Syllabus

Program: B.Sc. (Honours / Honours with Research) in Physics and B.Sc. in Physics

FIRST YEAR

First Semester

PHY1101: Mechanics [L T P C – 2 1 2 4]

Dynamics of a System of Particles: Centre of mass, conservation of momentum, idea of conservation of momentum from Newton's third law, impulse, motion of rocket. potential energy, stable and unstable equilibrium, elastic potential energy, work-energy theorem, work done by non-conservative forces, law of conservation of energy, elastic and inelastic collisions between particles. Rotational Dynamics: Angular momentum of a particle and system of particles, conservation of angular momentum, rotation about a fixed axis, moment of inertia, kinetic energy of rotation, motion involving both translation and rotation. Gravitation and Central Force Motion: Law of gravitation, inertial and gravitational mass, gravitational potential energy, potential and field due to spherical shell and solid sphere, motion of a particle under central force field, two body problem and its reduction to one body problem and its solution, the energy equation and energy diagram, orbits of artificial satellites, relation between elastic constants, twisting torque on a cylinder or wire. Inertial and Non-inertial systems: Reference frames, inertial frames and Galilean transformations non-inertial frames and fictitious forces, uniformly rotating frame, physics laws in rotating coordinate systems, centrifugal forces, Coriolis force, components of velocity and acceleration in cylindrical and spherical coordinate systems. Special Theory of Relativity: Postulates, Michelson-Morley experiment, Lorentz transformations, simultaneity and order of events, Lorentz contraction, variation of mass with velocity, rest mass, massless particles, mass-energy equivalence, relativistic Doppler effect, transformation of energy and momentum.
Experiential learning: To use a multimeter for measuring (a) resistances, (b) a/c and dc voltages, (c) ac and dc currents, (d) capacitances, and (e) frequencies, to test a diode and transistor using (a) a multimeter and (b) a CRO, to measure (a) voltage, (b) frequency and (c) phase difference using a CRO, to study random errors, to determine the height of a building using a sextant, to study the characteristics of a series RC circuit, to determine the acceleration due to gravity and velocity for a freely falling body, using digital timing techniques, to determine the moment of inertia of a flywheel, to determine the coefficient of viscosity of water by capillary flow method, to determine the young's modulus of a wire by optical lever method, to determine the modulus of rigidity of a wire by Maxwell's needle, to determine the elastic constants of a wire by Searle's method, to determine "g" by bar pendulum, to determine "g" by Kater's pendulum, to study the motion of a spring and calculate (a) spring constant (b) value of g, and (c) modulus of rigidity.

References:

1. D. Kleppner, R. J. Kolenkow, An Introduction to Mechanics, Tata McGraw-Hill, 2007.
2. D. S. Mathur, Mechanics, S. Chand & Company Limited, 2014.
3. M. R. Spiegel, Theoretical Mechanics, Tata McGraw-Hill, 2017.
4. C. Kittel, W. Knight, M. Ruderman, C. Helmholz, B. Moyer, Mechanics, Berkeley Physics course, Vol.-I, Tata McGraw-Hill, 2010.
5. F. W. Sears, M. W. Zemansky, H. D. Young, University Physics, Narosa Pub. House, 2013.
6. M. Alonso, E. Finn, Physics Addison-Wesley, 2000.
7. D. Chattopadhyay, P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
8. C. L Arora, BSc Practical Physics, S. Chand Publication, 2012.
9. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
10. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
11. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
12. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

Second Semester

PHY1201: Waves and Optics [L T P C – 2 1 2 4]

Simple Harmonic Motion: Simple harmonic oscillations, oscillations having equal frequencies and oscillations having different frequencies (beats), superposition of n-collinear harmonic oscillations with equal phase differences and equal frequency differences, superposition of two mutually perpendicular simple harmonic motions with frequency ratios 1:1 and 1:2 using graphical and analytical methods. Damped Oscillations: Log decrement, forced oscillations, transient and steady states, amplitude, phase, resonance, sharpness of resonance, power dissipation and quality factor, Helmholtz resonator. Standing Waves in a String: Fixed and free ends, analytical treatment, phase and group velocities, changes w.r.t position and time, energy of vibrating string, transfer of energy, normal modes of stretched strings. Wave Optics: Electromagnetic nature of light, definition and properties of wave front, Huygens principle, coherence. Interference: Division of amplitude and wavefront, Young's double slit experiment, Lloyd's Mirror, Fresnel's biprism, interference in thin films (parallel and wedge-shaped), fringes of equal inclination and thickness, Newton's Rings, Michelson Interferometer, Fabry-Perot interferometer. Diffraction: Fresnel diffraction, Fresnel's half-period zones, theory of a zone plate, multiple foci, comparison of a zone plate with a convex lens, Fresnel's integrals, Cornu's spiral, Fresnel diffraction pattern due to a straight edge, a slit, and a wire, diffraction due to a single slit, a double slit and a plane transmission grating, Rayleigh's criterion, resolving power, dispersive power of grating. Polarization: Light polarization by reflection, refraction, Brewster's Law, Malus Law, double refraction.

