Scheme of Studies for BS Physics Programme (Batch-2025 and Onward)

SCHEME OF STUDIES FOR BS PHYSICS (BSPH)

FIRST-YEAR

FALL SEMESTER					SPRING SEMESTER				
COURSE CODE	COURSE TILE	CREDIT HOURS			COURSE CODE	COURSE TILE	CREDIT HOURS		
		Th	Pr	Total			Th	Pr	Total
PH-131	Introductory Mechanics	3	1	4	PH-133	Waves and Optics	3	1	4
PH-132	Electricity and Magnetism	2	1	3	ES-105/ ES-127	Pakistan Studies/ Pakistan Studies (For Foreigners)	2	0	2
EA-128	Functional English	3	0	3	AF-101	IT Fundamentals and Applications	2	1	3
ES-108	Ideology and Constitution of Pakistan	2	0	2	MT-102	Quantitative Reasoning-II	3	0	3
ES-206/ ES-209	Islamic Studies/ Ethical Behaviour (For Non-Muslims)	2	0	2	MT-116	Calculus and Analytical Geometry	3	0	3
MT-101	Quantitative Reasoning-I	3	0	3					
MT-100	Introduction to Mathematics (For Pre Medical students)	-	-	NC					
	Total	**15**	**2**	**17**		**Total**	**13**	**2**	**15**

SECOND-YEAR

FALL SEMESTER					SPRING SEMESTER				
COURSE CODE	COURSE TILE	CREDIT HOURS			COURSE CODE	COURSE TILE	CREDIT HOURS		
		Th	Pr	Total			Th	Pr	Total
PH-208	Heat and Thermodynamics	2	1	3	PH-205	Classical Mechanics	3	0	3
CT-175	Programming Fundamentals	3	1	4	PH-209	Modern Physics	3	1	4
EL-232	Electronics	3	1	4	PH-303	Mathematical Physics-I	3	0	3
EA-244	Academic Reading and Writing	3	0	3	EL-238	Digital Electronics	3	1	4
MT-221	Linear Algebra & Ordinary Differential Equations	3	0	3	MG-485	Entrepreneurship	2	0	2
					AF-201	Civics & Community Engagement	2	0	2
					AF-200	Community Service	-	-	NC
	Total	**14**	**3**	**17**		**Total**	**16**	**2**	**18**

Scheme of Studies for BS Physics Programme (Batch-2025 and Onward)

THIRD-YEAR									
FALL SEMESTER					**SPRING SEMESTER**				
COURSE CODE	**COURSE TILE**	**CREDIT HOURS**			**COURSE CODE**	**COURSE TILE**	**CREDIT HOURS**		
		Th	**Pr**	**Total**			**Th**	**Pr**	**Total**
PH-301	Quantum Mechanic-I	3	0	3	PH-304	Electromagnetic Theory-I	3	0	3
PH-306	Statistical Mechanics	3	0	3	PH-316	Condensed Matter Physics	3	0	3
PH-307	Mathematical Physics-II	3	0	3	PH-317	Atomic and Molecular Physics	2	1	3
PH-314	Principles of Scientific Inquiry	3	0	3	PH-318	Introduction to Astronomy	3	0	3
PH-315	Nuclear Physics	2	1	3	PH-419	Fundamentals of Medical Physics	3	0	3
CT-262	Introduction to Artificial Intelligence	2	1	3	MG-110	Fundamentals of Management	3	0	3
					EA/ES###	Foreign Language-I	-	-	NC
	Total	**16**	**2**	**18**		**Total**	**17**	**1**	**18**

FOURTH-YEAR									
FALL SEMESTER					**SPRING SEMESTER**				
COURSE CODE	**COURSE TILE**	**CREDIT HOURS**			**COURSE CODE**	**COURSE TILE**	**CREDIT HOURS**		
		Th	**Pr**	**Total**			**Th**	**Pr**	**Total**
PH-308	Quantum Mechanics-II	**3**	**0**	**3**	PH-429	Environmental Physics	**3**	**0**	**3**
PH-309	Electromagnetic Theory-II	**3**	**0**	**3**	PH-431	Computational Physics	**3**	**1**	**4**
PH-407	Physics Design Project	**0**	**3**	**3**	PH-407	Physics Design Project	**0**	**3**	**3**
PH-###	Elective-I	**3**	**0**	**3**	PH-###	Elective-III	**3**	**0**	**3**
PH-###	Elective-II	**3**	**0**	**3**	PH-###	Elective-IV	**3**	**0**	**3**
EA/ES-###	Foreign Language-II	**-**	**-**	**NC**					
	Total	**12**	**3**	**15**		**Total**	**12**	**4**	**16**
						Grand Total			**134**

Scheme of Studies for BS Physics Programme (Batch-2025 and Onward)

ELECTIVE COURSES*									
		Credit Hours					Credit Hours		
Course Code	Course Title	Th	Pr	Total	Course Code	Course Title	Th	Pr	Total
PH-302	Laser Engineering	3	0	3	PH-424	Fundamentals of Health Physics	3	0	3
PH-310	Solid State Physics-I	3	0	3	PH-425	Microwaves Systems	3	0	3
PH-313	Cosmology and Theory of Relativity	3	0	3	PH-426	Fundamentals of Quantum Field Theory	3	0	3
PH-403	Solid State Physics-II	3	0	3	PH-427	Dielectric Materials	3	0	3
PH-411	Applications of Space Physics	3	0	3	PH-428	Renewable Energy Sources	3	0	3
PH-420	Nanoscience and Nanotechnology	3	0	3	PH-430	Optoelectronic Devices	3	0	3
PH-421	Vacuum Science	3	0	3	PH-432	Materials Science	3	0	3
PH-422	Plasma Physics	3	0	3	PH-433	Fundamentals of Quantum Computing	3	0	3
PH-423	Surface Science and Applications	3	0	3					

** Offering is subject to the department's discretion.*

Foreign Language-I		Foreign Language-II	
Course Code	Course Title	Course Code	Course Title
EA-220	Chinese Language-I	EA-221	Chinese Language-II
EA-231	Turkish Language-I	EA-232	Turkish Language-II
EA-224	German Language-I	EA-225	German Language-II
EA-226	French Language-I	EA-227	French Language-II
ES-222	Arabic Language-I	ES-223	Arabic Language-II
EA-233	Japanese Language-I	EA-234	Japanese Language-II
EA-235	Russian Language-I	EA-236	Russian Language-II

Scheme of Studies for BS Physics Programme (Batch-2025 and Onward)

FIRST-YEAR

PH-131 Introductory Mechanics:

Basic Concept: Review of vector algebra and vector calculus.
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's 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 Non-Conservative 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.
Elasticity and Fluid Mechanics: 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.

Recommended book(s):

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 (Sears and Zeemansky), *"University Physics with Modern Physics"*, 15th Edition, Pearson, 2019.

