& John V. Thill. Prentice Hall International Inc.
2. Process & product Approach to Business Communication by Mary Allen Guffy. Thomson Publishers
3. Business & Administrative Communication by Kitty O Locker, Irwin McGraw Hill.
4. Basic Business Communication, Skills for Empowering the Internet Generation, 9th Edition, LesikarFlatley, McGraw-Hill Irwin.
5. Business Communication 4th Edition, AC Buddy Krizan, Patricia Merrier, Carol Larson Jones, Jules Harcourt, International Thomson Publishing

PH-307 Mathematical Physics-II

Fourier Series and Integral Transforms, Fourier Series of Various Physical Functions, Uses and Applications of Fourier Series, Fourier Transforms, Convolution Theorems, Laplace transforms and applications, Vector calculus (differentiation, integration,

space curves, multi-variable vectors, surfaces, scalar and vector fields, gradient, divergence and curl, cylindrical and spherical coordinates, general curvilinear coordinates), change of basis, Cartesian tensor as a geometrical object, order/rank of a tensor, tensor algebra, quotient law, pseudo tensors, Kronecker delta and l evi-cevita, dual tensors, physical applications, integral theorems for tensors, non- Cartesian tensors, general coordinate transformations and tensors, Transformations, groups – definitions and examples, subgroups and Cayley's theorem, cosets and Lagrange's theorem, conjugate classes, invariant subgroups, factor groups, homomorphism, direct products, mappings, linear operators, matrix representations, similarity transformation and equivalent matrix representations, group representations, equivalent representations and characters, construction of representations and addition of representations, invariance of functions and operators, unitary spaces and Hermitian matrices, operators: adjoint, self-adjoint, unitary, Hilbert space, reducibility of representations, Schur's lemmas, orthogonality relations, group algebra, expansion of functions in basis of irreducible representations, Kronecker product, symmetrized and anti-symmetrized representations, adjoint and complex-conjugate representations, real representations.

Recommended Books:

1. G. Arfken, H. J. Weber, and F. E. Harris, "Mathematical Methods for Physicists", Academic Press, 7th ed. 2012.
2. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley, 8th ed. 1999.
3. M. Hamermesh, "Group Theory and its Applications to Physical Problems", Dover Publications 1989.

PH-311 Physics Lab-V

Experiments in Solid State Physics, electromagnetism and Mathematical Physics will be conducted, encompassing topics namely, the X-ray diffraction, crystal structures of crystalline materials, dielectric properties of the material and different analysis of Hall effect, ODE solution.

Recommended books:

Text book(s)

1. Laboratory Workbook for Physics Lab-V

Reference Book(s)

1. M.A. Wahab, "*Solid State Physics: Structure and Properties of Materials*",3rd edition, Narosa Publishing House, 2021.
2. David J. Griffiths, "*Introduction to Electrodynamics*", 4th edition, Cambridge University Press, 2017.

PH-415 Statistical Mechanics

Review of Classical Thermodynamics: Thermodynamic processes (engines, refrigerators), and phase equilibria.

Foundation of Statistical Mechanics: Phase Space, Trajectories in Phase Space, Specification of the state of a system, Macro and micro states, Conserved Quantities and Accessible Phase Space, Macroscopic Measurements and Time Averages, Ensembles and Averages over Phase Space, Liouville's Theorem, The Ergodic Hypothesis, Equal a priori Probabilities.

Statistical Ensembles: The concept of ensembles, Statistical, Microcanonical, canonical and grand ensemble**),** calculation of mean values, equipartition theorem and examples (ideal gas, harmonic oscillator), calculation of partition function and its relation with thermodynamic quantities**,** *total Partition function.*

Simple Applications of Ensemble Theory: Monoatomic ideal gas in the classical and quantum limit, Gibb's paradox and**,** *Entropy*, the specific heat of solids, quantum mechanical calculation of Para magnetism.

Classical and Quantum Statistics: *Relative population of two states Maxwell-Boltzmann (MB) distribution function Bose-Einstein (BE) distribution, Fermi-Dirac (FD) distribution,* quantum mechanical enumeration of states, polyatomic ideal gas (MB), black body radiation (photon statistics), conduction electrons in metals (FD), Bose condensation (BE), Systems of Interacting Particles, ferromagnets in mean field approximation.