Experiential learning: To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2–T law, To investigate the motion of coupled oscillators, To study Lissajous Figures, familiarization with: Schuster`s focusing; determination of angle of prism, To determine refractive index of the Material of a prism using sodium source, To determine the dispersive power and Cauchy constants of the material of a prism using mercury source, To determine the wavelength of sodium source using Michelson's interferometer, To determine wavelength of sodium light using Fresnel Biprism, To determine wavelength of sodium light using Newton's rings, To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film, To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating, to determine dispersive power and resolving power of a plane diffraction grating.

References:

1. F. A. Jenkins, H. Elliott White, Fundamentals of Optics, Tata McGraw-Hill, 2013.
2. A. Ghatak, Optics, Tata McGraw-Hill, 2015.
3. S. Subrahmaniyam, B. Lal, M. N. Avadhanulu, A Textbook of Optics, S. Chand, 2010.
4. E. Hecht, A. R. Ganesan, Optics, Pearson Education, 2002.
5. Al-Azzawi, Light and Optics: Principles and Practices, CRC Press, 2007.
6. M. Alonso, E. Finn, Physics Addison-Wesley, 2000.
7. D. Chattopadhyay, P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
8. C. L Arora, BSc Practical Physics, S. Chand Publication, 2012.
9. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
10. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
11. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
12. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

AEC-2: PHY1240: Academic Writing [L T P C – 2 0 0 2]

Basic concepts and conventions of Academic Writing. Academic Essay Writing in the form of – Expository, Argumentative and Compare & Contrast essays. Modules on writing a Paragraph, paraphrasing, summarizing and editing essays. Writing a coherent paragraph, Editing a paragraph, Transitional words and phrases**,** Generating thesis statement, From a Paragraph to an Essay, Essay Structure, Editing an Essay, Writing an Expository Essay, Developing and Organizing Arguments, Supporting Arguments, Strengthening Arguments, Reporting Verbs and Tones, Editing an Argumentative Essay, Compare and Contrast Essay Structure ,Useful Vocabulary and Style, Avoiding plagiarism , Citing the sources of information, Citations, quotations and integration, Drafting, Revising and Proof reading

References:

1. Fowler, R.H., Aaron, J.E. & McArthur, M., 2005. *The Little Brown Handbook*. 4th ed. Toronto: Pearson Longman.
2. Harris, M., 2008. *Prentice Hall Reference Guide*. 7th ed. New Jersey: Pearson Prentice Hall.
3. Heather, A., Lucille, S., Karen, T. & Kathleen, J.-C., 1995. *Thinking It Through: A Practical Guide To Academic Essay Writing*. 2nd ed. Peterborough: Academic Skills Centre Trent University Peterborough.
4. Hurling, S. et al., 2007. *Academic Writing Skills and Strategies II*. Shinjuku-ku: Waseda University International Co., Ltd.
5. Troyka, L.Q. & Hesse, D., 2005. *Simon & Schuster Handbook For Writers*. 4th ed. Toronto: Pearson Prentice Hall.
6. Graff, G., & Birkenstein, C. (2006). *"They Say/I Say".* New York: W.W. Norton & Company Ltd.

SECOND YEAR

Third Semester

PHY2101: Fundamentals of Electricity and Magnetism [L T P C – 2 1 0 3]

Electric Field and Electric Potential: Electric field and lines, electric flux, Gauss's law, Gauss's law in differential form, calculation of E due to various charge distribution, electric potential difference and electric potential v, potential and electric field due to various charge distribution force and torque on a dipole, conductors in an electrostatic field, description of a system of charged conductors, an isolated conductor and capacitance, electrostatic energy due to various charge distribution. Electric Field in Matter: Dielectric Constant, parallel plate capacitor with a dielectric, polarization charges and polarization vector, electric susceptibility, Gauss's law in dielectrics, displacement vector d, relations between the three electric vectors, capacitors filled with dielectrics. Magnetic Effect of Currents: Magnetic field B, Magnetic force between current elements and definition of B, magnetic flux, Biot-Savart's law: calculation of B due to various charge distribution, magnetic dipole and its dipole moment, Ampere's circuital law, B due to a solenoid and a toroid, curl and divergence of B, vector potential. forces on an isolated moving charge, magnetic force on a current carrying wire, torque on a current loop in a uniform magnetic field, Gauss's law of magnetism, magnetic intensity (H), relation between B, M and H, stored magnetic energy in matter, B-H curve, Faraday's law, Lenz's law, self and mutual induction, single phase transformer, energy stored in a magnetic field, potential energy of a current loop. Ballistic Galvanometer: Current and charge sensitivity, electromagnetic damping, logarithmic damping, critical damping.

