CURRICULUM OF PHYSICS

BS (Hons.)

Sub-Campuses

June, 2022

The Islamia University of Bahawalpur

LAYOUT FOR BS (Hons.) IN PHYSICS

COMPULSORY REQUIREMENTS		GENERAL COURSES		DISCIPLINE SPECIFIC FOUNDATION COURSES	
SUBJECT	**C. H.**	**SUBJECT**	**C. H.**	**SUBJECT**	**C. H.**
1. Islamic Studies	3+0	**1.** Communication Skills	3+0	**1.** Fundamentals of Mechanics	2+2
2. English Composition	3+0	**2.** Mathematics-III	2+0	**2.** Waves and Oscillations	3+0
3. Life and Academic Skills	3+0	**3.** Statistics	3+0	**3.** Heat and Thermodynamics	2+2
4. Pakistan Studies	3+0	**4.** Critical Thinking and Reasoning	3+0	**4.** Electricity and Magnetism	2+2
5. Arabic for Understanding Quran	3+0	**5.** Applied Mechanics	3+0	**5.** Concepts of Modern Physics	3+0
6. Mathematics-I	2+0	**6.** Introduction to Environmental Science	3+0	**6.** Light and optics	3+0
7. Mathematics-II	2+0	**7.** Language	3+0	**7.** Electrodynamics-I	3+0
8. Basic Computer Programming	3+0			**8.** Electronic Circuits and Devices	2+1
9. Constitution and Legal System of Pakistan	3+0			**9.** Thermal & Statistical Physics	3+0
TOTAL	**25**	**TOTAL**	**20**	**TOTAL**	**30**

MAJOR COURSES		ELECTIVE COURSES WITHIN THE MAJOR	
SUBJECT	**C.H.**	**SUBJECT**	**C.H.**
1. Solid State Physics-I	3+0	**1.** Advanced Elective-I	3+0
2. Solid State Physics-II	3+0		
3. Classical Mechanics	3+0	**2.** Advanced Elective-II	3+0
4. Modern Physics Lab.-I	0+2		
5. Modern Physics Lab.-II	0+2	**3.** Advanced Elective-III	3+0
6. Basic Electronics	2+1		
8. Digital Logic Design	2+1	**4.** Advanced Elective-IV	3+0
9. Nuclear Physics	3+0		
10. Electrodynamics-II	3+0	**5.** Project	3+0
11. Advanced Physics Lab.	0+2		
12. Quantum Mechanics-I	3+0		
13. Quantum Mechanics-II	3+0		
14. Atomic and Molecular Physics	3+0		
15. Computational Physics	2+2		
16. Methods of Mathematical Physics-I	3+0		
17. Methods of Mathematical Physics-II	3+0		
TOTAL	**46**	**TOTAL**	**15**

TOTAL CREDIT HOURS 136

B.S. PHYSICS CURRICULUM

(FOUR-YEAR PROGRAM OF STUDY)

FIRST YEAR					
SEMESTER–I			**SEMESTER–II**		
COURSE CODE	**COURSE TITLE**	**C.H.**	**COURSE CODE**	**COURSE TITLE**	**C.H.**
PHY-01101	Fundamentals of Mechanics	2+2	PHY-01201	Heat and Thermodynamics	2+2
PHY-01102	Waves and Oscillations	3+0	PHY-01202	Applied Mechanics	3+0
PHY-01103	Mathematics-I	2+0	PHY-01203	Mathematics-II	2+0
ENG-301	English Composition	3+0	STAT-302	Statistics	3+0
IS-301	Islamic Studies	3+0	EDU-302	Critical Thinking and Reasoning	3+0
MNGT-301	Life and Academic Skills	3+0	PHY-01206	Basic Computer Programming	0+3
	TOTAL	**18**		**TOTAL**	**18**
SECOND YEAR					
SEMESTER–III			**SEMESTER–IV**		
PHY-01301	Electricity and Magnetism	2+2	PHY-01401	Classical Mechanics	3+0
PHY-01302	Concepts of Modern Physics	3+0	PHY-01402	Light and Optics	3+0
PHY-01303	Mathematics-III	2+0	PHY-01403	Modern Physics Lab.-I	0+2
PS-401	Pakistan Studies	3+0	ES-402	Introduction to Environmental Science	3+0
TSAQN-401	Arabic for Understanding Quran	3+0	LAW-402	Constitution and Legal System of Pakistan	3+0
ENG-401	Communication Skills	3+0	-----402	Language	3+0
	TOTAL	**18**		**TOTAL**	**17**
THIRD YEAR					
SEMESTER–V			**SEMESTER–VI**		
PHY-01501	Methods of Mathematical Physics-I	3+0	PHY-01601	Methods of Mathematical Physics-II	3+0
PHY-01502	Basic Electronics	2+1	PHY-01602	Solid State Physics-I	3+0
PHY-01503	Modern Physics Lab.-II	0+2	PHY-01603	Electronic Circuits and Devices	2+1
PHY-01504	Atomic and Molecular Physics	3+0	PHY-01604	Advanced Physics Lab.	0+2
PHY-01505	Thermal and Statistical Physics	3+0	PHY-01605	Quantum Mechanics-I	3+0
PHY-015XX	Advanced Elective–I	3+0	PHY-016XX	Advanced Elective–II	3+0
	TOTAL	**17**		**TOTAL**	**17**
FINAL YEAR					
SEMESTER–VII			**SEMESTER–VIII**		
PHY-01701	Electrodynamics-I	3+0	PHY-01801	Electrodynamics-II	3+0
PHY-01702	Solid State Physics-II	3+0	PHY-01802	Nuclear Physics	3+0
PHY-01703	Quantum Mechanics–II	3+0	PHY-01803	Digital Logic Design	2+1
PHY-01704	Computational Physics	2+2	PHY-01804	Project (Report + Poster + Study tour*)	3+0
PHY-017XX	Advanced Elective–III	3+0	PHY-018XX	Advanced Elective–IV	3+0
	TOTAL	**16**		**TOTAL**	**15**

Note:

- Courses with theory + lab. (*i.e.* courses having 2+2 C.H.) will be evaluated accordingly: Both theory and lab. will be evaluated against 100 marks each (*i.e.* Theory = 100 marks & Lab. = 100 marks) and their weightage to final result will be 50% for theory and 50% for lab. resulting in a total of 100%. Student must have to pass each component separately.
- Courses with theory + lab. (*i.e.* courses having 2+1 C.H.) will be evaluated accordingly: Both theory and lab. will be evaluated against 100 marks each (*i.e.* Theory = 100 marks & Lab. = 100 marks) and their weightage to final result will be 75% for theory and 25% for lab. resulting in a total of 100%. Student must have to pass each component separately.
- *Students will visit the high-tech labs in cities like Islamabad, Lahore, Karachi, Taxila or wherever the labs. relevant to their projects/curriculum are available.

ADVANCED ELECTIVE-I			ADVANCED ELECTIVE-II		
COURSE CODE	**COURSE TITLE**	**C.H.**	**COURSE CODE**	**COURSE TITLE**	**C.H.**
PHY-01506	Introduction to Medical Physics	3+0	PHY-01606	Physics of Radiation Therapy	3+0
PHY-01507	Materials World	3+0	PHY-01607	Basic Properties of Materials	3+0
PHY-01508	Introduction to Semiconductor Physics	3+0	PHY-01608	Semiconductors and Nanotechnology	3+0
PHY-01509	Physics at Nanoscale	3+0	PHY-01609	Nanocrystals	3+0
ADVANCED ELECTIVE-III			**ADVANCED ELECTIVE-IV**		
PHY-01706	Radiation Protection and Health Physics	3+0	PHY-01806	Photodynamic Therapy	3+0
PHY-01707	Mechanics of materials	3+0	PHY-01807	Materials Simulation	3+0
PHY-01708	Fabrication and Characterization Techniques	3+0	PHY-01808	Defects in Semiconductors	3+0
PHY-01709	Magnetism and Superconductivity	3+0	PHY-01809	Introduction To Spectroscopy	3+0

SEMESTER – I

PHY-01101 FUNDAMENTALS OF MECHANICS (2+2) C.H.

Theory: 2 C.H.

Vector Analysis: Physical quantities and units, Precision and significant figures, Resolution of vectors, Addition of vectors, Multiplication of vectors, Gradient of a scalar, Divergence and curl of a vector; Gauss Divergence & Stoke's theorems (derivation and physical importance).

Motion and Newton's Laws: Review of displacement, velocity and acceleration, Freely falling objects, Velocity and acceleration in plane, Projectile motion, Concept of force, Newton's laws of motion, Free body diagrams, Contact forces and friction, Elastic forces, Forces in nature, Time dependent forces, Drag force.

Circular Motion and Gravitation: Dynamics of uniform circular motion (Banked curve, Conical pendulum, The rotor), Newton's law of gravitation, Satellite motion, Gravitational potential energy, Escape velocity, Terminal velocity, Kepler's Laws, Inertial and non-inertial frames.

Work, Energy and Momentum: Work done by constant & variable forces (one & two dimensional cases), Work-energy theorem, Conservation of energy, Conservative and non-conservative forces, Power, Linear momentum and its conservation, Elastic & inelastic collisions, Impulse, Centre of mass, Calculation of C.M. of different solid objects (*i.e.* uniform rod, cylinder and sphere).

Recommended Books:

1. R.A. Serway and J.W. Jewett, *Physics for Scientists and Engineers*, Golden Sunburst Series, 9th Ed. 2013.
2. H.D. Young, *College Physics*, Sears and Zemansky's, 9th Ed. 2012.
3. D. Halliday, R. Resnick and J. Walker, *Fundamentals of Physics*, John Wiley & Sons, 10th Ed. 2013.

Note: The Instructor may suggest any relevant/latest/reputed book available.

Lab. 2 C.H.

1. Modulus of Rigidity by Static & Dynamic method (Maxwell's needle).
2. To study the damping features of an oscillating system using simple pendulum of variable mass.
3. Measurement of viscosity of liquid by Stokes' or Poiseuille's method.
4. Surface tension of water by capillary tube or breakaway method.
5. To determine the value of "g" by compound pendulum or reversible pendulum.
6. To measure the velocity of sound by Kundts tube or CRO.
7. To determine frequency of AC supply by CRO.
8. To determine Horizontal/Vertical distance by Sextant.

Note: Students must have to perform at least 06 experiments from the list provided above or any other relevant experiment available in the laboratory. Teachers should emphasize on graphical analysis and error calculations.