Recomednded Books

Text book(s)

1. Jean Bricmont, "*Making Sense of Statistical Mechanics*", 1st edition, Springer, 2022.
2. Luca Salasnich, "*Modern Physics: Introduction to Statistical Mechanics*", 1st edition, Springer, 2022.

Reference Book(s)

1. Osvaldo Civitarese, Manuel Gadella, "*Methods in Statistical Mechanics: A Modern View*", 1st edition, Springer, 2020.
2. James P. Sethna, "*Statistical Mechanics: Entropy, Order Parameters, and Complexity*", 2nd edition, Oxford University Press, 2021.

PH- 403 Solid State Physics – II

Polarization, Depolarization, Local and Maxwell field, Lorentz field, Clausius-Mossotti relation, Dielectric Constant and Polarizability, Masurement of dielectric constant, ferro electricity and ferroelectric crystals, Phase Transitions, First and 2nd order phase transitions, General properties of semiconductors, intrinsic and extrinsic semiconductors, their band structure, carrier statistics in thermal equilibrium, band level treatment of conduction in semiconductors and junction diodes, diffusion and drift currents, collisions and recombination times, Interaction of light with solids, Optical Properties of Metals and Non-Metals, Kramers-Kronnig Relation, Excitons, Raman Effect in crystals, optical spectroscopy of solids, Magnetic dipole moment and susceptibility, different kinds of magnetic materials, Langevin diamagnetic equation, Paramagnetic equation and Curie law, Classical and quantum approaches to paramagnetic materials. Ferro-magnetic and anti – ferromagnetic order, Curie point and exchange integral, Effect of temperature on different kinds of magnetic materials and applications, Introduction to superconductivity, Zero-Resistance and Meissner Effect, Type I and Type II superconductors, Thermodynamic fields, Tow fluid model, London equations, BCS and Ginzburg – Landau Theory, Vortex Behaviour, Critical Current Density, Josephson effect and applications.

Recommended Books:

1. M. Fox, "Optical Properties of Solids", Oxford University Press, 2nd ed. 2010.

2. N. A. Spaldin, “Magnetic Materials: Fundamentals and Device Applications”, Cambridge University Press, 2nd ed. 2010.
3. C. Kittle, “Introduction to Solid State Physics”, John Wiley, 8th ed. 2005.

Fourth Year

PH-308 Quantum Mechanics-II

One Electron System: The Schrodinger equation in Spherical co-ordinates, central potential, separation of variable, radial equation, hydrogen wave function.
Addition of Angular Momenta: Total angular momentum in quantum mechanics, the addition of two arbitrary angular momenta, Clebsch-Gordon coefficients, coupling of orbital and spring angular momenta.
Approximation methods in Quantum Mechanics: Time-independent perturbation theory for non-degenerate and degenerate levels, the variational method, the WKB approximation, Application of the approximation methods to simple cases, time-dependent perturbation theory, linear and non-linear response of a two-level system subjected to a sinusoidal perturbation.
Identical Particles: Indistinguishably of identical particles, systems of identical particles, quantum dynamics of identical particle systems, statistics, symmetry of states, fermions, bosons.
Basics of Quantum Computing: Quantum bits, Bell states, Bloch sphere, Quantum gates.

Theory of Scattering: Scattering experiments and cross sections, potential scattering, the method of partial waves, the Bornn’s approximation **Recommended Books:**

1. Nouredine Zettili, “*Quantum mechanics: concept and application*”, 3rd edition, Wiley, 2022.
2. Bernhardt, Chris., "*Quantum computing for everyone*”, MIT Press, 2019.

Reference Book(s)

1. Richard L Liboff, “*Introductory Quantum Mechanics*”, 4th edition, Addison- Wesley, 2022.

PH-312 PHYSICS LAB VI

Experiments in Atomic and Molecular Physics, Nuclear Physics, and Computational Physics will be conducted, encompassing topics namely, concept of discrete energy level, radioactive decay process, numerical method related to root finding, integration, ODE solution, comparison of Poisson and Gaussian distribution.