Reference Book(s)

1. RC Brown, *"Mechanics and Properties of Matter"*, Hassell Street Press, 2023.

PH-132 Electricity & Magnetism:

Electrostatic: Electric Charge, Conductors and Insulators, Coulomb's Law, Electric Fields due to a Point Charge, 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, Capacitors in Series and Parallel, Energy Stored in Capacitors.
DC Circuits: Electric Current and Current Density, Resistance and Resistivity, Ohm's Law, Resistances in Series and Parallel, Circuit analysis rules and theorem**,** RC Circuits, Charging and Discharging of Capacitor.
Electromagnetic Induction: Inductance, Faraday's Law of Induction, Lenz's Law, Self- Inductance, RL Circuits.
Alternating Fields and Currents: Alternating Currents Circuit theory, Resonant circuits, Power in AC Circuits, Transformers, AC Bridges.
Magnetostatics: Magnetic force, Biot-savart law and its application, Ampere's circuital law and its application.

Recommended book(s):

Text book(s)

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

Reference Book(s)

1. V. K. Sachan, *"Electricity and Magnetism"*, KDP Print, 2020.
2. F. Kelly, *"Electricity and Magnetism"*, 1st edition, CRC Press, 2021

PH-133 Waves and Optics:

Oscillations: Definition, equation of motion, energy considerations. Types of damping, equation of damped motion. Concept of driving force, amplitude response, and resonance phenomenon. Application of oscillation.
Waves: Types of waves, Transverse and longitudinal waves. General wave equation, traveling and standing waves. Definitions and physical significance of Phase and group velocity. Electromagnetic Waves. Doppler's effect explanation, formula derivation, and applications in sound and light.
Geometrical Optics: Wave fronts, laws of reflection and refraction. Lens formula, magnification, Newtonian equation for a thin lens. Simple magnifiers, microscopes, and telescopes. Chromatic and monochromatic aberrations, spherical aberrations.
Wave Optics: Two-beam and multiple-beam interference, Michelson interferometer. Fraunhofer diffraction, diffraction grating, resolving power**.** Brewster's law, dichroism, birefringence, John Matrices and production of polarized light**.** Application of optical phenomena, Coherence and holography.
Laser: Basic principles of laser light; properties of laser and physical background of production; laser resonators, mirrors and modes, and types of lasers.

Recommended book(s):
Text book(s)
1. David Halliday, Robert Resnick ,Jearl Walker , *"Fundamentals of Physics"*, 12th edition, Wiley, 2021
2. P. French, *"Vibrations and Waves"*, CBS Publishers 2017

Reference Book(s)
1. A.G. Gurevich, G.A. Melkov, *"Magnetization Oscillations and Waves"*, 2020
2. C. A. Bennett, *"Principles of Physical Optics"*, John Wiley, 2022
3. Pedrotti, Frank L., Leno M. Pedrotti, and Leno S. Pedrotti, *"Introduction to optics"*, Cambridge University Press 2018.

EA-128 Functional English:

Listening skills and subskills
Effective listening techniques: listening for gist, details, and specific information in a range of situations (AV lectures, interviews, documentaries etc.)
Speaking skills
Speaking with fluency and accuracy in a variety of situations including conversations, group discussion, academic and social interaction, public speaking, presentation skills, and interviews Pronunciation improvement exercises (through websites, apps, and in class worksheets)
Reading and subskills
Reading strategies: Skimming, scanning, and detailed reading, identifying main ideas, supporting details, and inferences (multiple genres including newspapers, books, stories, documentaries etc). Reading Practice: Reading comprehension tasks. Reading output tasks (notes, summary, discussion, counter argument etc.)
Study skills
Effective note-taking strategies for lectures, meetings, and reading texts. Taking in varied forms paragraph, lists, infographics etc.) Interpreting instructions oral and written. Effective examination taking technique (comprehending instructions, planning, and writing answers ensuring relevance and precise
Writing skills
Writing process, Pre-writing strategies (Mindmapping, cubing, outlining, clustering etc.) Writing to describe, argue, compare and contrast, persuade through writing prompts. Writing academic and professional genres: emails, letters, short report, resume, cover letter, building profiles on various job portal. Writing accuracy: Identifying and overcoming grammatical problems.
Vocabulary and grammar development
Vocabulary Development strategies. Exposure and practice to develop everyday and academic vocabulary for formal contexts

Recommended book(s):
Reference Books
1. Pauline Cullen, Cambridge Vocabulary for IELTS, 2008, Cambridge University Press
2. Michael Mcarthy & Felicity O'Dell, English Vocabulary in Use (upper intermediate), 2008, Cambridge University Press
3. Academic Listening Encounters: Human Behaviour, 2004, Cambridge University Press
4. Kenneth J Pakenham, Making Connections: A Strategic Approach to Academic Reading, (2nd Ed), 2004, Cambridge University Press

5. Glendining & Holmstrom, Study Reading, (2nd Ed.), 2007, Cambridge University Press
6. Edmond H Weiss, The Elements of International Style: A Guide to Writing Correspondence, Reports, Technical Documents, and Internet Pages for a Global Audience, 2005, Prentice Hall.
7. Osborn, M. & Osborn, S. (2017). Exploring public speaking (4th ed.). Cengage Learning.
8. Rae, J., Skelton, J., Perez, E., & Beseta, S. (2020). Advanced Community College ESL Composition: An Integrated Skills Approach.

ES-108 Ideology and Constitution of Pakistan:

(Currently under Revision)

ES-206 Islamic Studies:

Fundamentals of Islam: Tauheed, Arguments for the Oneness of God; Al-Ambiya-22, Al-Baqarah-163-164, Impact of Tauheed on human life, Place of Man in the Universe: Al Israa/Bani Israil-70; Purpose of creation: Al zariyat-56, Prophethood, Need for Prophet, Characteristics of Prophet, Finality of Prophethood: Al-Imran-79, Al-Hashr-7, Al-Maidah-3, and Faith in Hereafter (Aakhirat), Effects on worldly life: Al-Hajj-5, Al-Baqarah-48, Hadith

Ibadah: Concept of Ibadah, Major Ibadah, Salat, Zakat, Hajj and Jihad. Al-Mu'minun-1-11, Al Anfaal- 60, & Two Ahadiths

Basic Sources of Shariah: The Holy Quran, Its revelation and compilation, the authenticity of the Text, Hadith, Its need, Authenticity and Importance, Consensus (Ijmaa), Analogy (Qiyas)

Moral and Social Philosophy of Islam: The concept of Good and Evil; **A'l e Imran - 110, Al Nahl-125,** Akhlaq-e-Hasna with special reference to **Surah Al-Hujrat, verses 10, 11, 12, 13,** Professional Ethics (Kasb-e-Halal) **Al Taha-81, Al Baqar 188, one hadith.**

Seerat of the Holy Prophet(PBUH):

a) Moral and ethical teachings of the Holy Prophet (PBUH) with special reference to Hajjat-ul-Wida, (Fundamentals of Islam, Social aspects, Economics aspects, political aspects

b). Personal Characteristics: perseverance & trust in Allah, honesty & integrity, simplicity & humility, mercy & compassion, clemency & forgiveness, bravery & valor, generosity, patience.

c) Engagement and communication with collaborators and foes:

Cases Study from Seerah: Charter of Madina, Ghazwa e Khandaq, Treaty of Hudaibya , Ghazwa e Khayber, Najran's Delegation, Victory of Makkah.

d) Social values and rights, (peace & harmony, tolerance, solidarity, collaborations, inclusivity & cohesion)

Case Studies from Seerah: Al –Fudoul Confederacy, Placement of Black stone, charter of Medina, Treaty of Hudaibya)

leadership skills (Vision, communication, negotiation, conflict management, decision making, relationship building, Integrity, positivity, compassion, empathy, loyalty, accountability, confidence, delegation, empowerment, problem- solving, foresightedness, openness, gratitude and justice).