PHY-01102 WAVES AND OSCILLATIONS 3+0 C.H.

Oscillations and Mechanical Waves: Motion of an object attached to a spring, Simple Harmonic Motion, Energy of the simple harmonic oscillator, Simple harmonic motion and uniform circular motion, The pendulum (simple and compound), Resonance, Damped oscillations, Forced oscillations.

Wave Motion: Propagation of a disturbance, Traveling waves, The speed of waves on strings, Reflection, transmission and superposition of waves, Rate of energy transfer by sinusoidal waves on strings, The linear wave equation, Standing waves and normal modes.

Superposition and Standing Waves: Waves in interference, Standing waves, Waves under Boundary conditions, Resonance, Standing waves in air columns, Standing waves in rods and membranes.

Sound Waves: Pressure variations in sound waves, Speed of sound waves, Intensity of periodic sound waves, Beats, The Doppler effect, Supersonic speeds and shock waves.

Recommended Books:

1. R.A. Serway and J.W. Jewett, *Physics for Scientists and Engineers*, Golden Sunburst Series, 9th Ed. 2013**.**
2. H.D. Young, *College Physics*, Sears and Zemansky's, 9th Ed. 2012.
3. D. Halliday, R. Resnick and J. Walker, *Fundamentals of Physics*, John Wiley & Sons, 10th Ed. 2013.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01103 MATHEMATICS-I 2+0 C.H.

Trigonometry: Complex numbers, The Argand diagram, Modulus and argument, DeMoivre's theorem, Roots, Exponential, trigonometric and hyperbolic functions, Logarithmic functions, Inverse-hyperbolic and inverse-trigonometric functions, Complex powers and summation of series.

Groups: Definitions, examples and properties of groups, Subgroups, Homomorphism and isomorphism, Cyclic groups, Cosets and Lagrange's theorem, Permutations, Cycles, Transpositions, Order of a permutation, Schur's lemma.

Vector Spaces: Rings, Vector spaces, Subspaces, Linear combination and spanning sets, Linear dependence and basis, Linear transformations.

Matrices and Determinants: Matrix and its algebra, Elementary row operations, Transpose, Unitary and Hermitian matrices, Singular matrix, Trace of a matrix, Diagonalization, Inverse and rank of a matrix, Matrix of a linear transformation, Systems of linear equations (Gaussian and Gauss-Jordon methods), Determinant of a square matrix, Axiomatic definition of a determinant, Determinant as sum of products of elements, Determinant of a transpose, Determinants and inverses of matrices, Cramer's rule.

Recommended books:

1. S.M. Yousuf, A. Majeed and M. Amin, *Mathematical Methods*, 2nd Ed., Ilmi Publishers, 1999.
2. E. Kreyszig, *Advanced Engineering Mathematics*, 10th Ed., John Wiley & Sons, 2010.
3. K.F. Riley, M.P. Hobson and S.J Bence, *Mathematical Methods for Physics and Engineering*, 3rd Ed., Cambridge University Press, 2006.

Note: The Instructor may suggest any relevant/latest book available.

ENG-301 ENGLISH COMPOSITION 3+0 C.H.

*The detailed contents will be provided by the relevant department offering the course.

IS-301 ISLAMIC STUDIES 3+0 C.H.

*The detailed contents will be provided by the relevant department offering the course.

MNGT-301 LIFE AND ACADEMIC SKILLS 3+0 C.H.

*The detailed contents will be provided by the relevant department offering the course.

SEMESTER – II

PHY-01201 HEAT AND THERMODYNAMICS (2+2) C.H.

Theory: 2 C.H.

Temperature: Temperature and the Zeroth law of thermodynamics, Thermometers and the Celsius temperature scale, The constant-volume gas thermometer and the absolute temperature scale, Thermal expansion of solids and liquids, Macroscopic description of an Ideal gas.

The First Law of Thermodynamics: Heat and internal energy, Specific heat and calorimetry, Latent heat, Work and heat in thermodynamic processes, The first law of thermodynamics, Some applications of the first law of thermodynamics, Energy transfer mechanisms in thermal processes.

The Kinetic Theory of Gases: Molecular model of an ideal gas, Molar specific heat of an ideal gas, Equipartition of energy, Adiabatic processes for an ideal gas, Distribution of molecular speeds.

Heat Engines, Entropy, and the Second Law of Thermodynamics: Heat engines and the second law of thermodynamics, Heat pumps and refrigerators, Reversible and irreversible processes, The Carnot engine, Gasoline and diesel engines, Entropy, Changes in entropy for thermodynamic systems, Entropy and the second law, Third law of thermodynamics, Maxwell-Boltzmann energy distribution.

Thermodynamic Functions: Internal energy U, Enthalpy H, Helmholtz free energy F, and Gibbs free energy G, Maxwell's relations, TdS equations, Liquification of gases, Joule-Thomson effect, Thermoelectricity, Thermocouple.

Recommended Books:

1. R.A. Serway and J.W. Jewett, *Physics for Scientists and Engineers*, Golden Sunburst Series, 9th Ed., 2013**.**
2. H.D. Young, *College Physics*, Sears and Zemansky's, 9th Ed., 2012.
3. D. Halliday, R. Resnick and J. Walker, *Fundamentals of Physics*, John Wiley & Sons, 10th Ed., 2013.
4. Gilbert Newton Lewis, Merle Randall, Kenneth S. Pitzer, Leo Brewer, *Thermodynamics*, Courier Dover Publications, 2020.

Note: The Instructor may suggest any relevant/latest book available.

Lab. 2 C.H.

1. Determination of thermoelectric emf and temperature diagram.
2. Determination of temperature coefficient of resistance of a given wire.
3. The determination of Stefan's constant.
4. Investigation of phase change and measurement of the velocity of sound by CRO.
5. Calibration of thermocouple by potentiometer.
6. Measurement of specific rotation of sugar by Polarimeter and determination of sugar concentration in a given solution.
7. Determination of thermal conductivity of conductors using Lee's and Searle's apparatus.
8. To study the laws of vibration of stretched string using sonometer.

Note: Students must have to perform at least 06 experiments from the list provided above or any other relevant experiment available in the laboratory. Teachers should emphasize on graphical analysis and error calculations.

PHY-01202 APPLIED MECHANICS 3+0 C.H.

Introduction: Precision, Accuracy and Uncertainty, Significant figures, Algebraic, simultaneous and quadratic equations, Trigonometry: Right-angle triangles, Sine and cosine laws: Non-right-angle triangles, Geometry.

Rotational Motion: Rotational dynamics, Relation between linear & angular variables; K.E. of rotation, Rotational inertia of solid bodies, Torque, Parallel & perpendicular axes theorems, Rolling without slipping, Conservation of angular momentum, Angular momentum of a particle, Relation between torque & angular momentum, Spinning top, Work and power in rotational motion.

Equilibrium and Elasticity: Equilibrium, The requirements of equilibrium, Centre of gravity, Indeterminate structures, Stress, Strain and deformation, Tension, Compression, Elasticity, Yield strength.

Fluids: Density & pressure, Pascal's and Archimedes' principles, Viscosity, Concepts of fluid flow, Equation of continuity, Bernoulli's equation, Poiseuille's law.

Recommended Books:

1. R.A. Serway and J.W. Jewett, *Physics for Scientists and Engineers*, Golden Sunburst Series, 9th Ed., 2013**.**
2. H.D. Young, *College Physics*, Sears and Zemansky's, 9th Ed., 2012.
3. D. Halliday, R. Resnick and J. Walker, *Fundamentals of Physics*, John Wiley & Sons, 10th Ed., 2013.

Note: The Instructor may suggest any relevant/latest/reputed book available.

PHY-01203 MATHEMATICS-II 2+0 C.H.

Differential Calculus: Bounds, limits and continuity, Properties of continuous functions, Derivatives, Leibnitz and Rolle's theorems, Lagrange's and Cauchy's mean value theorems, Generalized mean value theorems, Indeterminate forms, Taylor's and Maclaurin's series.
Integral Calculus: Anti-derivatives, Techniques of integration, Riemann integral, Properties of definite integrals, mean value theorem, Reduction formulae, Improper integrals, Beta and gamma integrals.
Fourier Series: Periodic function, Periodic extensions, Even and odd functions, Fourier coefficients, Expansion of functions in Fourier series, Functions with arbitrary periods, Fourier sine and cosine series.
1st Order Differential Equations: Differential equations, Formation and solution, Equations of first order, Initial and boundary value problems, Various methods of solving first order differential equations (Separable, Exact & Homogeneous equation, integration factor and orthogonal trajectories), Non-linear first order equations, Singular solutions.

Recommended books:

1. S.M. Yousuf, A. Majeed and M. Amin, *Mathematical Methods*, 2nd Ed., Ilmi Publishers, 1999.
2. E. Kreyszig, *Advanced Engineering Mathematics*, 10th Ed., John Wiley & Sons, 2010.
3. K.F. Riley, M.P. Hobson and S.J Bence, *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press, 2006.

Note: The Instructor may suggest any relevant/latest book available.

STAT-302 STATISTICS 3+0 C.H.

*The detailed contents will be provided by the relevant department offering the course.

EDU-302 CRITICAL THINKING AND REASONING 3+0 C.H.

*The detailed contents will be provided by the relevant department offering the course.

PHY-01206 BASIC COMPUTER PROGRAMMING 0+3 C.H.

Introduction to Programming and Importance for a physics Graduate; Basics of Programming and Software Development; C++ Development Environment and Basic Program Construction; Header Files and Library Files; Variables and Data Types; Operators (Arithmetic, Logical, Increment, Decrement) and Precedence; Type Conversion; Input and Output Statements in C++/ Matlab/ Maple, IF Statement; IF -ELSE Statement; ELSE-IF Statement; Conditional Operator Switch Statement, Arrays, One Dimensional and Two Dimensional Arrays, FOR Loop, Nested FOR loops, Loops with Arrays, WHILE Loop, DO-WHILE Loop, Continue Statement; Functions and its Importance: Parts of Functions, Passing Arguments to Functions, Returning Values from Functions, Inline Functions, Default Arguments, Pointers and Arrays, Pointers and Function (Call by Value and Call by Reference), Pointers and Strings; Basics of graphics; Application in Various Physics Problems.

Note: Students will focus excessively on the programming relevant to the contents cited above.