Recommended Books:

1. Laboratory Workbook for Physics Lab-VI.

Reference Book(s)

1. Raymond Serway, Clement Moses ,Curt Moyer, “*Modern Physics”*, 6th edition, W. H. Freeman, 2012.
2. Clough, David E, Steven C. Chapra, “*Introduction to Engineering and Scientific Computing with Python*”, CRC Press, 2022.

PH-409 Atomic and Molecular Physics

One Electron System, Fermi Golden rule, Quantum numbers, Atoms in radiation field,

Radiative transitions, Einstein coefficients, Selection rules, normal Zeeman effect, Stark effect, Hyperfine structure. Many body Systems, Periodic system of the elements, Stern Gerlach experiment, Spin orbit coupling, Central field approximation, Hartree Fock methods and self consistent field, Thomas Fermi potential, LS coupling, jj coupling and other type of coupling, X-ray spectra. Interaction with field, Many electron atoms in an electromagnetic field, Anomalous Zeeman effect, Paschen back effect, Stark effect. Molecules, Ionic and covalent bonding, Diatomic molecules rotational, vibrational, and electronic spectra; Born Oppenhimer approximation, Transition probabilities of diatomic molecules, electron spin and Hund's cases, Polyatomic molecules (brief introduction), Raman effect, Hydrogen Molecular ion (LCAO approximation), Hydrogen molecule (Heitler London and molecular orbital theories)

Recommended Books:

1. W. Demtroder, "Atoms, Molecules and Photons", y, Springer, 2nd ed. 2010.
2. B. H. Bransden and C. J. Joachain, "Physics of Atoms and Molecules", Pearson Education, 2nd ed. 2008.
3. C. J. Foot, "Atomic Physics", Oxford University Press, 2005. 4. J. M. Hollas, "Basic Atomic & Molecular Spectroscopy", John Wiley, 2002.

PH-417 Nuclear Physics

Properties of Nucleus, Nuclear size, nuclear mass, Binding energy, Magnetic dipole and electric quadrupole moment, Parity and statistics, nuclear forces, nuclear spin, Charge independence and spin dependence of nuclear force, MRI (Magnetic resonance imaging) Principle and working. Nuclear Models, Liquid drop model, Shell model, Collective model, Fermi gas Model. Nuclear Decay, Nuclear decay, nuclear equilibrium, Transient equilibrium, Permanent equilibrium, Alpha decay, Beta decay, Neutrino hypothesis. Nuclear reactions, Q values and threshold energy of nuclear reaction, Cross sections for nuclear reactions, Direct reaction, Resonance reaction. Radiation Detectors, Scintillators, Geiger Muller counter, Bubble chamber, Cloud chamber.

Recommended Books:

1. B. Povh, K. Rith, C. Scholtz, F. Zetsche, "Particle and Nuclei", 1999.
2. Green, "Nuclear Physics", McGraw Hill, 1995.
3. K. S. Krane, "Introducing Nuclear Physics", John Wiley, 3rd ed. 1988. 4. Kaplan, "Nuclear Physics", Addison-Wisely, 1980. 5. E. Segre, "Nuclei and Particles", Bejamin-Cummings, 2nd ed. 1977.

PH-418 Computational Physics

Computer languages: A brief Introduction to computer languages and known software packages of computation.

Errors: Error analysis and technique for elimination of systematic and random errors, determination of relative true error and relative approximate error in numerical methods.

Numerical Methods: Bracketing and open methods to find root of equation, solution of linear algebraic equations, regression and interpolation, Newton's divideddifference and Lagrange interpolation technique, the trapezoidal and Simpson's rules for

numerical integration, differentiation, numerical methods for solutions of ordinary differential equation (ODE).

Modeling & Simulations: Conceptual models, the mathematical models, Random numbers and random walk, Doing Physics with random numbers, Computer simulation, Relationship of modeling and simulation

.

Modeling of Physical Systems: Motion of falling objects, projectile motion, oscillatory motion, planetary motion, many particle systems, dynamic systems, wave phenomena, Field of static charges and current, Diffusion, Populations genetics.