Teaching of Holy Quran: Translation and tafseer of **Surah-e- Fatiha**, and The Selected Section of Sura Al-Furqan verses (63-77), Surah**-e-Luqman** (verses (12-19)).

Nazraah and Tajveed of: Suratul Fatiha, Ayatal Kursi, and last 10 surahs of the Holy Quran. (Ghunnah, Qalqalah, Al-Madd, Noon Sakinah & Tanween Rules).

ES-209 Ethical Behaviour (For Non Muslims):

Nature, Scope and Methods of Ethics: Ethics and Religion, Ethical teachings of World Religions

Basic Moral Concepts: Right and Wrong, Good and Evil

Ethical Systems in Philosophy: Hedonism, Utilitarianism, Rationalism & Kant, Self-Realization Theories, Intuitionism

Islamic Moral Theory: Ethics of Qur'an and its Philosophical basis, Ethical precepts from Qur'an and Hadith and Promotion of Moral Values in Society.

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 book(s):

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 Foreigners):

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

AF-101 IT Fundamentals and Applications:

Fundamentals of IT: Introduction to Information and Communication Technologies (ICT), Components and scope of ICT, ICT productivity tools, Emerging technologies and future trends, Ethical Considerations in Use of ICT Platforms and Tools, Applications of ICT in education, healthcare and finance. Digital citizenship.
Data Representation and Number Systems: Binary, octal, decimal, hexadecimal systems, data representation: characters, numbers, multimedia.
Databases: Fundamentals of databases: organization and storage, introduction to Information Systems (IS) and Management Information Systems (MIS), real world IS and MIS applications.
Data Communication and Computer Networking:
Network topologies, types of network.
Programming Languages: Evolution and structures: syntax, semantics, special purpose vs. general-purpose languages, comparative study of data types, control structures and algorithms, basics of coding, practical problem solving.

Recommended book(s):
Text book(s)

1. Emily Jones, "Fundamentals of Computer Programming", States Academic Press, 2022.
2. Prasun Barua, "Fundamentals of Information and Communication Technology (ICT)", Independently published, 2023.

Reference Book(s)

1. Dr. Shun-Ping Chen, *"Fundamentals of Information and Communication Technologies"*, 1st Edition, Cambridge Scholars Publishing, 2020.
2. Muhammad Misbahudeen, *"The Fundamentals of Programming: Basic Terms and Concepts in Programming for Beginners"*, 2024.

MT-100 Introduction to Mathematics (For Pre-Medical Students):

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-101 Quantitative Reasoning-I:

Numerical Literacy

Number system and basic arithmetic operations; Units and their conversions, area, perimeter and volume; Rates, ratios, proportions and percentages; Types and sources of data; Measurement scales; Tabular and graphical presentation of data; Quantitative reasoning exercises using number knowledge.

Fundamental Mathematical Concepts

Basics of geometry (lines, angles, circles, polygons etc.); Sets and their operations; Relations, functions, and their graphs; Exponents, factoring and simplifying algebraic expressions; Algebraic and graphical solutions of linear and quadratic equations and inequalities; Quantitative reasoning exercises using fundamental mathematical concepts.

Fundamental Statistical Concepts

Population and sample; Graphical presentation of the data; Summarizing data; Measures of central tendency, dispersion and their applications; Rules of counting (multiplicative, permutation and combination); Basic concept of probability; Applications of a priori and relative frequency approach Quantitative reasoning exercises using fundamental statistical concepts.

Recommended book(s):

Text Book(s)

1. C, William Briggs, Using & Understanding Mathematics: A Quantitative Reasoning Approach (7th Edition) Pearson Education, Inc. (2019).

Reference Book(s)

1. Eric Zaslow , Quantitative Reasoning: Thinking in Numbers, Cambridge University Press (2020)
2. Paul A. Calter, Michael A. Calter, Technical Mathematics, John Wiley & Sons, (2011)

MT-102 Quantitative Reasoning-II:

Logic, Logical and Critical Reasoning

Introduction and importance of logic; Inductive, deductive and adductive approaches of reasoning; Propositions, arguments (valid; invalid), logical connectives, truth tables and propositional equivalences; Logical fallacies; Venn Diagrams; Predicates and quantifiers; Quantitative reasoning exercises using logical reasoning concepts and techniques.

Mathematical Modeling and Analyses

Introduction to deterministic models; Use of linear functions for modeling in real-world situations; Modeling with the system of linear equations and their solutions; Elementary introduction to derivatives in mathematical

modeling; Linear and exponential growth and decay models; Quantitative reasoning exercises using mathematical modeling.

Statistical Modeling and Analyses
Introduction to probability models; Basic concept of Normal distribution and Binomial distribution with simple applications, Bivariate analysis, scatter plots; Pearson correlation; Simple linear regression, Concept of statistical Inference in decision making; Chi-square test of association, Quantitative Reasoning exercises using statistical modeling.

Recommended book(s):
Text Book(s)

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", 7th edition, by McGraw-Hill, 2010.
2. C, William Briggs, "Using & Understanding Mathematics: A Quantitative Reasoning Approach" (7th Edition) Pearson Education, Inc. (2019).

Reference Book(s)

1. Eric Zaslow , "Quantitative Reasoning: Thinking in Numbers", Cambridge University Press (2020)

MT-116 Calculus & Analytical Geometry:

Set and Functions:
Define rational, irrational and real numbers; rounding off a numerical value to specified value to specified number of decimal places or significant figures; solving quadratic, and rational inequalities in involving modulus with graphical representation; Definition of set, set operations, Venn diagrams, De Morgan's laws, Cartesian product, Relation, Function and their types (Absolute value, greatest integer and combining functions). Graph of some well-known functions. Limit of functions and continuous and discontinuous functions with graphical representation.
Differential Calculus:
Differentiation and Successive differentiation and its application: Leibnitz theorem. Taylor and Maclaurin theorems with remainders in Cauchy and Lagrange form, power series. 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, extreme values of a function of two variables with and without constraints. Solution of non-linear equation, using Newton Raphson method.
Integral Calculus:
Indefinite integrals and their computational techniques, reduction formulae, definite integrals and their convergence. Beta and Gamma functions and their identities, applications of integration relevant to the field.
Sequence & Series:
Sequence, Infinite Series, Application of convergence tests such as comparison, Root, Ratio, Raabe's and Gauss tests on the behavior of series.
Analytical Geometry:
Review of vectors, scalars and vector products, Three-dimensional coordinate system and equation of straight line and plane and sphere, curve tracing of a function of two and three variables, surface revolutions, coordinate transformation
Complex Number:
Argand diagram, De Moivre formula, root of polynomial equations, curve and regions in the complex plane, standard functions.