Recommended Books:

1. Introduction to Programming with C++, 3rd Edition, Pearson Publishing, 2014, by Y. Daniel Liang
2. Deitel, P., & Deitel, H. (2016). C++ How to Program (Latest Ed.). Prentice Hall.
3. Lafore, R. (2005). Object-oriented programming in C (Latest Ed.). Indianapolis, Ind: Sams.
4. Kanetkar, Y. (2004). Basic programming in C++ (Latest Ed.). BPB Publications.

Note: The Instructor may suggest any relevant/latest book available.

SEMESTER – III

PHY-01301 ELECTRICITY AND MAGNETISM (2+2) C.H.

Theory **2 C.H.**

Electrostatics: Coulomb's law: An overview, Electric field of a continuous charge distribution, Electric flux, Gauss's law and its applications (**E** due to ring and disc of charges), Electric potential and potential energy due to point charge, Electric potential due to continuous charge distributions (due to dipole and spherical charge distribution).

Capacitance and Dielectrics: Capacitance and its calculation (for parallel, cylindrical, and spherical capacitors), Capacitors with dielectrics, Energy stored in a charged capacitor, Dielectrics: An atomic view, Dielectrics and Gauss's law.

Magnetic Fields: Motion of a charged particle in a uniform magnetic field, Magnetic force acting on a current-carrying conductor, Torque on a current loop in a uniform magnetic field, The Hall effect.

Sources of Magnetic Fields: Calculating magnetic field due to current, The Biot–Savart law, Ampere's law, Solenoids and Toroids, A current carrying coil as a magnetic dipole.

Recommended Books:

1. R.A. Serway and J.W. Jewett, *Physics for Scientists and Engineers*, Golden Sunburst Series, 9th Ed., 2013**.**
2. H.D. Young, *College Physics*, Sears and Zemansky's, 9th Ed. 2012.
3. D. Halliday, R. Resnick and J. Walker, *Fundamentals of Physics*, John Wiley & Sons, 10th Ed., 2013.
4. Gilbert Newton Lewis, Merle Randall, Kenneth S. Pitzer, Leo Brewer, *Thermodynamics*, Courier Dover Publications, 2020.

Note: The Instructor may suggest any relevant/latest book available.

Lab. **2 C.H.**

1. Measurement of resistance using a Neon flash bulb and condenser.
2. Conversion of a galvanometer into Voltmeter and an Ammeter.
3. Calibration of an Ammeter and a Voltmeter by potentiometer.
4. Study of B.H. curve and measurement of the magnetic parameters.
5. Measurement of low resistance coil by a Carey Foster Bridge.
6. Resonance frequency of an acceptor and rejector circuits.
7. Study of the parameter of wave i.e. amplitude, phase and time period of a complex signal by CRO.
8. Measurement of the ionization potential of mercury (Hg).

Note: Students must have to perform at least 06 experiments from the list provided above or any other relevant experiment available in the laboratory. Teachers should emphasize on graphical analysis and error calculations.

PHY-01302 CONCEPTS OF MODERN PHYSICS 3+0 C.H.

Relativity: Special relativity, Time dilation and Doppler effect, Length contraction and Twin Paradox, Mass and Energy ($E = mc^2$), Relativistic energy and momentum, Hubble law; Galilean transformation, Lorentz transformations, General Relativity.

Wave-particle Duality: Electromagnetic waves, Blackbody radiation (Wein's displacement law, Raleigh-Jeans paradox, Planck's law) Photoelectric and Compton effects, Pair production, Photons and gravity, De Broglie waves, Particle diffraction, Uncertainty principle I and II.

Atomic Structure and Quantum Mechanics: The nuclear atom, Electron orbits, Atomic spectra, The Bohr atom and energy levels, Correspondence principle, Nuclear motion, Atomic excitation and LASER, Wave function and wave equation, Schrodinger equation (Time independent and dependent), Quantum numbers.

Many Electron Atoms: Electron spin, Exclusion principle, Spin-orbit coupling, Total angular momentum, X-ray spectra, Frank-Hertz experiment, Zeeman effect, Statistical distributions (Maxwell-Boltzmann, Fermi-Dirac, Bose-Einstein).

Recommended Books:

1. A. Beiser, *Concepts of Modern Physics*, 6th Ed., McGraw-Hill (2008).
2. J.C. Morrison, *Modern Physics for Scientists and Engineers*, Academic Press (2009).
3. R.A. Serway and J.W. Jewett, *Physics for Scientists and Engineers*, Golden Sunburst Series, 9th Ed., 2013.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01303 MATHEMATICS-III 2+0 C.H.

Infinite Series: Sequences, Infinite series, The basis and limit comparison tests, Integral, ratio, and Cauchy's root tests, Alternating series, Absolute and conditional convergence.

Higher Order Differential Equations: Higher order homogeneous differential equations with constant coefficients, Superposition of solutions, Cauchy-Euler's equations, Systems of two first order linear homogenous equations, Nonlinear equations.

Miscellaneous Equations: Total differential equation of 1st order, System of total differential equations, Partial differential equations (P.D.E.), Formation of 1st order P.D.E., Linear P.D.E. of 1st order.

Elementary Probability Theory: The concept and axioms of probability, Discrete and continuous probability distributions, Moments of a probability distribution, Binomial, Poisson and normal distributions.

Recommended books:

1. S.M. Yousuf, A. Majeed and M. Amin, *Mathematical Methods*, 2nd Ed., Ilmi Kitabkhana Lahore, 1999.
2. E. Kreyszig, *Advanced Engineering Mathematics*, 10th Ed., John Wiley & Sons, 2010.
3. K.F. Riley, M.P. Hobson and S.J Bence, *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press, 2006.

Note: The Instructor may suggest any relevant/latest book available.

PS-401 PAKISTAN STUDIES 3+0 C.H.

*The detailed contents will be provided by the relevant department offering the course.

TSAQN-401 ARABIC FOR UNDERSTANDING QURAN 3+0 C.H.

*The detailed contents will be provided by the relevant department offering the course.

ENG-401 COMMUNICATION SKILLS 3+0 C.H.

*The detailed contents will be provided by the relevant department offering the course.

SEMESTER – IV

PHY-01401 CLASSICAL MECHANICS 3+0 C.H.

Elementary Principles: Overview of classical mechanics, Inertial frames, Brief survey of Newtonian mechanics of a system of particles, Conservation of linear and angular momentum, Constraints, Alembert's principle, Virtual work.

Variational Principle and Central Force Problem: Calculus of variation and Hamilton's principle, Derivation of Lagrange's equation from Hamilton's principle, Two body problem and its reduction to one body problem, Equation of motion and its first integral, The Virial theorem, Bertrand's theorem, The Kepler problem (Inverse-square law of force).

Kinematics of Rigid Body Motion: Orthogonal transformations, The Cayley-Klein parameters, Euler angles and theorem, The Coriolis effect, Angular momentum, Tensors and dyadic, Moment of inertia, Rigid body problems and Euler's equations of motion.

Hamilton Equation of Motion: Legendre transformation and Hamilton equations of motion, Conservation theorems, Canonical transformations, Lagrange and Poisson brackets.

Recommended Books:

1. H. Goldstein, C. Poole, J. Safko, *Classical Mechanics*, 3rd Ed., Addison Wesley (2000).

2. J.R. Taylor, *Classical Mechanics*, Edwards Brothers (2005).
3. G. Aruldhas, *Classical Mechanics*, PHI Learning Private Limited (2008).

Note: The Instructor may suggest any relevant/latest book available.

PHY-01402 LIGHT AND OPTICS 3+0 C.H.

The Nature of Light and the Principles of Ray Optics: The nature of light, Measurements of the speed of light, The ray approximation in ray optics, Huygens's principle, Dispersion, Total internal reflection.

Image Formation: Images formed by flat and spherical mirrors, Images formed by refraction, Images formed by thin lenses, Lens aberrations, The camera, The Eye, The simple magnifier, The compound microscope, The telescope.

Wave Optics: Young's double-slit experiment, Intensity distribution of the double-slit interference pattern, Change of phase due to reflection, Interference in thin films, The Michelson interferometer.

Diffraction Patterns and Polarization: Introduction to diffraction patterns, Diffraction patterns from narrow slits, Resolution of single-slit and circular apertures, The diffraction grating, Diffraction of X-rays by crystals, Polarization of light waves.

Recommended Books:

1. R.A. Serway and J.W. Jewett, *Physics for Scientists and Engineers*, Golden Sunburst Series, 9th Ed., 2013**.**
2. H.D. Young, *College Physics*, Sears and Zemansky's, 9th Ed., 2012.
3. D. Halliday, R. Resnick and J. Walker, *Fundamentals of Physics*, John Wiley & Sons, 10th Ed., 2013.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01403 MODERN PHYSICS LAB-I 0+2 C.H.

1. Estimation of carrier concentration of n-type Ge crystal by Hall measurements.
2. Estimation of Hall Coefficient of n-type Ge crystal.
3. Study of the visible part of hydrogen spectrum (Balmer series).
4. Analysis of random data by Poisson distribution.
5. Determination of Planck's constant by photoelectric effect.
6. Measurement of i) operating voltage, ii) resolving time correction and iii) random nature of the radioactive radiations using G.M. tube.
7. Determination of Rydberg's constant.
8. Charge on an electron by Millikan's oil drop method.

Note: Students must have to perform at least 06 experiments from the list provided above or any other relevant experiment available in the laboratory. Teachers should emphasize on graphical analysis and error calculations.

ES-402 INTRODUCTION TO ENVIRONMENTAL SCIENCE 3+0 C.H.

*The detailed contents will be provided by the relevant department offering the course.

LAW-402 CONSTITUTION AND LEGAL SYSTEM OF PAKISTAN 3+0 C.H.

*The detailed contents will be provided by the relevant department offering the course.

……-402 LANGUAGES 3+0 C.H.

*The detailed contents will be provided by the relevant department offering the course.

SEMESTER – V

PHY-01501 METHODS OF MATHEMATICAL PHYSICS-I 3+0 C.H.

Vector Analysis and Curvilinear Coordinates System: Review of vectors algebra, Vector differentiation, Gradient, Divergence and Curl of a vector, Vector integration, Gauss's divergence theorem, Green's theorem in the plane, Stokes' theorem, Curvilinear coordinate

system, Transformation, Orthogonal C.C., Unit vectors, Scale factors, Arc length and volume elements in C.C., Cartesian, Spherical and Cylindrical coordinate system.

Matrices and Determinants: Matrices and their types, Symmetric and anti-symmetric matrices, Eigenvalues and eigenvectors of matrices, Diagonalization of matrices, Determinants.