Recommended Books(s)

1. Sujaul Chowdhury, "*Computational Physics"*, American Academic Press, 2021.
2. Omair Zubairi, Fridolin Weber, "*Introduction to Computational Physics for Undergraduates"*, IOP, 2018.
3. Steven C. Chapra; Raymond P. Canale, "Numerical Methods for Engineers" 8th edition, McGraw Hill. 2021
4. Clough, David E, Steven C. Chapra, "*Introduction to Engineering and Scientific Computing with Python*", CRC Press, 2022.

MG-481 Entrepreneurship

Understanding the Entrepreneurship Mind-Set: The revolution impact of Entrepreneurship; The individual Entrepreneurship Mind-set; Corporate Entrepreneurship Mind-set; The Social and Ethical perspective of Entrepreneurship.

Conceptualizing Entrepreneurship: Definitions and perspective; Four dimensions of an entrepreneurship venture-individuals, organization, environmental and process.

Formulation of Entrepreneurship: The assessment of function with opportunities; The marketing aspects of new ventures; Financial statements in new ventures; Business plan preparation for new ventures.

Launching Entrepreneurship Ventures: Creativity and innovations; Methods to initiate ventures; Legal challenges in Entrepreneurship; The search for Entrepreneurship.

Strategies perspectives in Entrepreneurship: Strategies growth in Entrepreneurship; Valuation challenges in Entrepreneurship; Final harvest of a new venture.

RECOMMENDED BOOKS

1. Introduction to Entrepreneurship by Donald F. Kuratko 2. The

Entrepreneurial Mindset by McGrath R. G. & McMillan I.

ELECTIVE COURSES:

PH-413 Surface Sciences

Basic of Surface Sciences: Surface reactions, adsorption phenomena, Heterogeneous catalysis, Semiconductor technology, Corrosion, Nanotechnology, Surface Structure and *Classification of solids*, *Crystal structure, Unit cell, Bravais*

lattices, the Band structure of metals, insulators and semiconductors, Fermi level, Screening, Work Function, Surface States, Electron Affinity, Ionization Potential, Surface Chirality, Thermodynamics of Surfaces, Equilibrium Crystal Shape. **Quantum Confinement of Electrons at Surfaces:** Nucleation and growth of nanostructures and films, Surface Magnetism and magnetic imaging, *Diamagnetism, Para magnetism, Anti-*
Ferromagnetism, Magnetism in
thin films.

Microscopic and Spectroscopic Techniques: Kerr microscopy (MOKE), Spin-Polarized Photoemission (SP-PEEM), Magnetic Force Microscopy (MFM), Surface Study Techniques and comparison of Low-Energy Electron Diffraction (LEED) and Reflection, High-Energy Electron Diffraction (RHEED), Near-Edge Xray Absorption Fine Structure (NEXAFS), High-Resolution Electron Energy Loss Spectroscopy (HREELS), Desorption Techniques, Electron Spectroscopy, mean free path, Koopman's Theorem, Spin-orbit coupling effects, chemical shifts, binding energy, Electron Analyzer, Electron optics, Scanning Tunneling Microscopy (STM).

Applications: Silicon Surfaces, Molecular Adsorption on Semiconductor Surfaces, Adsorption Properties of CO on Metal Single-Crystal Surfaces, Molecular or dissociative adsorption, Chemical bonding, and Orientation, Adsorption Site as a function of coverage, Overlayer long- range order, Ammonia Synthesis

Recomended Books:

1. Mario Rocca, Talat Rahman ,Luca Vattuone, "*Springer Handbook of Surface Science*", Springer, ·2021.
2. .Kurt W. Kolasinski, "*Surface Science: Foundations of Catalysis and Nanoscience*", 4th edition, Wiley, 2019.

PH-313 Cosmology and Theory of Relativity

Theory of relativity: Galilean Relativity, the Concept of ether, the Michelson-Morely Experiment, Einstein's Postulates of Special Theory of Relativity, Lorentz Transformations, Minkowskian geometry of space-time, Four-dimensional space-time, Light-cone, the relativity of simultaneity, Time dilation, Length contraction, Mass variation, Twin paradox, Velocity transformation and velocity addition, Relativistic Mechanics, the variational principle for free particle motion, light rays, Principles of General Theory of Relativity, The curved space-time of general relativity, metric coordinate transformations, Equation of geodesics.