Recommended book(s):
Text Book(s)

1. Joel Hass, Christopher Heil, Maurice Weir, Przemyslaw Bogacki, 'Thomas' Calculus', 15th ed., Pearson, 2023.
2. James Stewart, Daniel Klegg, Saleem Watson, 'Calculus', 9 th ed., Cengage Learning, 2020.

Reference Book(s)

1. Howard Anton, 'Calculus', 12th ed., Wiley, 2021.

SECOND-YEAR

PH-208 Heat and Thermodynamics:

Basic Concepts and Definitions in Thermodynamics: Thermodynamic system, Surrounding and Boundaries, Macroscopic and microscopic description of system, Extensive and Intensive properties, Mechanical and Thermal Equilibrium, state, Path, Process, cycle, Zeroth Law of Thermodynamics, Consequence of Zeroth law of Thermodynamics.

Heat and Temperature: Temperature, temperature scales, Kinetic theory of ideal gas, Internal energy of an ideal gas, Equipartition of Energy, Intermolecular forces, ideal and real gases, The Van der Waals equation of state, compressibility factor.

Thermodynamics: 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, Entropy, Entropy in reversible process, Entropy in irreversible process. Entropy and Second law of thermodynamics, Entropy and Probability, Thermodynamic functions, Internal energy, Enthalpy, Gibb's functions, Entropy, Helmholtz functions, Maxwell's relations, TdS equations, Energy equations and their applications, Low Temperature Physics, Joule-Thomson effect and its equations. Thermoelectricity, Thermocouple, Seabeck's effect, Peltier's effect, Thomson effect.

Recommended book(s):

Text book(s)

1. David Halliday, Robert Resnick ,Jearl Walker , *"Fundamentals of Physics"*, 12th edition, Wily, 2021
2. Henry Clyde Foust III, *"Thermodynamics, Gas Dynamics, and Combustion"*, 1st edition, Springer, 2022

Reference Book(s)

1. Pokrovskii, Vladimir, *"Thermodynamics of Complex Systems: Principles and applications*", IOP Publishing, 2020

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.

PH-209 Modern 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 and Radioactive dating, 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 book(s):
Text books

1. R. A. Freedman, H. D. Young, and A. L. Ford, *"University Physics with Modern Physics"*, 15th edition, Pearson, 2019.
2. Kenneth S. Krane, "Modern Physics" 4th edition, Wiley, 2019.

Reference Book(s)

1. Gary N. Felder , Kenny M. Felder, *"Modern Physics"* ,Cambridge University Press, 2022

PH-303 Mathematical Physics-I:

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 Book(s):

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.

EA-224 Academic Reading & Writing:

Introduction to Academic Literacy
Academic reading and writing (Academic v/s non-academic texts). Finding, evaluating, and presenting credible academic sources.
Critical Reading: Identifying main ideas, annotating texts, and analyzing arguments.
Academic Texts: Structure of research proposals, Arguments & Evidence Writing Logical reasoning, integrating evidence, and avoiding fallacies, journal articles, literature review, lab report, policy brief, case study etc.
Academic Writing: Tone, voice, formal vs. informal writing, and structured paragraphs. Academic Vocabulary Development: DisciplineSpecific Academic Vocabulary
Academic Writing Process
Outlining, organizing, and refining essay plans. Writing Introductions: Engaging openings, summarizing key points, and implications.
Synthesizing Research: Connecting multiple sources and writing literature and critical reviews.
Drafting & Revising: Overcoming writer's block, refining drafts, and incorporating feedback. Editing & Proofreading: Improving clarity, grammar, style, and structure. Add attention to technical formatting (e.g., equations, symbols, figures in STEM fields). Citation & Referencing: Using APA or IEEE styles and integrating sources.
Interpreting Visuals: Charts, graphs and tables
Drawing logical conclusions from information contained in graphs, diagrams, pie charts and tables with specific reference to the relevant disciplines and their requirements.

Recommended book(s):
Textbook(s):

1. Bailey, S. (2018). Academic writing: A handbook for international students (5th ed.). Routledge.

Reference Book(s):

1. Gillet, A., Hammond, A., & Martala, M. (2019). English for academic study: Reading and writing source book (4th ed.). Garnet Education.
2. Cassuto, L. (2024). Academic writing as if readers matter. Princeton University Press.

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 andCMOS, 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.

MT-221 Linear Algebra & Ordinary Differential Equations:

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), 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, matrix of linear transformations, eigen value and eigen vectors of a matrix, Diagonolization. Applications of linear algebra in relevant engineering problem.

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 and orthogonal trajectories: Application in relevant Engineering.

2nd and Higher Orders Equations

Special types of IInd 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.

Fourier Series

Periodic functions and expansion of periodic functions in Fourier series and Fourier coefficients: Expansion of function with arbitrary periods. Odd and even functions and their Fourier series; Half range expansions of Fourier series.

Recommended Book(s):

1. Elementary Linear Algebra,Howard Anton,Seven Edition
2. Advance Engineering Mathematics,Erwin Kreyszig,Seven Edition
3. Differential Equation A modeling Perspective,Robert L. Barrelli,1998
4. Introduction to Differential Equation,J. Farlaw G. zill,1994

CT-175 Programming Fundamentals:

Introduction to programming languages, Different generations of Languages (1GL, 2GL, 3GL, 4GL, 5GL), Basic Programming Constructs, Introduction to problem solving, role of compiler and linker, Pre-processor Directives, introduction to algorithms, Basic data types ,Variables, (Local and Global), Constants input/output constructs, Types of Operators (Unary, Binary, Ternary), Relational Operators, Arithmetic Operators, Assignment Operators, Logical Operators, prefix and Postfix Increment and Decrement Operators, Repetition Structures, Loops (FOR, WHILE, DO WHILE), Conditional Structures (If, If-Else, Switch), Break and Continue, Introduction to Arrays, Multidimensional arrays, Functions and Procedures, Function Overloading, how to pass an array to a function (Pass by value and Pass By reference), Introduction to modular programming, string and string operations, Structures, pointers/references, static and dynamic memory allocation, File I/O operations.

Recommended Book(s):

1. "Python 3 Object Oriented Programming", Dusty Phillips, 3rd Edition, 2018, Packt Publishing.
2. "Let us C", Yashavant P. Kanetkar, Jones & Bartlett Publishers, 15th Edition, 2016.

3. Paul J. Deitel and Harvey Deitel," C++ How to Program", 10th Edition, Prentice Hall , 2017.

AF-200 Community Service:

Orientation to Community Service: [Taught component]
Introduction to the concept and practice of community service. Need, objectives and benefits of community service. Foundational theories (educational, undergraduate curriculum, humanities, social science, corporate social responsibility etc.). Tools and skills needed in community service. Contextual examples in community service; case examples. Professional and ethical conduct during community service
Community Service Attachment
Completing 30-35 hours of formal assignment at an organization
Community Service Experience Documentation
Writing a report documenting the experience and submitting it on the prescribed format.