Tensors: The summation convention, Covariant, contravariant and mixed tensors, Rank of tensor, Kronecker delta (or tensor), Tensor algebra, Tensor field, Symmetric and Skew-symmetric tensors, Fundamental operations with tensors, Generalization of tensors, Quotient rule.

Functions of a Complex Variable: Introduction to complex variables and functions of complex variables, Cauchy-Riemann conditions and analytic functions, Harmonic and conjugate functions, Cauchy integral theorem and integral formula, Taylor and Laurent series, Calculus of residue, Complex integration.

Recommended Books:

1. G.B. Arfken, *Mathematical Methods for Physicists: A Comprehensive Guide*, 7th Ed., Academic Press (2013).
2. M.R. Spiegel, S. Lipschutz, *Schaum's Outline of Vector Analysis*, 2nd Ed., McGraw Hill Professional (2009).
3. M.R. Spiegel, *Schaum's Outline of Complex Variables*, 2nd Ed., McGraw Hill Professional (2009).
4. H.K. Dass, *Mathematical Physics*, Revised Edition, S Chand (2008).
5. Hassani, *Mathematical Physics: A Modern Introduction to its Foundations*, Springer Science and Business Media (2013).
6. T.L. Chow, *Mathematical Methods for Physicists: A Concise Introduction*, Cambridge University Press (2000).

Note: The Instructor may suggest any relevant/latest book available.

PHY-01502 BASIC ELECTRONICS (2+1) C.H.

Theory **2 C.H.**

Semiconductor and P-N junction: Energy bands and energy gaps in solids. Conduction in pure semiconductors, Doping, p-type, n-type semiconductor, p-n junction diode, its structure, characteristics and application as rectifiers (half-wave, Full wave center taped transformer and bridge circuits, PIV, average output voltage) Capacitor filters ripple factor. Diode limiting and clamping circuits, Voltage multiplier circuits.

Special Diodes: Light emitting LASER and photo diodes, Varactor diodes, Schottky diodes, Tunnel diodes and it application as oscillator, and Zener diodes its application as voltage and current regulator.

Bipolar Junction Transistor (BJT): Thevenin and Norton equivalence, Bipolar junction transistors, Biasing and stability, Common emitter, Common base and Common collector amplifiers, h-parameter model, Multistage amplifiers, Frequency response, Power amplifiers, Class A, B, AB push pull and C amplifiers and their efficiencies.

Junction Field Effect Transistor (FET): Junction FET, MOSFET, construction, operation and characteristics, biasing, common source and common drain amplifiers, frequency response.

Operational Amplifier: Ideal op-amps, simple op-amp arrangements, Differential amplifiers, op-amp applications: Inverting and non-inverting circuits, comparators, summing, integrator and differentiator. Instrumentation amplifier.

Electronics Instruments: Galvanometer, Ammeter, Voltmeter, Multimeter, and Cathode ray oscilloscope (CRO), Signal generator.

Recommended Books:

1. T.L. Floyd, *Electronic Devices*, 9th Ed., Prentice Hall (2013).
2. D.S. Sedra and K.C. Smith, *Microelectronic Circuits*, 6th Ed., Oxford University Press (2009).
3. B.L. Theraja, *Basic Electronics*, 5th Ed., S. Chand & Company Ltd, (2007).
4. R.L. Boylest and L. Nashelsky, *Electronic devices and Circuit theory*, 11th Ed., Pearson.
5. J.D. Ryder and C.M. Thomson, *Electronic Circuits and System*, Prentice Hall Inc. (Latest Edition).
6. A.P. Malvino, *Electronic Principles*, Tata McGraw Hill.

Note: The Instructor may suggest any relevant/latest book available.

Lab. 1 C.H.

1. To develop understanding and uses of electronic devices, CRO, Signal Generator, Multimeter.
2. Characteristics of a semiconductor diode (Compare Si with Ge diode).
3. Setting up of half & full wave rectifier & study of following factors:
    i. Smoothing effect of a capacitor.
    ii. Ripple factor & its variation with load.
    iii. Study of regulation of output voltage with load.
4. To set up the diode clipper (positive. Negative biased, doubled biased and Zenor diode).
5. To set up positive and negative diode clamper.
6. To set up half wave and full wave voltage doubler.
7. To set up a single stage amplifier & measure its voltage gain and bandwidth.
8. To set up and study various logic gates (AND, OR, NAND etc.) using diode and to develop their truth table.
9. To set up an electronic switching circuit using transistor LDR and demonstrate its use as a NOT Gate.
10. To set up an op-amp as inverting amplifier of a given gain.
11. To set up an Op-amp as non-inverting amplifier of a given gain.

Note: Students must have to perform at least 06 experiments from the list provided above or any other relevant experiment available in the laboratory. Teachers should emphasize on graphical analysis and error calculations.

PHY-01503 MODERN PHYSICS LAB-II 0+2 C.H.

1. Measurement of linear absorption coefficient of i) β through Al sheets, ii) γ through Pb sheets and iii) maximum energy of β particles using G.M. tube.
2. Solar cell experiments (Dark I-V characteristics and efficiency of solar cell).
3. Determination of e/m of electron using fine beam tube.
4. Study of the Zeeman Effect.
5. Study of electron diffraction.
6. Measurement of excitation potential of mercury (Frank-Hertz Experiment).
7. Measurement of speed of light in various media (air, water, glass *etc*.).
8. Determination of the linear polarization of the light produced by the He-Ne laser.

Note: Students must have to perform at least 06 experiments from the list provided above or any other relevant experiment available in the laboratory. Teachers should emphasize on graphical analysis and error calculations.

PHY-01504 ATOMIC AND MOLECULAR PHYSICS 3+0 C.H.

Atomic Structure and One Electron System: Review of Bohr's theory, Sommerfeld model, Frank Hertz experiment and approximation methods, Review of Schrodinger equation for hydrogen atom, Fermi Golden rule, Quantum numbers, Atoms in radiation field, Radiative transitions, Einstein coefficients.

Many Body Systems: Pauli exclusion principle, Spin orbit coupling, Central field approximation, Hartree Fock methods and self-consistent field, Thomas-Fermi potential, L-S, j-j and other types of coupling, X-ray spectra.

Interaction with Electromagnetic Field: Selection rules, Normal Zeeman effect, Anomalous Zeeman effect, Stark effect, Raman effect, Hyperfine structure.

Molecular Physics: Diatomic molecules, Rotational, vibrational, and electronic spectra, Born Oppenhimer approximation, Electron spin and Hund's cases, Hydrogen Molecular ion (LCAO approximation), Hydrogen molecule (Heitler London and molecular orbital theories).

Recommended Books:

1. A. Beiser, *Concepts of Modern Physics*, 6th Ed., McGraw-Hill (2008).
2. R.A. Serway and J.W. Jewett, *Physics for Scientists and Engineers*, Golden Sunburst Series, 9th Ed., 2013.
3. D.J. Griffiths, *Introduction to Quantum Mechanics*, 3rd Ed., Cambridge University Press (2008).

Note: The Instructor may suggest any relevant/latest book available.

PHY-01505 THERMAL AND STATISTICAL PHYSICS 3+0 C.H.

Equilibrium Thermodynamics: Phase space, Basic postulates, Fundamental equations and equations of state, Multiplicity function, Response functions, Maxwell's relation, Reduction of derivatives.

Probability and Statistics: Probabilities, Distribution functions, Statistical interpretation of entropy, Boltzmann H-theorem, Ensembles, Counting of states (in classical and quantum mechanical systems), Partition function, Boltzmann distribution, Formation of micro-canonical, canonical and grand canonical partition function.

Partition Function: Relations of partition function with thermodynamic variables, Examples (collection of simple harmonic oscillators), Pauli and Van-Vleck paramagnetism, Theorem of Equipartition of energy, most probable distribution, Quantum concentration (Thermal wavelength, Free energy, Fermi gas at low temperatures), Chemical potential.

Statistical Mechanics of Interacting Systems: Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac statistical systems (and examples of thermodynamics of these systems), Black body radiations, Electron gas in solids, Van der Waals gas, Mean field calculation, Fluctuations, Bose-Einstein condensation, Density matrix approach.

Books Recommended:

1. C. Kittel, H. Kroemer, *Thermal Physics*, 2nd Ed., W.H. Freeman and Company (1980).
2. S.K. Roy, *Thermal Physics and Statistical Mechanics*, New Age International (2011).
3. F. Mandl, *Statistical Physics*, 2nd Ed., ELBS/John Willey (1988).
4. H. Gould, J. Bochnik, *Thermal and Statistical Physics*, Open Court Publishing Company (2006).

Note: The Instructor may suggest any relevant/latest book available.

PHY-015XX ADVANCED ELECTIVE-I 3+0 C.H.

SEMESTER – VI

PHY-01601 METHODS OF MATHEMATICAL PHYSICS-II 3+0 C.H.

Differential Equations in Physics: Introduction to differential equations and their types, Separation of variables, Homogeneous differential equations, Linear and exact differential equations.

Integral Transforms: Fourier transform and its properties, Fourier sine and cosine transform, Convolution theorem, Elementary Laplace transform and its application, Inverse Laplace transform, Solution of differential equations by using Laplace transform.

Special Functions: Introduction to special functions and series solution, Bessel functions and Recurrence relations, Legendre polynomials, Laguerre polynomials, Hermite polynomials, Applications of special functions.

Green's Function: Introduction to Green's function, Strum-Liouville operator, Construction of Green's function, Applications of Green's function to non-homogeneous problems.

Recommended Books:

1. G.B. Arfken, *Mathematical Methods for Physicists: A Comprehensive Guide*, 7th Edition, Academic Press (2013).
2. M.R. Spiegel, S. Lipschutz, *Schaum's Outline of Vector Analysis*, 2nd Edition, McGraw Hill Professional (2009).
3. M.R. Spiegel, *Schaum's Outline of Complex Variables*, 2nd Edition, McGraw Hill Professional (2009).
4. H.K. Dass, *Mathematical Physics*, Revised Edition, S Chand (2008).
5. Hassani, *Mathematical Physics: A Modern Introduction to its Foundations*, Springer Science and Business Media (2013).
6. T.L. Chow, *Mathematical Methods for Physicists: A Concise Introduction*, Cambridge University Press (2000).

Note: The Instructor may suggest any relevant/latest book available.

PHY-01602 SOLID STATE PHYSICS-I 3+0 C.H.

Structure of Solids: Lattices and basis, Symmetry operations, Fundamental types of lattices, Position and orientation of planes in crystals, Simple crystal structures, Atomic potential and binding forces.