Cosmology: Einstein's field Equation, Cosmology Newtonian Cosmology, Hubble's Law*, locally inertial and Riemann normal co-ordinates,* Expansion of the Universe, Cosmic Microwave Background Radiation, and Big Bang model of the Universe, *Big Bang vs Inflation.*

Tensor Applications: *Tests of general relativity models, black holes, cosmological models.* **Introduction of Space Science:** Introduction of Space Science Introduction, formation and types of Galaxies, Milky Way Galaxy, Types and properties of stars, Nebulae and Supernova, Solar system models, Sun, Planets, Moon, Comet and Asteroids, planetary orbits, Atmosphere of planets and Magnetosphere.

Recommended Books:

1. Nicola Vittorio, "*An Overview of General Relativity and Space-Time*" 1st edition, CRC Press, 2022.
2. Bernard Schutz, "*A First Course in General Relativity*",3rd Edition, Cambridge University Press, 2022.

PH-420 Nanotechnology and Nano Sciences

Introduction: Feynman talks on small structures, Nano scale dimension,

Surfaces and Interfaces: Interfaces, Surface chemistry and physics, Surface modification, Thin Films, Sputtering, Self-assembled films. Single-walled and multiwalled carbon nanotubes, and their applications.

Material Properties: Subatomic physics to chemical systems, types of chemical bonds. **Synthesis Nano Materials:** Top-Down and Bottom-Up approaches, Sol-gel, Hydrothermal and other methods, Lithography (photo and electron beam), MBE, Self-assembly, FIB, Stamp technology, Nano junctions.

Characterization Techniques:

Electron Microscopy (STM, AFM, SEM and TEM), Fluorescence methods, Synchrotron Radiation, XRD, VSM.

Electrons in Nano Structures: Single electron transistor, Resonant tunneling,

Applications: Silicon Surfaces, Molecular Adsorption on Semiconductor Surfaces, Adsorption Properties of CO on Metal Single-Crystal Surfaces, Molecular or dissociative adsorption, Chemical bonding, and Orientation, Adsorption Site as a function of coverage, Overlayer long- range order, Ammonia Synthesis

Recomended Books:

3. Mario Rocca, Talat Rahman ,Luca Vattuone, "*Springer Handbook of Surface Science*", Springer, ·2021.
4. .Kurt W. Kolasinski, "*Surface Science: Foundations of Catalysis and Nanoscience*", 4th edition, Wiley, 2019.

PH-421 Vaccum Science

Vacuum Science: Importance of vacuum, Pressure and molecular density, Adsorption, Desorption, Diffusion and Permeation, Gas-Solid Interactions, Flow Regime, Conductance, Vacuum Pump Technologies, and its parameters, detecting leaks in vacuum systems, Valves and Seals for high and ultra-high vacuum, Gas Load, Effects of humidity on vacuum system performance, Outgassing, Surface finishes for vacuum applications, Calculations of ultimate base pressure of a vacuum system.

Vacuum Systems: Chamber Design, Materials for Vacuum, Vacuum Pumps for High and Ultra- High Vacuum Applications Pressure regimes, Types of vacuum pumps and pumping technologies, Wet vs Dry pumps, Pumping speed, Pump throughput, Rotary Vane Pumps, Dry scroll pumps, Diaphragm pumps, Cryo Pumps, Turbomolecular pumps and hybrids, Diffusion pumps, Ion Pumps. Titanium sublimation pumps,

NonEvaporable Getter (NEG) Pumps, Vacuum Gauging and systems, detection of Leaks in Vacuum Systems, Residual Gas Analyzers and Partial Pressure Analyzers.

Applications of Vacuum: Thin film deposition technologies, Thin Film Growth Models, Effects of Deposition Conditions on Film Characteristics, Enhanced Deposition Techniques, Atomic Layer Deposition (ALD), Thin film growth models, Enhanced Reactivity of Precursors and Carrier Gases, Alternative Pulse Regimes, Impact of the ALD Process on Balance-of-Plant and its applications, Sealing techniques and system components, Actuation mechanisms, Configurations, Fine control gas admission systems, Mass flow controllers.