Recommended book(s):
Reference book(s):

1. Soria, K. M., & Mitchell, T. D. (Eds.). (2016). Civic Engagement and Community Service at Research Universities: Engaging Undergraduates for Social Justice, Social Change and Responsible Citizenship. Springer.
2. Butin, D. (2005). Service-learning in higher education: Critical issues and directions. Springer.
3. Crews, R. J. (2002). Higher education service-learning sourcebook. Greenwood Publishing Group.
4. Butin, D. (2012). Service-learning in theory and practice: The future of community engagement in higher education. Springer.
5. Lewis, B. A. (2009). The kid's guide to service projects: Over 500 service ideas for young people who want to make a difference. Free Spirit Publishing.

AF-201 Civics & Community Engagement:

Introduction to Civics and Citizenship: Definition of civics, citizenship and civic engagement, Historical evolution of civics participation, Types of citizenship: active, participatory, digital etc. The relationships between democracy and citizenship
Civics and Citizenship: Concepts of civics, citizenship and civic engagement, Foundation of modern society and citizenship. Types of citizenship: active, participatory, digital etc.
State, Government and Civil Society: Structure and functions of government in Pakistan, The relationships between democracy and civil society, Right to vote and importance of political participation and representation **Rights and Responsibilities:** Overview of fundamental rights and liberties of citizens under constitution of Pakistan 1973,Civic responsibilities and duties, Ethical considerations in civic engagement (accountability, non-violence, peaceful dialogue, civility, etc.)
Community Engagement: Concept, nature and characteristics of community, Community development and social cohesion, Approaches to effective community Engagement, case studies of successful community driven initiatives
Advocacy and Activism: Public discourse and public opinion, role of advocacy in addressing social issues, Social action movements
Digital Citizenship and Technology: The use of digital platforms for civic engagement, Cyber ethics and responsible use of social media, Digital divides and disparities (access, usage, socioeconomic, geographic etc.) and their impact on citizenship
Diversity, Inclusion and Social Justice: Understanding diversity in society (ethnic, cultural, economic, political etc.), Youth, women and minorities' engagement in social development, Addressing social inequalities and injustice in Pakistan, Promoting inclusive citizenship and equal rights for societal harmony and peaceful co-existence.

Recommended book(s):

1. Civics Today: Citizenship, Economics & You by McGraw-Hill Education
2. Citizenship in the Diverse Societies by Will Kymlicka and Wayne Norman
3. Engaging Youth in Civics Life by James Youniss and Peter Levine
4. Digital Citizenship in action: Empowering students to engage in online communities by Kristen Mattson

5. Globalization and Citizenship: In the pursuit of a Cosmopolitan Education by Graham Pike and David Selby
6. Community Engagement: Principles, Strategies, and Practices by Becky J. Feldpausch and Susan M. Omilian Creating Social Change: A Blueprint of a Better World by Matthew Clarke and Marie-Monique Steckel

MG-485 Enterpreneurship:

Introduction to Entrepreneurship; The concept of entrepreneurship, entrepreneurial mindset, social entrepreneurship, and essential entrepreneurial skills;
Initiating entrepreneurial ventures; innovation and creativity, assessment of entrepreneurial opportunities, pathways to entrepreneurial ventures, sources of capital;
Developing the entrepreneurial plan; legal challenges, marketing challenges, financial planning, export orientation, developing an effective business plan;
Growth strategies; strategic entrepreneurial growth through scaling, valuation of entrepreneurial ventures, and harvesting the entrepreneurial venture.

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-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 Book(s):

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

PH-306 Statistical Mechanics:

Review of Classical Thermodynamics Thermodynamic processes (engines, refrigerators), Maxwell relations, phase equilibria. Foundations of Statistical Mechanics, Phase Space, Trajectories in Phase Space, 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. Specification of the state of a system, concept of ensembles, Statistical Ensembles Microcanonical ensemble, canonical ensemble and examples (e.g., paramagnet), calculation of mean values, calculation of partition function and its relation with thermodynamic quantities, the grand canonical ensemble and examples (e.g. adsorption), calculation of partition function and thermodynamic quantities Simple Applications of Ensemble Theory Monoatomic ideal gas in classical and quantum limit, Gibb's paradox and quantum mechanical enumeration of states, equipartition theorem and examples (ideal gas, harmonic oscillator), specific heat of solids, quantum mechanical calculation of Para magnetism, Quantum Statistics Indistinguishability and symmetry requirements, polyatomic ideal gas (MB), black body radiation (photon statistics), conduction electrons in metals (FD), Bose condensation (BE), Systems of Interacting Particles: Lattice vibrations in solids, van der Waals gas, mean field calculation, ferromagnets in mean field approximation.

Recommended Book(s):

1. F. Reif, "Fundamentals of Statistical and Thermal Physics", Waveland PrInc, 2008.
1. W. Brewer, F. Schwabl, "Statistical Mechanics", Springer, 2nd ed. 2006.
2. T. L. Hill, "Statistical Mechanics", World Scientific Publishing Company, 2004.
3. K. Huang, "Statistical Mechanics", John Wiley, 2nd ed. 1987.
4. A.J. Pointon, "Introduction to Statistical Physics", Longman 1967.

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 Levi-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 Book(s):

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-314 Principles of Scientific Inquiry:

Foundations of Scientific Inquiry*:* Introduction to Science and the Nature of Inquiry, History and Philosophy of Science.

The Scientific Method: Steps and Applications, Laws, Theories, and Hypotheses, The Role of Observation and Experimentation Logical Reasoning and Problem-Solving in Science, Understanding Uncertainty and Error in Science, Error Analysis

Experimental Design and Methodology*:* Types of Scientific Investigations (Observational, Experimental, Theoretical), Designing Controlled Experiments, Independent, Dependent, and Control Variables, Sampling Techniques and Representativeness, Measurement and Instrumentation Basics, Calibration and Standardization in Experiments, Reproducibility and Validity of Results, Common Experimental Pitfalls and Biases, Lab Safety and Ethical Considerations, Ethical use of Generative AI.

Data Collection and Management: Techniques for Data Collection (Manual, Automated, Digital Sensors), Recording Observations Accurately, Organizing and Managing Data Sets, Introduction to Spreadsheets and Data Tools

Data Analysis and Interpretation: Descriptive Statistics, Graphical Data Representation, Introduction to Statistical Inference, Understanding Confidence Intervals and p-values, Curve Fitting and Trend Analysis, Identifying Correlations and Causations, Handling Outliers and Anomalies, Dimensional Analysis and Unit Conversions, Basic Data Analysis, Drawing Conclusions from Data. **Communicating Scientific Ideas:** The Structure of Scientific Explanations, Writing Clear and Logical Lab Reports, Creating Effective Visual Aids (Charts, Graphs, and Diagrams), Basics of Scientific Posters and Presentation Design, Explaining Complex Concepts to Non-Experts, The Role of Peer Feedback and Constructive Criticism.