Crystal Diffraction and Reciprocal Lattice: Diffraction of X-rays, Neutrons and electrons from crystals, Bragg's law, Reciprocal lattice, Reciprocal lattice to sc, bcc, fcc, orthorhombic and hexagonal crystals, Laue's method, Rotating crystal method, Powder method, Scattered wave amplitude, Ewald construction and Brillouin zone, Fourier analysis of the basis.

Phonons and Lattice Vibrations: Vibrations of 1D monoatomic and diatomic lattices (dispersion relations), Phonons, Momentum of phonons, Inelastic scattering of photons by phonons, Lattice heat capacity, Classical model, Einstein model, Density of state in one, two and three dimensions, Debye model of heat capacity, Comparison with experimental results, Thermal conductivity and resistivity, Umklapp processes.

Free Electron Fermi Gas: Free electron gas in one and three dimensions, Quantum state and degeneracy, The density of states, Fermi-Dirac statistics and Effect of temperature, Electrical conductivity and Ohm's law, Thermionic emission, Hall's effect.

Recommended Books

1. C. Kittle, Introduction to Solid State Physics, 8th Edition, John Wiley & Sons, Inc. 2005.
2. M.A. Wahab, Solid State Physics, 2nd Edition, Narosa Publishing House, 2015.
3. M.A. Omar, Elementary solid-state physics: Principles and applications. Pearson Education, 2009.
4. J.S. Blakemore. Solid State Physics. Cambridge University Press, 1991.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01603 ELECTRONIC CIRCUITS AND DEVICES (2+1) C.H.

Theory: 2 C.H.

Thyristors and Special Devices: Schockley diode, Silicon Controlled Rectifier (SCR), LASCR and SCS, Diac, Triac, Unijunction transistor (UJT) and PUJT, Phototransistor.

Oscillators: Oscillator principles, RC feedback oscillators (Wein-Bridge, Phase shift). LC Feedback oscillator (Hartley and Colpitts oscillators). Relaxation oscillator (Triangular Wave, Sawtooth wave, Square wave)

Multivibrators Bistable, Monostable and Astable multivibrators, using BJT.555 timer as an Astable and monostable multivibrators.

Active Filters: Basic filter response, Active Low pass, High pass, Band pass and Band stop filters.

Voltage Regulators: Voltage regulation, basic series, shunt and switching regulators, integrated circuit voltage regulators.

Communication Circuits: Fundamental of modulation, Amplitude modulation, the frequency and power spectrum in AM, the linear detection for AM signals, Basic receivers, Super heterodyne AM receiver, Frequency modulation, The frequency spectrum of FM signals.

Recommended Books:

1. T.L. Floyd, *Electronic Devices*, 9th Ed., Prentice Hall (2013).
2. D.S. Sedra and K.C. Smith, *Microelectronic Circuits*, 6th Ed., Oxford University Press (2009).
3. B.L. Theraja, *Basic Electronics*, 5th Ed., S. Chand & Company Ltd, (2007).
4. R.L. Boylest and L. Nashelsky, *Electronic devices and Circuit theory*, 11th Ed., Pearson.
5. J.D. Ryder and C.M. Thomson, *Electronic Circuits and System*, Prentice Hall Inc. (Latest Edition).
6. A.P. Malvino, *Electronic Principles*, Tata McGraw Hill.

Note: The Instructor may suggest any relevant/latest book available.

Lab. 1 C.H.

1. Introduction to components and laboratory equipment and their use.
2. Design and construct a single stage R-C coupled Common source amplifier.

3. Design and construct a- stable multivibrator using BJT.
4. Design and construct monostable multivibrator using BJT.
5. Design and construct bistable multivibrator using BJT.
6. Design and construct a- stable multivibrator using 555 timers.
7. Design and construct monostable multivibrator using 555timer.
7. Illustrate the on/off application (burglar) alarm of a silicon-controlled rectifier.
8. Design and construct an R-C phase shift oscillator using BJT or Op-Amp.
9. Design and construct square-wave oscillator using op-amp.
10. Design a low pass and high pass filter circuit using Op-Amp and draw its response.
11. Design and construct a dual-polarity dc voltage power supply using IC voltage regulators.

Note: Students must have to perform at least 06 experiments from the list provided above or any other relevant experiment available in the laboratory. Teachers should emphasize on graphical analysis and error calculations.

PHY-01604 ADVANCED PHYSICS LAB. 0+2 C.H.

1. Verification of Bragg's law conditions using microwaves.
2. Verification of Bragg's law using X-ray diffraction technique.
3. Determination of dielectric constant of a liquid/solid.
4. Detection of the conductivity of a liquid as a function of temperature and concentration.
5. Calibration of a thermocouple and measurement of melting point of a given solid.
6. Determination of wavelength of LASER light using diffraction grating.
7. Study of B-H curve for ferromagnetic materials.
8. Study of Faraday Effect.

Note: Students must have to perform at least 06 experiments from the list provided above or any other relevant experiment available in the laboratory. Teachers should emphasize on graphical analysis and error calculations.

PHY-01605 QUANTUM MECHANICS-I 3+0 C.H.

Origin of Quantum Physics: Historical note, Particle aspect of radiation (Black body radiation, Photoelectric effect, Compton effect, Pair production), Wave aspect of particles (de-Broglie hypothesis and matter waves), Classical and quantum views of particles and waves, Wave-particle duality and principle of superposition, Heisenberg's uncertainty principle and quantization rules, Wave packets.

One-Dimensional Problems: Time-independent Schrodinger equation, Hamiltonian, Properties of one-dimensional motion (Bound and unbound states), The free particle, The potential step, The potential barrier and well, Tunneling effect, The infinite square-well potential (Symmetric and unsymmetric potential wells), The finite square well potential (Scattering and bound state solutions), The harmonic oscillator.

Operators and Measurements: Postulates of quantum mechanics, Stern-Gerlach experiment, Hilbert space and quantum state vectors, Matrix notation, General quantum systems, Operators, Eigenfunctions, eigenvalues and eigenvectors, Matrix representation of operators, Diagonalization of operators, Hermitian and projection operators, Parity operator, Inverse and unitary operators, Commuting observables, Spin component in a general direction, S^2 operator, Spin-1 system, Orthonormality, Expectation values, Dirac notation.

Angular Momentum: Classical angular momentum, Quantum mechanical angular momentum, Orbital angular momentum, Spin angular momentum, Eigenfunctions of orbital angular momentum (Eigenfunctions and eigenvalues of $\hat{L}_z$, Eigenfunctions of $\hat{\vec{L}}^2$,).

Recommended Books:

1. D. McIntyre, C.A. Manogue, J. Tate, *Quantum Mechanics: A Paradigm Approach*, Addison Wesley Publishing Company (2012).
2. R.L. Liboff, *Introductory Quantum Mechanics*, 4th Ed., Addison Wesley Publishing Company (2002).
3. D.J. Griffiths, *Introduction to Quantum Mechanics*, 3rd Ed., Cambridge University Press (2008).
4. N. Zettili, *Quantum Mechanics: Concepts and Applications*, 2nd Ed., John Wiley and Sons Ltd. (2009).

Note: The Instructor may suggest any relevant/latest book available.

PHY-016XX ADVANCED ELECTIVE-II 3+0 C.H.

SEMESTER – VII

PHY-01701 ELECTRODYNAMICS-I 3+0 C.H.

Review of Vector Analysis: Vector algebra (Vector operations, Triple products, How vectors transform), Differential calculus (Gradient, the Del operator, the divergence, the curl), Integral calculus (Line, Surface, and Volume integrals), Curvilinear coordinates (Spherical and cylindrical), The Dirac Delta function (One and three dimensional).

Advanced Approach in Electrostatics: The electric field, Continuous charge distributions, Electric dipole, Multipole expansion of electric fields, Divergence and curl of electrostatic fields, Electric potential, Potential of a localized charge distribution, Boundary conditions.

Problems in Electrostatics: Poisson's and Laplace equations, Uniqueness theorem, Laplace equation in one independent variable, Solution to Laplace equation in spherical coordinates (Zonal harmonics), Laplace in rectangular coordinates, Conduction sphere in a uniform electric field, Electrostatic images, Point charge and conducting sphere.

Electric Fields in Matter: Dielectrics, Induced dipoles, Polarization, Bound charges, The field inside a dielectric, The electric displacement, Gauss's law in presence of dielectrics, Susceptibility, permittivity, dielectric constant, Energy and forces in dielectrics.

Recommended Books:

1. David J. Griffiths, *Introduction to Electrodynamics*, 4th Edition, Pearson, 2013
2. J.D. Jackson, *Classical Electrodynamics*, 3rd Edition, John Wiley & Sons Inc., New York, USA, 1999.
3. J.R. Reitz, F.J. Milford and R.W. Christy, *Foundations of Electromagnetic Theory*, 4th Edition, Addison-Wesley, 1992.

Note: The Instructor may suggest any relevant/latest/reputed book available.

PHY-01702 SOLID STATE PHYSICS-II 3+0 C.H.

Band Theory: Nearly free electron model, Bloch function and theorem, The Kronig-Penney model, Construction of Brillouin Zones (one, two & three dimensions), Extended, reduced and periodic zone schemes, Effective mass and speed of an electron, Conductors, semiconductors and insulators.

Magnetism in Solids: Magnetism (History and types), Diamagnetism (Langevin's classical theory, Quantum theory), Paramagnetism (Langevin's classical theory, Quantum theory), Ferromagnetism (Weiss theory), Nature and origin of Weiss molecular field, Concepts of domains and hysteresis, Antiferromagnetism, Ferrimagnetism.

Superconductivity: Electrical resistivity, Meissner effect, Supercurrents and penetration depth, Critical field and temperature, Type I and II superconductors, Isotope effect, Flux quantization, Josephson Effects and tunneling, BCS theory, High temperature ceramic superconductors.

Dielectric Properties of Solids: Polarization and susceptibility, Dielectric constant and polarizability, Sources of polarizability, Electronic, ionic and dipolar polarizability, Ferroelectricity, Piezoelectricity.

Recommended Books

1. C. Kittle, Introduction to Solid State Physics, 8th Edition, John Wiley & Sons, Inc. 2005.
2. M.A. Wahab, Solid State Physics, 2nd Edition, Narosa Publishing House, 2015.
3. M.A. Omar, Elementary solid-state physics: Principles and applications. Pearson Education, 2009.
4. J.S. Blakemore. Solid State Physics. Cambridge University Press, 1991.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01703 QUANTUM MECHANICS -II 3+0 C.H.