Recommended books

1. Pramod K. Naik, "*Vacuum: Science, Technology and Applications*", 1st edition, CRC Press, 2020.
2. J.R. Gaines, Matthew Healy, "*Fundamentals of Vacuum Science and System Design for High and Ultra-High Vacuum*", 1st edition, Elsevier, 2023.

PH-422 Plasma Physics

Introduction to Plasma: Occurrences of plasma in nature, Plasma conditions, Plasma Confinement, Debye shielding, Criteria for plasma.

Characteristic Parameters of Plasma: Number density and temperature, Debye length, plasma frequency, cyclotron frequency, Collision frequency, number of electrons per Debye cube, de- Broglie wavelength, quantum effects.

Single Particle Motion Model: Uniform and non-uniform electric and magnetic field, Time varying electric and magnetic fields, Adiabatic invariants.

Plasma Fluid Model: Fluid equation of motion, convection derivative, Stress tensor, collision, comparison with ordinary hydrodynamics, equation of continuity, equation of state.

Controlled Fusion: Introduction to controlled fusion, Basic nuclear fusion reaction, Reaction rates and power density, Radiation losses from plasma, Operational conditions.

Recommended Books:

1. Richard Fitzpatrick, "*Plasma Physics: An Introduction*", 2nd edition, CRC Press, 2022.
2. Francis F. Chen, "*Introduction to Plasma Physics and Controlled Fusion*", 3rd edition, Springer, 2016
3. Donald A. Gurnett, Amitava Bhattacharjee, "*Introduction to Plasma Physics: With Space, Laboratory and Astrophysical Applications*", 2nd edition, Cambridge University Press, 2017

PH-419 Fundamentals of Medical Physics

Basic Terminologies: Historical Review, Radiobiology, Role of Medical Physicist and Medical Technologists in current medical facilities.

Radiation-related Units: Radiation Exposure, Radiation dose, the Radiation dose to different mediums, Kinetic Energy Released Per Unit Mass (KERMA), Radiation Quality and Quantity.

Radioactivity and Radiation-related Instruments: Radioactivity, Half-life, Radioactive radiation sources, X-Ray, Linear Accelerator, Cobalt 60 (Co 60), Brachytherapy, Nuclear Medicine, Computed Tomography (CT) scan, Magnetic Resonance Imaging (MRI), Dose measurement, Ionization Chambers, Dose measurement instruments.

Biological Effects of Radiation: Harmful effects of radiation, Radiation protection, As Low As Reasonably Achievable (ALARA) principle, Rem, Sievert, Dose Equivalent, Effective dose equivalent.

Radiation Measurement Instrument: Exposure limits for the public and workers, Radiation exposure monitoring devices, Film badges, Pocket dosimeters, and ThermoLuminescent Dosimeters (TLDs).

Recommended Books

1. Stephen Frederick Keevil, Cornelius Lewis, Anthony Greener, "*Introduction to Medical Physics*", 1st edition, CRC Press, 2022.
2. Debbie Peet, Emma Chung, "*Practical Medical Physics: A Guide to the Work of Hospital*", 1st edition, CRC Press, 2021.

MY-402 Advance Materials

Survey and classification of materials according to electronic, magnetic, and optical properties. Classification of materials according to magnetic properties, origin of magnetic moment of atoms, theories of all types of magnetism. Magnetization curves, hysteresis, magnetic domains, domain walls, methods of observations of domains, soft magnetic materials, hard magnetic materials, powder magnets. Materials for semiconductor devices and VLSI. Thin film technology, metalization, packaging, opto-electronic devices, and solar cells.

PH-424 Essentials of Health Physics

Ionizing Radiation Detectors: Basic principles of radiation detection, Ionization chambers, Proportional and Geiger-Muller counters, and Scintillation detectors.

Radiation Spectroscopy: Radiation spectroscopy using scintillation detectors; Semiconductor detectors, CdZnTe detectors, and Neutron detection techniques.

Safety Standards for Ionizing Radiation Exposure: Radiation quantities & units, Safety standards for medical exposure, Estimation and control of external & internal exposure hazards, Absorbed dose estimation from external exposure, and Shielding.