Recommended book(s) :

Text book(s)

1. Leavy, P., *"Research Design: Quantitative, Qualitative, Mixed Methods, Arts-Based, And Community-Based Participatory Research Approaches"*, 2nd edition. Guilford Press, London, 2022.
2. Alasuutari, P., & Qadir, A, *"Introduction to Research Methods: A Beginner's Guide To Quantitative, Qualitative, And Mixed Methods Research"*, Routledge London, 2023.

Reference Book(s)

1. Merriam, S. B., & Tisdell, E. J. (2020). *"Qualitative research: A guide to design and implementation"*, 5th edition, John Wiley & Sons, 2020
2. Creswell, J. W., & Guetterman, T. C., *"Educational Research: Planning, Conducting, and Evaluating Quantitative And Qualitative Research"*, 6th edition. Pearson Publications, 2018.

PH-315 Nuclear Physics:

Properties of the nucleus and nuclear forces: nuclear size, mass, and radius, Binding energy and semi-empirical mass formula, Magnetic dipole and electric quadrupole moments, Parity, statistics, and isobaric spin, nuclear spin and energy levels. Nuclear force nature and theory.

Nuclear Models: Liquid drop model and semi-empirical mass formula, Shell model: magic numbers, closed shells, and spin-orbit interaction, Collective model and nuclear deformations, Fermi gas model.

Radioactive Decay: Laws of radioactive disintegration, Quantum theory of radioactive decay, Alpha decay: quantum theory, angular momentum, parity selection rules, spectroscopy, Beta decay: Fermi theory, neutrino hypothesis, parity violation, double beta decay, Gamma decay: multi- polarity, angular momentum, selection rules, nuclear isomerism and internal conversion.

Nuclear Reactions: Conservation laws in nuclear reactions, Q-values and threshold energy, Cross-sections and energy levels, Direct and resonance reactions, Compound nucleus theory and its limitations, Breit-Wigner formula for nuclear reactions. Nuclear fission and fusion.

Radiation Detection and Measurement: Basic principle of detection, Ionization chamber, proportional counter, and Geiger-Muller counter, Scintillation counters and semiconductor detectors, Bubble chamber and cloud chamber.

Recommended book(s) :

Text book(s)

1. Samuel S. M. Wong, *"Introductory Nuclear Physics"*, 2nd edition, Wiley-VCH, 2024.
2. Alexandre Obertelli and Hiroyuki Sagawa, *"Modern Nuclear Physics: From Fundamentals to Frontiers",* 1st edition, Springer, 2021.

Reference Book(s)

1. K. Heyde, *"Basic Ideas and Concepts in Nuclear Physics: An Introductory Approach",* 3rd edition, CRC Press, 2020.
2. Isao Tanihata, Hiroshi Toki, Toshitaka Kajino, *"Handbook of Nuclear Physics"*, 1st edition, Springer; 2023.

PH-316 Condensed Matter Physics:

Crystal Structure: Fundamental Types of Lattices, Simple crystal structures, Miller indices, Theoretical determination of density from crystal structure, Diffraction of x-rays by crystals, Fourier Analysis of the Basis, Reciprocal lattice vectors, Brillouin zone Interpretation, Determination of cubic structure by XRD.

Electrical Conductivity and Free Electron Fermi gas: Classical free electron theory (Drude Model) of metals, electrical conductivity and Ohm's Law, Matthiessen law, thermal conductivity of metals, Wiedemann-Franz law and Lorentz number, cyclotron frequency, Hall effect.

Lattice Vibrations and Thermal Properties: Vibration of lattice with monoatomic, Classical theory of Specific heat. Einstein and Debye models of specific heat.

Semiconductor Physics: General properties of semiconductors, intrinsic and extrinsic semiconductors, band structure and Fermi Dirac distribution, Carrier statistics in intrinsic and extrinsic semiconductors, variation of conductivity with temperature.

Dielectrics: Types of polarizations, Types of dielectric materials, Measurement of dielectric constant, Dielectric constant and polarizability, Local field and Maxwell field, Claussius-Mossotti equation, AC Polarizability.

Magnetism: Magnetic dipole moment and susceptibility, different types of magnetic materials, Langevin diamagnetic equation. Paramagnetic equation and Curie law, Ferromagnetism, Saturation magnetization, Ferromagnetic Domains and their origin.

Superconductivity: Superconductivity, critical temperature, Meissner effect, Type I and Type II superconductors, BCS theory of superconductivity.

Recommended book(s):

Text book(s)

1. Saurabh Basu, *"Condensed Matter Physics: A Modern Perspective"*, IoP Publishing Ltd, 2023.
2. Vimal Kumar Jain, *"Solid State Physics"*, 3rd edition, Springer Nature Switzerland AG, 2022.

Reference Book(s)

1. Sharon Ann Holgate, *"Understanding Solid State Physics"*, 2nd edition, CRC Press, 2021.
2. M.A. Wahab, *"Solid State Physics: Structure and Properties of Materials"*, 3rd edition, Alpha Science, 2017.

PH-317 Atomic and Molecular Physics:

One-Electron Systems: Bohr model and Schrödinger equation for one-electron atoms, Reduced mass and atomic units, Energy levels, spectra, and spectroscopic notation, Quantum angular momentum and spherical harmonics, Electron spin and spin-orbit interaction, Lamb shift, hyperfine structure, and isotopic shifts.

Many-Electron Atoms: Schrödinger equation for multi- electron atoms, Pauli's exclusion principle and periodic table structure, coupling of angular momenta: LS coupling, jj coupling, Central field approximation

Interaction of atom with radiation: Electromagnetic field interactions with charged particles, Radiative transition rates and dipole approximation, Einstein coefficients and selection rules, Dipole-allowed and

forbidden transitions, Metastable levels, line intensities, and lifetimes, Zeeman effect and Stark effect with types, Paschen-Back effect.

Molecular Structure and Bonding: Covalent and ionic bonding, Born-Oppenheimer approximation, Hydrogen molecular ion (LCAO approximation), Hydrogen molecule (Heitler-London and molecular orbital theories).

Molecular Spectra: Rotational, vibrational, and electronic spectra of diatomic molecules, Transition probabilities and selection rules, Franck-Condon principle and Hund's cases,Raman spectroscopy and Mossbauer spectroscopy.

Recommended book(s):

Text book(s)

1. Luciano Prof. Colombo, *"Atomic and Molecular Physics: A Primer"*, IOP Publishing Ltd, 2019.

Reference Book(s)

1. C. J. Foot, *"Atomic Physics"*, Oxford University Press, 2005.
2. J. M. Hollas, *"Basic Atomic & Molecular Spectroscopy"*, John Wiley, 2002.

PH-318 Introduction to Astronomy:

Introduction: Scientific notations, Special Units, Approximations, Units of distance in astrophysics.