Approximate Methods: Time independent perturbation theory for non-degenerate and degenerate levels, the Variational method, and WKB approximation, Time dependent

perturbation theory (Transition probability, Transition probability for a constant and harmonic perturbation).

Theory of Scattering: Scattering experiments and cross sections, Potential scattering, the method of partial waves (Elastic and inelastic scattering), The Born's approximation, Application of Quantum Mechanics for the interaction of quantum systems with radiation; Electromagnetic field and its interaction with one electron system, the spin of photon and its helicity.

Identical Particles: Indistinguishability of identical particles, Systems of identical particles (Exchange degeneracy, Symmetrization postulate, Symmetric and anti-symmetric functions), Quantum dynamics of identical particle systems, Statistics, Symmetry of states, Fermions, Bosons, Concept of Entanglement.

Relativistic Quantum Mechanics: Schrodinger relativistic equation, Probability and current densities, Klein-Gordon equation, Dirac relativistic equation.

Recommended Books:

1. D. McIntyre, C.A. Manogue, J. Tate, *Quantum Mechanics: A Paradigm Approach*, Addison Wesley Publishing Company (2012).
2. R.L. Liboff, *Introductory Quantum Mechanics*, 4th Ed., Addison Wesley Publishing Company (2002).
3. D.J. Griffiths, *Introduction to Quantum Mechanics*, 3rd Ed., Cambridge University Press (2008).
4. N. Zettili, *Quantum Mechanics: Concepts and Applications*, 2nd Ed., John Wiley and Sons Ltd. (2009).

Note: The Instructor may suggest any relevant/latest book available.

PHY-01704 COMPUTATIONAL PHYSICS 2+2 C.H.

Revision of basic concepts of scientific computing.

Nature of solution of a problem, Characteristics of numerical computing, Absolute, relative and percentage error, Chopping off and rounding off error, Truncation error, Order of error, Propagation of error, Algorithm, Rules for algorithm design, Programming and flowcharting. Introduction to numerical solutions of transcendental equations, Root, Iterative methods, Search method for initial guess, Bisection method, False position method, Newton-Raphson method, Secant method, Comparison of different root methods.

Introduction to elimination methods for solving simultaneous equations. Gauss elimination method.

Solution of simultaneous equations by iterative methods, System of non-linear systems. Introduction to interpolation and extrapolation, Polynomial interpolation, Lagrange's interpolation method, Newton's divided difference interpolation, Applications of interpolation. Solutions of ordinary differential equations, Runge-Kutta method for different orders. Numerical Integration: Trapezoidal rule, The Newton-Cotes integration Formula (Simpson's 1/3rd rule and Simpson's 3/8th rule).

Recommended Books:

1. Joseph F. Boudreau, Eric Scott Swanson, *Applied Computational Physics*, Oxford University Press (2018).
2. Omair Zubairi and Fridolin Weber, *Introduction to Computational Physics for Undergraduates*, 4th Ed., Morgan & Claypool Publishers (2018).
3. M.L. De Jong, *Introduction to Computational Physics*, Addison Wesley Publishing Company Inc., Massachusetts (1991).
4. S.T. Koonini, *Computational Physics*, The Benjamin/Coming Publishing Inc., California (1986).
5. P.K. Macheown and D.J. Merman, *Computational Techniques in Physics*, Adm Hilger, Bristol (1987).

Note: The Instructor may suggest any relevant/latest book available.

PHY-017XX ADVANCED ELECTIVE-III 3+0 C.H.

SEMESTER – VIII

PHY-01801 ELECTRODYNAMICS-II 3+0 C.H.

Magnetostatics: The Lorentz force law, Steady currents, The magnetic field of a steady current, The Divergence and Curl of **B**, Straight-line currents, Ampère's law, Comparison of magnetostatics and electrostatics, Magnetic vector potential, Multipole expansion of the vector potential.

Magnetic Fields in Matter: Magnetic dipole moment, Magnetization, Diamagnets, Paramagnets, Ferromagnets, Torques and forces on magnetic dipoles, Effect of a magnetic field on atomic orbits, Bound currents, The magnetic field inside matter, The auxiliary field **H**, Magnetic susceptibility and permeability.

Maxwell's Equations and Applications: Electrodynamics before Maxwell, How Maxwell fixed Ampère's law, Maxwell's equations, Magnetic charge, Maxwell's equations in matter, Boundary conditions, Plane monochromatic waves in non-conducting and conducting media, Reflection and refraction at the boundary of two non-conduction media (normal incidence, oblique incidence), Brewster's angle, Critical angle.

Optical Dispersion in Materials: Drude Lorentz Harmonic oscillator model, Resonance absorption by bound charges, Cauchy's relation, The Drude free electron theory, Kramers-Kronig relations, Guided waves.

Recommended Books:

1. David J. Griffiths, *Introduction to Electrodynamics*, 4th Edition, Pearson, 2013
2. J.D. Jackson, *Classical Electrodynamics*, 3rd Edition, John Wiley & Sons Inc., New York, USA, 1999.
3. J.R. Reitz, F.J. Milford and R.W. Christy, *Foundations of Electromagnetic Theory*, 4th Edition, Addison-Wesley, 1992.

Note: The Instructor may suggest any relevant/latest/reputed book available.

PHY-01802 NUCLEAR PHYSICS 3+0 C.H.

Nucleus, Nuclear Forces and Models: Nuclear spin, Magnetic dipole and electric quadrupole moment, Parity and statistics, Yukawa's theory of nuclear forces, Nucleon scattering, Charge independence and spin dependence of nuclear force, Isotopic spin, Liquid drop model, Fermi gas model, Shell model, Collective model.

Theories of Radioactive Decay: Theory of Alpha decay, Measurement of Beta ray energies, The magnetic lens spectrometer, Fermi theory of Beta decay, Neutrino hypothesis, Theory of Gamma decay, Multipolarity of Gamma rays, Nuclear isomerism.

Nuclear Reactions: Conservation laws of nuclear reactions, Q-value and threshold energy of nuclear reaction, Cross sections for nuclear reactions, Compound nucleus theory of nuclear reaction and its limitations, Theory of nuclear fission and thermonuclear reactions, Breit-Wigner one level formula.

Detectors and Accelerators: Interaction of nuclear radiation with matter, Gas-filled detectors (Ionization chamber, Proportional and GM counter), Scintillation counter, Van-de Graff generator, Linear accelerator, Cyclotron, Synchro-cyclotron, Betatron.

Elementary Particles: Strong *e.m.* and weak interactions (Salam Weinberg model), Quark model, Hadrons (quark-antiquark states, three quarks states), Neutrinos and anti-neutrinos, Muons, Pions, K-Mesons, Hyperons, Concepts of Charm, Beauty and other such particles.

Recommended Books:

1. B.R. Martin, *Nuclear Physics and Particle Physics: An Introduction*, 2nd Ed., Wiley (2009).
2. S.B. Patel, *Nuclear Physics: An Introduction*, 2nd Ed., Anshan (2011).
3. I. Kaplan, *Nuclear Physics*, 2nd Ed., Addison Wesley Publishing Company (1980).
4. Anwar Kamal, *Nuclear Physics*, Springer-Verlag Berlin Heidelberg (2014).
5. Stefaan Tavernier, *Experimental Techniques in Nuclear and Particle Physics*, Springer-Verlag Berlin Heidelberg (2010).

Note: The Instructor may suggest any relevant/latest book available.

PHY-01803 DIGITAL LOGIC DESIGN (2+1) C.H.

Theory: 2 C.H.

Number Systems and Logic Gates: Binary, Octal and hexadecimal numbers systems, their inter-conversion, Binary arithmetic, Signed numbers, Different codes (BCD, ASCII, Gray *etc*.), Parity in codes, Digital and analog quantities, Concepts of logic, Truth table, Basic logic gates, NAND, NOR, Exclusive-OR, Exclusive NOR gates, Basic characteristics of a logic family (fan-in, fan-out, propagation delay time, power dissipation, noise margins *etc*.), Boolean laws, De-Morgan's theorem, Simplification of Boolean expression by Boolean laws and theorems, Standard forms of Boolean expressions, K-maps and their uses.

Combinational Logic Circuit: Half adder, Full adder, Comparators, Encoders, Decoders, Code converters, Multiplexers, Demultiplexers.

Flip-Flops and Counters: Latches, Edge-triggered flip-flops (D-FF, T-FF, JK-FF), Operating characteristics of flip-flops, Asynchronous counter operation, Synchronous counter operation, UP/Down synchronous counters, Cascaded counters, Counter Decoding.

IC's and Registers: TTL Subfamilies and Characteristics, CMOS subfamilies and specifications, Interfacing TTL to CMOS, Emitter Coupled Logic (ECL), Interfacing (ECL) to other Logic Families, Basic shift register functions, Serial In/Serial Out, Parallel In/Serial Out, Parallel In/Parallel Out Shift Registers, Bidirectional shift register, Shift register counters, Shift register applications.

Recommended Books:

1. L.D. Jones, *Principles and Applications of Digital Electronics*, Macmillan Publishing Company.
2. B. Holdworth and C. Woods, *Digital Logic Design*, 4th Ed., Elsevier (2002).
3. M.M. Mano, *Digital Logic and Computer Design*, Prentice Hall of India.
4. R.L. Tokheim, *Digital Electronics*, McGraw Hill.
5. T.L. Floyd, *Digital Fundamentals*, Prentice Hall (2009).

Note: The Instructor may suggest any relevant/latest book available.

Lab. 1 C.H.

1. Introductory digital experiments.
2. Constructing a logic probe.
3. Number systems.
4. Logic gates.
5. Boolean laws and DeMorgan's theorem.
6. Logic circuit simplification.
7. The perfect pencil machine
8. Adder and magnitude comparator.
9. Combinational logic using multiplexer.
10. The D latch and D flip-flop.
11. The J-K flip flop.
12. Four digit decades counter.
13. Two digit up/down counter.
14. Twenty-four hour digital clock.
15. The Fillmore Furniture Factory.

Note: Students must have to perform at least 06 experiments from the list provided above or any other relevant experiment available in the laboratory. Teachers should emphasize on graphical analysis and error calculations.

PHY-01804 PROJECT (Report+Poster+Study tour*) 3+0 C.H.

PHY-018XX ADVANCED ELECTIVE-IV 3+0 C.H.

ADVANCED ELECTIVE-I

PHY-01506 INTRODUCTION TO MEDICAL PHYSICS 3+0 C.H.