Radiation Dose Estimation Models and Calibration: Design of neutron and gamma sources, Dose estimation from internally deposited radionuclides, International Atomic Energy Agency safety regulations for the transport of radioactive materials, Radiation accident management & early medical treatment of radiation injury, Calibration of survey meters.

Shielding Design of Radiation Facility and Radioactive Waste Management: Shielding and other design considerations for medical facilities, Regulatory and licensing requirements for medical facilities, and Radioactive waste disposal methods.

Recommended Books:

1. Kirsten Franklin, Paul Muir, Terry Scott, Paul Yates, "*Introduction to Biological Physics for the Health and Life Sciences"*, 2nd edition, Wiley, 2019
2. John P. Gibbons*,"Khan's The Physics of Radiation Therapy", 6th edition*, Lippincott Williams & Wilkins (LWW), 2019

PH- 425 MICROWAVE SYSTEM:

Plane Waves: Wave equation, Poynting theorem, Plane wave propagation in different media. Reflection, Refraction, Scattering, Absorption, and diffraction.

Smith Chart and Scattering Parameters: Smith chart theory and applications, Smith chart Impedance, Admittance manipulation on the chart, Reflection coefficient, Impedance of distributed circuits, Impedance matching, and S-Parameters.

Microwave Passive Devices: Coupled Quasi-TEM Lines, The Directional Coupler, Interference Couplers, Power Combiners and Dividers.

Microwave Active Devices: Bipolar and field effect transistors, Varactors, Step recovery diodes, Multipliers, Parametric amplifiers, Tunnel diodes, Negative resistance amplifier, Gunn effect, Avalanche effect diode, Klystron, Magnetron, and traveling wave tube.

Recommended Books: 1. Subhash Chandra Bera, *"Microwave Active Devices and Circuits for Communication"*, 1st edition, Springer, 2019

2. Cameron, Richard J, Chandra M Kudsia, and Raafat R Mansour "*Microwave filters for communication systems: fundamentals, design, and applications"*, 2nd edition, John Wiley & Sons, 2018

PH-426 Essential of Quantum Field Theory

Preliminary Concepts: Nonrelativistic quantum mechanics, Lorentz covariance, Klein-Gordon equation, Feynman-Stuckelberg solutions, Nonrelativistic perturbation theory, Scattering amplitude.

Lagrangian Field Theory: Classical field theory, Canonical quantization, Noether's theorem.

Klein-Gordon Field: Real Klein-Gordon field, Complex Klein-Gordon field, Covariant commutation relations, Meson propagator.

Dirac Field: Number representation for fermions, Quantization of Dirac field, Spin-statistics theorem, Fermion propagator.

Electromagnetic Field: Classical electromagnetic field, Covariant quantization, Photon propagator.

Interacting Fields: Interaction Lagrangian and gauge invariance, Interaction picture, S-matrix expansion, Wick's theorem, Feynman diagrams, Feynman rules for Quantum electrodynamics (QED), Cross sections and decay rates. **Recommended Books:**

1. Jakob Schwichtenberg, "*No-Nonsense Quantum Field Theory: A Student-Friendly Introduction*", No-Nonsense Books, 2020 2. Tom Lancaster, Stephen J. Blundell, "*Quantum Field Theory for the Gifted Amateur*", Oxford University Press; Illustrated edition, 2014

PH-427 Dielectric Materials

Dielectrics in Electrostatics: Electric dipole moment and the electric polarization mechanisms, Perfect and a real dielectric, bound charge densities, Polarization current density, Local field, Electric susceptibility, Electric displacement D, Electric permittivity, Molecular polarizability and Clausius-Mossotti equation, Langevin equation, Dielectrics in time-varying electric fields, Response of a dielectric in time and frequency domain, Kramers-Kronig relations, Dispersion.

Theories for Interpretation of Data: Debye model, DRT, Power law, Universal response, Lowfrequency dispersion, Maxwell-Wagner response, Diffusive model, Many body phenomena, Local field theory.

Measuring Techniques: Frequency and time domain techniques, DC measurements, DC potential probing, Resonance method, Phase method, Schering bridge, Optical methods.