The origin of Astronomy: Classical astronomy, Copernicus, Planetary motion, Gravitation, Gravitation near the Earth's Surface, Isaac Newton and Orbital Motion, Laws related to the motion of Planets and Satellites, Energy Consideration in Planetary and Satellite motion, Kepler's Law, Surface temperature and luminosity of Sun, Solar and Infrared flux,

Earth and the Sky: Latitude, Longitude, Equator, Hemisphere, Movements of Earth: Rotation (on its axis), Revolution (around the Sun), the resulting effects of some of these movements: day & night, seasons, atmospheric layers of Earth, leap year.

The Solar System: The survey of solar system, The Sun, life and death of Sun, Internal Structure and the Atmosphere of Sun, motion of the Sun, Solar Wind and Aurora.

Planets: Definition of Planet, Terrestrial Planets, Planetary Properties, Dwarf Planets, special case of Pluto, Asteroids, Meteors, Comets.

Moon: Lunar Phases, motion of the Moon, Solar & Lunar Eclipses.

Beyond the Sun: Stars and Types of Stars, Life Cycle of Stars: Formation, Evolution and Death of Stars, Nebulas and their types, Constellations. Celestial Sphere,

Galaxies: Types of Galaxies; Milky Way Galaxy, Nearby Galaxies. Supermassive Black Holes and Active Galaxies.

Recommended book(s):

Text book(s)

1. Kwok, S. *"Our Place in The Universe: Understanding Fundamental Astronomy from Ancient Discoveries"*, 2nd edition, Springer 2017.

Reference Book(s)

1. Morison I. *"Introduction to Astronomy and Cosmology*", Wiley 2008.
2. Seeds, M. A., & Backman, D. E. *"Astronomy: The Solar System and Beyond*", 6th edition, Brooks / Cole Cengage Learning, (2010).

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 Thermo-Luminescent Dosimeters (TLDs).

Recommended Book(s):

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.

MG-110 Fundamentals of Management:

Introduction to management: The Evolution of Management, the External Environment, Organizational Culture, Managerial Decision Making, Planning, Strategic Management.
Ethics and Corporate Responsibility, International Management, Entrepreneurship: The Business Plan, Organization Structure, Organizational Agility, Human Resource Management, Leadership, Motivating for Performance Teamwork, Managerial Control, Managing Technology and Innovation, relevant Case studies

CT-262 Introduction to Artificial Intelligence:

Introduction: Introduction to Artificial Intelligence (AI), Branches of Artificial 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 Book(s):

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.

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 Book(s):
Text 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-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 Book(s):

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.

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 Book(s):

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-431 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 divided difference 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 book(s) :
Text book(s)

1. Sujaul Chowdhury, *"Computational Physics"*, American Academic Press, 2021.
2. Omair Zubairi, Fridolin Weber, *"Introduction to Computational Physics for Undergraduates"*, IoP, 2018.

Reference Book(s)

1. S. C. Chapra and R. P. Chanle, *"Numerical Methods for Engineers with Personal Computer Applications"*, McGraw Hill,1990.

ELECTIVE COURSES

PH-302 Laser Engineering:

Brief history of laser development, principle components of laser, types of lasers, properties of laser beam, an overview of laser technology, energy states in atom, transition between energy states (absorption, spontaneous and stimulated emission), principles of laser, power and energy, special features of laser beam (directionality, diffraction, intensity, monochromaticity, coherency, line-width), Thermal equilibrium, Einstein coefficients, condition for large stimulated emissions, condition for light amplification, population inversion, energy state, metastable state, three level laser, four level laser, line broadening, laser rate equations (two, three, and four level systems), generic laser, gain medium, pumping source, resonant cavity, Amplification and gain, optical resonator, laser action, gain of active medium (mathematical treatment), threshold condition, gain calculation, conditions for steady state oscillation, cavity resonance frequencies, laser modes (longitudinal and transverse), single mode operation, Resonator (cavity) configuration, Fabry Perot resonator or plane parallel cavity, confocal resonator, hemispherical cavity or combination of plane and spherical resonator, long radius cavity, stability criterion, examples (stable and unstable resonator), What is pumping, pumping methods, optical pumping, electric pumping (direct discharge), electric pumping for semiconductor laser, chemical pumping, flash lamps, optical pumping configuration, optical pumping assembly, active mediums (atoms, molecules, liquids, dielectric solids, semiconductor material), Introduction to control of laser output beam, frequency selection, generation of high power pulses, Q-factor, Q-switching and giant pulses, methods of Q-switching, active Q-switching (mechanical Q-switching, acousto-optic Q-switching, electro-optic Q-switching), passive Q-switching (saturable absorber, cavity dumping), introduction to mode-locking, mode-locking techniques (active mode-locking, passive mode- locking), Q-switched Nd:YAG laser system, Industrial applications, material processing (laser drilling, laser cutting, laser welding), LIDAR (laser imaging detection and ranging),photolithography, medical applications (LASIK surgery, laser seizer), isotope separation using laser, Nuclear fusion, brief overview of major laser facility (NIF facility), laser holography, military applications.

Recommended Book(s):

1. K. Thyagarajan, “Lasers: Fundamentals and Applications”, Springer, 2nd ed. 2010.

2. O. Svelto, “Principles of Lasers”, Springer, 5th ed. 2009.

3. K. R. Nambiar, “LASERS: Principles, Types and Applications”, New Age, 2009.

4. W. Koecher, “Solid-State Laser Engineering”, Springer, 2009.

5. W. T. Silfvast, “Laser Fundamentals”, Cambridge, 2nd ed. 2008.

6. R. F. Walter, “Gas Lasers (Optical Science and Engineering)”, CRC Press, 2006

PH-310 Solid State Physics-I:

Lattices and basis, Symmetry operations, Fundamental Types of Lattice, Position and Orientation of Planes in Crystals, Simple crystal structures, Diffraction of X-rays, Neutrons and electrons from crystals; Bragg’s law; Reciprocal lattice, Ewald construction and Brillouin zone, Fourier Analysis of the Basis, 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, 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 orbital’s in one dimension, effect of temperature on the Fermi–Dirac distribution function, properties of the free electron gas, electrical conductivity and Ohm’s Law, thermal and electrical conductivities of metals and their ratio, motion of free electrons in magnetic fields, cyclotron frequency, static magneto conductivity and Hall Effect along with applications.

Recommended Book(s):

1. C. Kittle, “Introduction to Solid State Physics”, John Wiley, 8th ed. 2005.

2. M. A. Omar, “Elementary and Solid-State Physics”, Pearson Education, 2000.

3. M. A. Wahab, "Solid State Physics", Narosa Publishing House, 1999.

4. S. R. Elliott, "The Physics and Chemistry of Solids", John Wiley, 1998

5. H. M. Rosenberg, "The Solid State", Oxford Science Publication, 3rd ed. 1988.

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 co-ordinate 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 Book(s):

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-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 Behavior, Critical Current Density, Josephson effect and applications.

Recommended Book(s):

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.