Medical physics and imaging principles: intensity, resolution, contrast, X-ray physics; Photon interactions: Attenuation, X-ray imaging, X-ray production & detection, Mammography, Computed tomography, Nuclear medicine physics: Radioactivity, Nuclear medicine imaging, radioisotope production; SPECT; PET; Radiation exposure physics; radiobiology, dosimetry, kerma; Radiation exposure principles: safety, risk, radiation therapy, radiation protection; Ultrasound physics: waves, reflection, transmission, attenuation; Ultrasound imaging principles: echoes, resolution, speckle, Doppler; Nuclear magnetic resonance physics: Magnetic moment, Magnetization, Relaxation, Nuclear magnetic resonance spectroscopy (NMRS) and imaging; MRI principles: chemical shift, magnetic resonance signal induction and relaxation, pulse sequences, spatial encoding.

Recommended Books:

1. W.R. Hendee and E.R. Ritenour. Medical Imaging Physics. 4th Edition John Wiley & Sons, 2003.
2. Faiz M Khan, John P Gibbons. Khan's the Physics of Radiation Therapy. 5th Edition, Lippincott Williams & Wilkins, 2014.
3. Leonard L. Clinical Radiation Oncology. 4th Edition. Elsevier Health Sciences, 2015.
4. Jerrold T Bushberg. The Essential Physics of Medical Imaging. 3rd Edition, Lippincott Williams & Wilkins, 2011.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01507 MATERIALS WORLD 3+0 C.H.

Historical Perspective, Classification of Materials: Metals, Semi-metals, Spin-polarized Materials, Half-metals, Dielectrics, Ceramics, Polymers, Composites, Glasses, Semiconductors, Spin Gapless Semiconductors, Superconductors, Energy Storage Materials, Smart Materials, Nano Materials, Bio-materials, Advanced Materials, Ultra-hard Materials, Transparent Conducting Oxides (TCOs), Magnetic Materials (Diamagnetic, Paramagnetic, Ferromagnetic, Antiferromagnetic, Ferrimagnetic materials), Dilute Magneto Semiconductors, Ferroelectrics, Piezoelectric Materials.

Imp. The main theme of the course is to give basic information of these materials to the students without going into the details.

Recommended Books:

1. Callister Jr, W. D., & Rethwisch, D. G. (2020). *Callister's materials science and engineering*. John Wiley & Sons.
2. Kakani, S. L. (2004). *Material science*. New Age International (P) Ltd., Publishers.
3. Kittel, C. (2005). Introduction to solid state physics, John Wiley & Sons. *Inc., Sixth edition,(New York, 1986)*.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01508 INTRODUCTION TO SEMICONDUCTOR PHYSICS 3+0 C.H.

Introduction; a survey of semiconductors, elemental semiconductors, binary compounds, oxides, layered semiconductor, organic/inorganic semiconductors, crystals and semiconductor materials and structure theory, properties of widely exploited semiconductors; group iv (e.g. Si) and III-V compounds (e.g. GaAs), impurities and artificial doping of semiconductors, charge carriers in bands (Fermi-dirac and Boltzmann distributions), effective density of states, fermi energy in intrinsic and extrinsic semiconductors, variation of conductivity and mobility with temperature, law of mass action, hall effect. Introduction to electronic and photonic devices; metal-semiconductor junctions. Schottky vs. Ohmic junctions, p-n junctions and diode behavior and their applications. Transistor, bipolar junction transistors and field effect transistors.

Recommended Books:

1. M.S. Tyagi. Introduction to Semiconductor materials and devices. John Wiley and Sons, 2017.
2. David K. Ferry. Semiconductors. Macmillan Publishing Co. New York, 2017.
3. C. Kittel. Introduction to Solid State Physics. John Wiley & Sons, Inc., New York, 2018.
4. S.M. Sze. Physics of Semiconductor Devices. 3rd Edition, John Wiley and Sons Inc., 2004.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01509 PHYSICS AT NANOSCALE 3+0 C.H.

Introduction and basic theory. Origins and nature of nanotechnology, Nanotechnology in society, Current issues, The wave-like nature of electrons, Standing waves and electron energy levels. Travelling waves, Reflection and tunneling. Electrons in metals. Nanomaterials: Length scales, Top down and bottom up approaches. Importance of the surface, Engineering Materials, Particle Shape and the surface, Surface and volume, Atomic structure, Particle orientation, Materials at nanoscale. Common growth methods, Properties of selected nanomaterials, including magnetic materials, dielectric materials, optical materials, carbon nanotubes, metallic nanoclusters. Graphene. Quantum dots. Nano semiconductors. Nanoheterostructures.

Recommended Books:

1. C. S .Barrett, Structure of Metals (McGraw-Hill). A.V. Tobolsky, Properties and Structure of Polymers (John-Wiley and Sons).
2. F.C.Phillips, An Introduction to Crystallography (John-Wiley and Sons).A.H.Cottrell, Theory of Dislocations in Crystals (Gordon and Breach) \Maser. R. (ed)
3. Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices (Wiley-VCH, Weinheim, 2003).
4. Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience » E. L. Wolf, Willey-VCH 2015

Note: The Instructor may suggest any relevant/latest book available.

ADVANCED ELECTIVE-II

PHY-01606 PHYSICS OF RADIATION THERAPY 3+0 C.H.

Definition and basic objects in radiotherapy; Use of ionizing radiation in radiotherapy for controller effects in cancer patients; measurement and calculation of absorbed dose; dose distribution and scatter analysis; Treatment planning: Isodose distribution patient data, corrections and setup, field shaping skin dose and field separation; electron beam therapy; Teletherapy; Treatment planning and its implementation; Treatment planning by computer; Brachytherapy: calibration of brachytherapy sources, exposure rate calibration; Treatment planning for implant therapy; Tumor and normal tissue dose computation by manual & computerized techniques, use of wedge filters, bolus & tissue compensators; Heavy particle therapy; Introduction to chemotherapy, quality control and assurance procedures; General description of a linear accelerator and its component systems, Basic processes in electron acceleration, The accelerating waveguide, Microwave system & its high-voltage supplies, Vacuum, cooling & ancillary systems, Electron beam (production & transport), Treatment head, Dose monitoring and control system, Treatment verification, Radiation protection & room design, Accelerator operation, Simulators & topographic scanners, Contemporary developments, installation & commissioning of Linear accelerators (linacs), testing procedures of linacs, mechanical testing & optical of linacs, beam shaping characteristics, Multileaf Collimators (MLCs), Portal imaging.

Recommended Books:

1. Faiz M Khan, John P Gibbons. Khan's the Physics of Radiation Therapy 5th Edition, Lippincott Williams & Wilkins, 2014.
2. Hendee WR, Ibbott GS, Hendee EG. Radiation Therapy Physics. John Wiley & Sons, 2013.
3. Bryon G, Dasher, Anne Marie Vann. Portal Design in Radiation Therapy. R.L. Bryan Company, 2006.
4. Karzmark CJ, Morton RJ, James L, Corporation MPP. A Primer on Theory and Operation of Linear Accelerators in Radiation Therapy. Medical Physics Publishing, Incorporated; 3rd Edition, 2018.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01607 BASIC PROPERTIES OF MATERIALS 3+0 C.H.

Thermal Properties: The Specific Heat of Solids, The Classical Model, The Einstein Model, The Density of States, The Debye Model, Thermal Resistance of Solids.

Semiconducting Properties: Free Carrier Concentration, Fermi Level and Carrier Concentration, Mobility of Charge Carriers, Effect of Temperature on Mobility, Electrical Conductivity of Semiconductors, Hall Effect in Semiconductors.

Dielectric Properties: Dipole Moment and Polarization, Electric Field of a Dipole, Local Electric Field at an Atom, Dielectric Constant and Polarizability, The Classical Theory of Electronic Polarizability, Dipolar Polarizability, Piezo-, Pyro- and Ferroelectric Properties of Crystals.

Optical Properties: Absorption Process, Photoconductivity, Photoelectric and Photovoltaic Effects, Photoluminescence, LASER and MASER.

Recommended Books:

1) M.A. Wahab, *Solid State Physics*, 2nd Ed., Narosa Publishing House (2005).
2) C. Kittel, *An Introduction to Solid State Physics*, 8th Ed., John-Wiley and Sons (2005).
3) M.A. Omar, *Elementary Solid State Physics*, Pearson Education (2000).

Note: The Instructor may suggest any relevant/latest book available.

PHY-01608 SEMICONDUCTORS AND NANOTECHNOLOGY 3+0 C.H.

Introduction of nanomaterials and nanotechnologies, features of nanostructures, background of nanostructures, synthesis techniques of nanomaterials, tools of nanoscience, applications of nanomaterials and technologies. Bonding and structure of the nanomaterials, predicting the type of bonding in a substance crystal structure, implications for semiconductor physics, nano-structures; various types of nano-semiconductor structures and nano-crystals. Classification of bulk nanostructured semiconductor materials, 0D, 1D, 2D structures, size effects, surfaces of materials, thermal properties of nanomaterials. Electrical properties, conductivity and resistivity, nano thin films, and nanocomposites.

Recommended Books:

1. Introduction to Nanoscale Science and Technology (Nanostructure Science and Technology) by Massimiliano Ventra, Stephane Evoy and James R. Heflin (Jun 30, 2004)
2. Nanostructures and Nanomaterials: Synthesis, Properties, and Applications (World Scientific Series in Nanoscience and Nanotechnology) by Guozhong Cao and Ying Wang (Jan 3, 2011)
3. Understanding Nanomaterials by Malkiat S. Johal (Apr 26, 2011)

Note: The Instructor may suggest any relevant/latest book available.

PHY-01609 NANOCRYSTALS 3+0 C.H.

Structure of atoms, Types of bonds and bonding in metals, Ionic bond, Covalent bond, Metallic bond, Crystal systems, Structure and crystal geometry, Imperfections in crystals, Grain boundaries, Dislocations, stacking faults, Frenkel and Schottky disorder, Nanocrystals and nanostructures, 0-D, 1-D, 2-D, 3-D Structures, Particulates, Colloids, Liquid crystals, Thin films, Synthesis of nanomaterials, Wet synthesis, Dry synthesis, Mechanical grinding, Annealing, Sintering, Calcination. Structural characterization of nano-architectures.

Recommended Books.