Analysis of Dielectric Measurements: Impedance spectroscopy, Admittance spectroscopy, Cole-Cole plot, Cole Davidson plot, Normalization of dielectric data, Arrhenius plot, Experimental results on different materials. **Recommended Books:**

1. Evgenij Barsoukov, J. Ross Macdonald, "*Impedance Spectroscopy: Theory, Experiment, and Applications*", Wiley, 2018.
2. ByGorur Govinda Raju, "*Dielectrics in Electric Fields*", 2nd edition, Taylor & Francis, CRC, 2016

PH-428 Renewable Energy Sources

Significance of Alternative Sources of Energy: Limitation of fossil fuels, Need for renewable energy, Renewable energy resources, and their sustainable development, Potentials, and possibilities.

Solar Energy: Solar energy its importance, Solar cell, Photovoltaic (PV) systems and characteristics, Sun tracking systems.

Wind Energy: Fundamentals of wind energy, Wind turbines, and different electrical machines in wind turbines.

Tidal Energy: Ocean energy potential against wind and solar, Wave energy devices, Tide energy technologies, Ocean thermal energy, Osmotic power, and Ocean bio-mass.

Geothermal Energy: Geothermal resources, Geothermal technologies, Liquid-dominated plants, Enhanced geothermal systems.

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydropower sources.

Other Sources of Alternate energy: Biomass, Biochemical conversion, Biogas generation.

Recommended Books:

1. John Twidell, "*Renewable Energy Resources*", 4th edition, Routledge, 2021.
2. Martin Stutzmann, Christoph Csoklich, "*The Physics of Renewable Energy*", 1st edition, Springer, 2023

PH-429 Environmental Physics

Essentials of Environmental Physics: Economic system, Living in the greenhouse, Enjoying the sun, Transport of Matter, Energy, and momentum.

Basic Environmental Spectroscopy: emission spectrum of the sun, Transition electric dipole moment, Einstein coefficients, Lambert – Beer's law, Spectroscopy of bi-molecules, Solar UV and life, Ozone filter.

The Global Climate: Energy balance, Zero-dimensional greenhouse model, Elements of weather and climate, Climate variations and modeling.
Noise: Basic acoustics, Human perceptions, and noise criteria, Reducing the transmission of sound, Active control of sound.

Radiation: General laws of radiation, natural radiation, Interaction of electromagnetic radiation and plants, Utilization of photosynthetically active radiation.

Atmosphere and Climate: Structure of the atmosphere, Vertical profiles in the lower layers of the atmosphere, Lateral movement in the atmosphere, Atmospheric circulation, Cloud and precipitation, Atmospheric greenhouse effect, Climatology, and measurements of climate factors.

Recommended Books:

1. Robert Zakinyan, Arthur Zakinyan, "*Physics of the Atmosphere, Climatology and Environmental Monitoring: Modern Problems of Atmospheric Physics, Climatology and Environmental Monitoring*", 1st edition, Springer, 2023

PH-430 Optoelectronic Devices

Excitation and Emission processes: Radiative and non-radiative process, energy-momentum diagram, direct and indirect band transitions.

Photovoltaics: Solar radiation and air mass, Photovoltaic effect and solar cells, I-V characteristics, Solar cell classifications and materials, Arrays, and modules.

Lasers: Necessary requirements for laser production, Classes of lasers, Doped insulator lasers, Gas lasers, Liquid lasers, Semiconductor lasers, Semiconductor laser structures, Homojunction lasers, Hetero junction lasers, Quantum well lasers.

Photodiodes: Principle of optical detection, Quantum efficiency and responsitivity, Photodetectors, P-N junction, Positive-Intrinsic-Negative diode (PIN) and materials, Schottky and avalanche photodiodes, Phototransistor.

Light Emitting Diodes: Optical processes in semiconductors, Electroluminescence, Internal quantum efficiency, Critical angle, Optical efficiency.

Optoelectronic Integration: Hybrid and monolithic integration, Applications of optoelectronic integrated circuits.

Recommended Books:

1. **Naci Balkan, Ayşe Erol, "*Semiconductors for Optoelectronics: Basics and Applications*", 1st edition, Springer, 2021**
2. Safa Kasap, "*Optoelectronics & Photonics: Principles & Practices*", 2nd edition, Pearson, 2