4. G. Burns, "High Temperature Superconductivity - An Introduction", Academic Press, 1992.

PH-411 Applications of Space Physics:

Space Weather Atmosphere A brief overview, Earth: The Habitable Planet, Weather & Climate, Atmospheric Chemistry, Weather Systems, Key Concepts, Introduction, Brief History Importance Space Environment, Spacecraft Orbits, Vacuum Neutral, Plasma, Radiation, Particles, Interactions. Effect of Space Weather Communication, Navigation, Space Technologies Magnetic Reconnection X-region Separatrix Region Solar Wind Interaction with Magnetized Planets with Magnetic Field Solar Wind Interaction with Unmagnetized Bodies Moon like bodies with Atmosphere Plasma Astrophysics Introduction to Magnetohydrodynamics (MHD) MHD Shocks & Waves, Interstellar Medium (ISM) Accretion Disks & Jets Instrumentation Optical & other Astronomy Sun Monitoring Magnetosphere and Geomagnetic field Measurements Ionospheric Monitoring Satellite Applications Weather forecasting Environmental Monitoring Navigation and Surveillance Astronomical Applications Resource Surveying Telecommunication Defense Application.

Recommended Book(s):

1. Kennedy Davis, "Electronic Communication Systems" McGraw Hill (2000)
2. May-Britt Kallendrode, "Space Physics an Introduction to Plasmas and Particles in the Heliosphere and Magnetosphere" Springer Verlag, (2004)
3. J.N Xanthakis, "Solar Physics", London (Latest Edition)
4. M. G. Kivelson, "Introduction to Space Physics" Cambridge University Press (Latest Edition).

PH-420 Nano Science & Nano Technology:

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 multi-walled 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,
Molecular Electronics: Lewis structures, Approach to calculate Molecular orbitals, Electron transfer between molecules, single molecule electronics.
Nano Materials: Quantum dots, nano wires, nano photonics, magnetic nano structures, nano thermal devices, Nano fluidic devices, biomimetic materials, DNA micro-arrays, Protein and DNA Assembly. **Nanotechnology Innovations:** Nanostructure innovation, Quantum Informatics, Energy solutions.

Recommended Book(s):

1. Massimo F. Bertino, "*Introduction to Nanotechnology*", WSPC, 2022.
2. Chris Binns, "*Introduction to Nanoscience and Nanotechnology*", 2nd edition, Wiley, 2021.
3. Deb Newberry, "*Nanotechnology Past and Present",* Morgan & Claypool Publishers, 2020

PH-421 Vacuum 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, Non- Evaporable 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 book(s):

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 Book(s):

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-423 Surface Science and Applications:

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 X-ray 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 Book(s):

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-424 Fundamentals 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 Book(s):
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 Microwaves Systems:

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 Book(s):
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 Fundamentals 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 Book(s):
1. Jakob Schwichtenberg, "*No-Nonsense Quantum Field Theory: A Student-Friendly Introduction*", NoNonsense 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 Book(s):
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 Resources:

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 Book(s):
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-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 Book(s):
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, 2012.

PH-432 Material Sciences:

Structures and bonding: Atomic and Subatomic Structures, Micro, Macro and Nano structures, Crystalline and Amorphous, Structures of Common Metallic Materials, Crystallographic Planes and Directions, Primary, Secondary and Mixed bonding.
Defects in solids: Point Imperfections, Vacancies, Interstitial Defect, Line Imperfection, Edge Defect and Surface Imperfections.
Classification of materials: Metals, Types of Metal Alloys, Ceramics, Classification and Applications of Ceramics, Properties of Ceramics, Polymers Polymer Basics, Polymer Identification, Polymer molecules, Additional Polymerization, Step Growth Polymerization, Measurement of Molecular weight, Thermosetting polymers and Gels, Rubbers and Rubber Elasticity, Introduction to Biomaterials, Materials Selection, Biopolymers, Hard Materials, Biomedical Materials.
Mechanical properties: Elastic deformation macroscopic approach, Elastic deformation microscopic approach, the elastic limit, Dislocations, shear strength of single crystals, slips, stress fields of dislocation, Low angle grain boundaries, Dislocation densities, Dislocation multiplication and slip, Strength of alloys, Dislocations and crystal growth, Hardness of materials. Thermal Expansion, Estimate of the Yield stress, , Fracture Mechanics, Ductile fracture, Brittle fracture, Griffith Criterion, Ductile fracture, Creep, Fatigue.
Electrical and Magnetic Properties: Conductivity and mobility, Electronic and ionic conduction, Electron-Phonon Interaction in Metals, Influence of Temperature on Magnetic behavior, Magnetic Anisotropy.
Optical Properties: Light interaction with solids, Optical properties of Metals and Non -Metals, Luminescence, Photoconductivity.
Material characterization Techniques: Scanning electron microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, X- ray Diffraction, Energy Dispersive X-Ray Spectroscopy.

Recommended book(s):
Text book(s)
1. Shackelford, J. F., *"Introduction to materials science for engineers"*, 9th edition, Pearson education limited, 2022.
2. Callister Jr, W. D., & Rethwisch, D. G. *"Materials science and engineering: an introduction"*, 10th edition John wiley & sons, 2020.
Reference Book(s)
1. Charles Kittle. *"Introduction to Solid State Physics",* 8th edition, Wiley and Sons, 2018
2. Ortega, E. O., Hosseinian, H., Meza, I. B. A., López, M. J. R., Vera, A. R., & Hosseini, S., *"Material characterization techniques and applications"*, 1st edition, Singapore: Springer, 2022.

PH-433 Fundamentals of Quantum Computing:

Introduction to Quantum Mechanics, Review of linear algebra: vector spaces, inner products, and operators. Postulates of quantum mechanics. Qubits and quantum states: superposition and normalization.
Quantum Gates and Circuits: Single-qubit gates: Pauli matrices, Hadamard, and phase gates. Multi-qubit systems: tensor products and entanglement. Controlled operations: CNOT gate and general controlled gates. Quantum circuit representation and design.
Quantum Algorithms: Deutsch-Jozsa algorithm, Quantum Fourier Transform (QFT), Shor's algorithm for integer factorization, Grover's search algorithm.
Quantum Errors and Correction: Quantum noise and decoherence, The Shor and Steane codes.
Physical Implementations of Quantum Computers: Superconducting qubits, trapped ions, Photonic Qubits, spin qubits and Diamond Qubits.
Quantum Cryptography: Uncertainty principle, Polarization and Spin basis, BB84, BB90, and Ekert protocols, Quantum cryptography with and without eavesdropping.

Recommended book(s) :
Text book(s)
1. Bernhardt, Chris, *"Quantum Computing for Everyone"*, MIT Press, 2023.
2. Mermin, N. David, *"Quantum Computer Science: An Introduction"*, Cambridge University Press, 2023.
Reference Book(s)
1. Jordan, Andrew N., and Irfan A. Siddiqi., *"Quantum Measurement: Theory and Practice"*, Cambridge University Press, 2024.
2. Kaiser, Sarah, and Christopher Granade, *"Learn Quantum Computing with Python and Q#"*, Manning Publications, 2021.

Scheme of Studies for BS Physics Programme (Batch-2025 and Onward)

Course Dependency Chart of Scheme of Studies for Batch 2025 & Onwards