1. Solid State Physics: An introduction to Materials Science, H. Ibach, H. Luth, Springer-Verlag. 4th edition, 2009.
2. Principles of Materials Science and Engineering Smith, W.F., McGraw Hill, 1996
3. Nanostructures and nanomaterials, synthesis, properties and applications, Cao, Guozhong, Imperial College Press, 2004
4. Nanostructured materials, processing, properties and potential applications, Carl C. Koch, Noyes publications, William Andrew publishing, NY, USA, 2002.

Note: The Instructor may suggest any relevant/latest book available.

ADVANCED ELECTIVE-III

PHY-01706 RADIATION PROTECTION AND HEALTH PHYSICS 3+0 C.H.

Radiation quantities & units; International organizations setting standards, Radiation Protection standards; Principles & control of external & internal exposure hazards; absorbed dose

estimation from external exposure; Health Physics instrumentation; Dose estimation from internally deposited radionuclides; Radiation accident management & early medical treatment of radiation injury; Patient doses audit, Shielding and other design considerations for medical facilities, Regulatory and licensing requirements for medical facilities; Radioactive waste disposal methods, Handling of I-131 therapy patients; Practical demonstrations of radiation protection procedures in health physics, i.e. SSDL, whole body counting, bioassay counting; Verification of inverse squre law; Calibration of survey meters; Bioassay technique.

Recommended Books:

1. Claus Grupen. Introduction to Radiation Protection: Practical Knowledge for Handling Radioactive Sources. Springer Science & Business Media, 2010.
2. Alan Martin and Samuel, A Harbison. An Introduction to Radiation Protection. 2nd Edition, Springer, 2013.
3. ICRP Publication No.26. Recommendations of International Commission on Radiological Protection. Pergamon Press, 1977.
4. Jaeger RG, Agency IAE. Engineering Compendium on Radiation Shielding: Volume I: Shielding Fundamentals and Methods: Springer Berlin Heidelberg, 2013.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01707 MECHANICS OF MATERIALS 3+0 C.H.

Mechanical Properties of Materials: The tension and compression test, Stress-strain curve, Stress- strain behavior of ductile & brittle materials, Liner elasticity, Hook s Law and Poisson ratio, Volumetric strain and its expression, Elastic constant, Shear stress & strain, Mohr's circle for plane stress, Work and strain energy.

Axial Load and Torsion: Saint-venant's principle, Elastic deformation of an axially loaded member, Thermal and residual stress, Torsional formula, Power transmission, Angle of twist, Inelastic torsion.

Bending and Loading: Shear and moment diagram, Bending deformation of a straight member, The Flexure formula, Unsymmetric bending, Inelastic bending, The shear formula, State of stress caused by combined loading.

Energy Methods: External work and strain energy, Elastic strain energy for various types of loading, Conservation of energy, Principle of virtual work, Castigliano's Theorem.

Recommended Books:

1. R C Hibbler, *Mechanics of Materials*, Pearson, 10th Ed., 2018**.**
2. J. R. Barber, *Intermediate Mechanics of Materials*, McGraw-Hill, 2nd Ed., 2000.
3. D. Halliday, R. Resnick and J. Walker, *Fundamentals of Physics*, John Wiley & Sons, 10th Ed., 2013.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01708 FABRICATION AND CHARACTERIZATION TECHNIQUES 3+0 C.H.

Introduction to semiconductor growth techniques; Czochralski method, Bridgman method, chemical vapor deposition, molecular beam epitaxy, liquid phase epitaxy, vapor phase epitaxy. Chemical synthesis techniques; sol gel, microemulsion, co-precipitation, and hydrothermal methods. Fabrication of semiconductor devices/structures, characterization of solid materials; bulk, surface, and interface characterization techniques. Vacuum concepts. Sample preparation information, production of electrons & ions from sources. X-ray diffraction, scanning electron microscopy, UV-Visible, photoluminescence, and electrical measurements.

Recommended Books:

1. Hartmut Frey, Hamid R. Khan. Handbook of Thin Film Technology. Springer Science & Business Media, 2015.
2. Ludmila Eckertova. Physics of Thin Films. Springer Science & Business Media, 2012.
3. M.S. Tyagi. Introduction to Semiconductor materials and devices. John Wiley and Sons 2017.
4. David K. Ferry, Semiconductors. Macmillan Publishing Co. New York, 2017.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01709 MAGNETISM AND SUPERCONDUCTIVITY 3+0 C.H.

Introduction, Magnetic dipoles, Magnetic moments, Intensity of magnetization, Magnetic effects of currents, Spin and orbital magnetic moments, SI units of magnetism and their interconversion,

Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagetism, Ferrimagnetism, Superparamagnetism, Magnetic domains, Susceptibility, Permeability, Hystresis loop, Saturation magnetization, Coercive field, Remanence, Squareness ratio, Magnetic energy, Magnetic anisotropy, Soft magnetic materials, Hard magnetic materials, Superconductivity, heat capacity, IR reflectivity, Superconductors: Type I and type II superconductors, Band gap of superconductors, Meissner effect, Isotope effect, BCS theory, Electron-phonon coupling: electron & phonon self-energy, Weak and strong coupling, Magnetic mechanisms of pairing, Coexistence of superconductivity and magnetism.

Recommended Books:

1. B. D. Cullity, C. D. Graham. Introduction to Magnetic Materials. 2nd Edition, John Wiley & Sons, 2011.
2. Raul Valenzuela. Magnetic Ceramics. Cambridge University Press 2005.
3. M.C Lovel. Physical Properties of Materials. Springer Science & Business Media, 2012
4. Allan H. Morrish. The Physical Principles of Magnetism. John wiley, 2001.

Note: The Instructor may suggest any relevant/latest book available.

ADVANCED ELECTIVE-IV

PHY-01806 PHOTODYNAMIC THERAPY 3+0 C.H.

Basics of Biology; Introductory Concepts, Electronic Absorption Spectroscopy, Lasers With Their Application in Photodynamic Therapy, Photochemistry induced by Exogenous Photosensitizers; Light-Activated Therapy, Photodynamic Therapy: Basic Principles, Photosensitizers for Photodynamic Therapy (Porphyrin Derivatives, Chlorins and Bacteriochlorins, Benzoporphyrin Derivatives, 5-Aminolaevulinic Acid (ALA), Texaphyrins, Phthalocyanines and Naphthalocyanines, Cationic Photosensitizers, Dendritic Photosensitizers); Applications of Photodynamic Therapy, Mechanism of Photodynamic Action; Light Irradiation for Photodynamic Therapy (Light Source, Laser Dosimetry, Light Delivery); Two-Photon Photodynamic Therapy; Current Research And Future Directions.

Recommended Books:

1. Paras N. Prasad. Introduction to Biophotonics. A John Wiley & Sons, Inc., Publication, 2003.
2. Xun Shen, Roeland Van Wijk. Biophotonics: Optical Science and Engineering for the 21st Century. Springer Science-HBusiness Media, Inc. 2005.
3. Markolf H. Niemz. Laser-Tissue Interactions: Fundamentals and Applications. Springer-Verlag Berlin Heidelberg, 2007.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01807 MATERIALS SIMULATION 3+0 C.H.

Introduction and Overview: Introduction of simulation, Why simulation is important in materials science? Strengths and weaknesses of the simulation, Various simulation methods and computational complexity with a range of trades between speed and accuracy, Hardware and software environment for simulation, Steps in a simulation study.

Structural Optimization: Energy minimization for optimizing the internal atomic positions of a crystal structure, Required parameters for structural optimization, Total energy Vs volume curve, Different approximation techniques to optimize a structure within your lifetime. Energy minimization algorithms for optimization.

Electronic Structure: Solution of the Schrödinger equation to calculate the energy of a system of electrons and atoms, Introduction to quantum mechanical modeling: Hartree-Fock & post-Hartree-Fock methods and Kohn-Sham (KS) Equations. Density Function Theory (DFT).

Atomistic Methods: General theory of atomistic simulations, Advanced methods for the generation of atomistic samples, Molecular dynamics (MD), Interatomic potentials, Born-Oppenheimer Approximation, Monte Carlo, and kinetic Monte Carlo methods.

Recommended Books:

1. K. Burke, *The ABC of DFT*, Rutgers University, 2003.
2. E.G. Lewars, *Computational Chemistry*, Springer, 2nd Ed. 2011.
3. J. D. Chen, *Monte-Carlo Simulation-Based Statistical Modeling*, Springer, 2017

Note: The Instructor may suggest any relevant/latest book available.

PHY-01808 DEFECTS IN SEMICONDUCTORS 3+0 C.H.

Introduction to semiconductor crystal, growth mechanisms and doping. Generation and recombination mechanism of carriers in semiconductors. Defect classifications; point defects, antisite, interstitial, vacancy, complexes, and line defects. Slip systems in semiconductors, and structure of perfect dislocations, dislocation motion in semiconductors, effect of doping on dislocation velocity, dislocation mobility and stress, two/three dimensional defects; stacking faults, twins, and grain boundaries.

Recommended Books:

1. C. Kittel. Introduction to Solid State Physics. John Wiley & Sons, Inc., New York, 2018.
2. S.M. Sze. Physics of Semiconductor Devices. 3rd Edition, John Wiley and Sons Inc., 2004.
3. M.S. Tyagi. Introduction to Semiconductor materials and devices. John Wiley and Sons 2017.
4. David K. Ferry, Semiconductors. Macmillan Publishing Co. New York, 2017.

Note: The Instructor may suggest any relevant/latest book available.

PHY-01809 INTRODUCTION TO SPECTROSCOPY 3+0 C.H.

Introduction: The electromagnetic spectrum, General aspects of spectroscopy, instrumental aspects of specific spectroscopic techniques. Fundamentals and applications of the following methods: Electronic absorption and emission spectroscopy of atoms and molecules, IR spectroscopy, Scanning Electron Microscopy (SEM)-Energy-Dispersive X-Ray Spectroscopy (EDS), X-rays Diffraction (XRD), Photoluminescence (PL) and Vibrating Sample Magnetometer (VSM), Vector Network Analyzer (VNA).

Recommended Books:

1. C Ricbard Brundle, Charles A. Evans, Jr.Sbaun Wihon, “Encyclopedia of materials characterization”, Manning Publications Co. 1992.
2. K.C. Barua, “Introduction to Condensed Matter Physics”, Narosa Publishing House, 2007.
3. Mark, Fox, “Optical Properties of Solids” Oxford University Press, 2001.
4. B. D. Cullity, and C. D. Graham “Introduction to Magnetic Materials”, IEEE Press, 2009.

Note: The Instructor may suggest any relevant/latest book available.

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