References:

1. D. J. Griffiths, Introduction to Electrodynamics, PHI learning, 2015.
2. E. M. Purcel, Electricity and Magnetism, Tata McGraw-Hill Education, 2011.
3. J. H. Fewkes, J. Yarwood, Electricity and Magnetism, Oxford University Press, 1991.
4. D. C. Tayal, Electricity and Magnetism, Himalaya Publishing House, 2014.
5. M. Alonso, E. Finn, Physics, Addison-Wesley, 2000.

PHY2130: Practicals on Electricity and Magnetism [L T P C – 0 0 2 1]

To determine a low resistance by Carey Foster's bridge, to determine a low resistance by a potentiometer, to determine high resistance by leakage of a capacitor, to determine the charge sensitivity, current sensitivity, logarithmic decrement of Ballistic Galvanometer (B.G.), to determine the ratio of two capacitances by de Sauty's bridge, to determine the dielectric constant of a dielectric placed inside a parallel plate capacitor using a B.G., to determine self-inductance of a coil by Anderson's bridge using ac, to determine self-inductance of a coil by Rayleigh's method, to determine the mutual inductance of two coils by absolute method using a B.G., to study the response curve of a series and parallel LCR circuit and determine its resonant frequency, impedance at resonance and quality factor and band width.

References:

1. D. Chattopadhyay & P. C. Rakshit, *An Advanced Course in Practical Physics*, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, *BSc Practical Physics*, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, *Practical Physics*, New Age Publisher, 2006.
4. D. P. Khandelwal, *A Laboratory Manual of Physics for Undergraduate Classes*, Vani Publication House, New Delhi, 2000.
5. G. Sanon, *B. Sc. Practical Physics*, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, *Advanced Practical Physics*, Asia Publishing House, 2002.

PHY2102: Mathematical Physics [L T P C – 3 1 0 4]

Linear Vector Spaces: Abstract systems, binary operations and relations, introduction to groups and fields, vector spaces and subspaces, linear independence and dependence of vectors, linear transformations, algebra of linear transformations, non-singular transformations. Matrices: Addition and multiplication of matrices, types of matrices, transpose and conjugate of a matrix, Hermitian and Skew-Hermitian matrices, adjoint of a matrix, inverse of a matrix by adjoint method, similarity transformations, orthogonal and unitary matrices, trace of a matrix, inner product, eigen-values and eigenvectors, Cayley-Hamilton theorem, diagonalization of matrices, solutions of coupled linear ordinary differential equations, bilinear and quadratic forms, functions of a matrix. Partial Differential Equations: General solution of wave equation in 1 dimension, transverse vibrations of stretched strings, oscillations of hanging chain, wave equation in 2 and 3 dimensions, vibrations of rectangular and circular membranes, heat flow in one, two and three dimensions, rectangular systems of finite boundaries, temperature inside circular plate, Laplace equation in cartesian, cylindrical and spherical coordinate systems, problems of steady flow of heat in rectangular and circular plate.

References:

1. A. W. Joshi, Matrices and Tensors in Physics, New Age Int. Pub., 2014.
2. F. Ayres Jr., Matrices, McGraw-Hill 2010.
3. N. M. Kapoor, A Text Book of Differential Equations, Pitambar Publishing, 2010.
4. S. J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publishers, 2012.
5. E. Kreyszig, Advanced Engineering Mathematics, Wiley Eastern, 2011.

SEC-4: PHY2140: Basic Instrumentation Skills [L T P C – 2 1 0 3]

Basics of Measurements: Screw gauge, Vernier calipers, Travelling microscope, optical labelling, mechanical labelling, Instruments accuracy, Errors in measurements. Multimeter: Measurement of dc and ac voltage current, Electronic Voltmeter: Advantage over conventional multimeter, Principles of voltage measurement (block diagram only), Specifications of an electronic Voltmeter/Multimeter. AC millivoltmeter: Type of AC millivoltmeters, Amplifier-rectifier, and rectifier-amplifier. Cathode Ray Oscilloscope: Block diagram, construction and working principle. Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators, pulse generator, and function generator. Impedance Bridges & Q-Meters: Block diagram of bridge, working principles of basic, RLC bridge, Block diagram and working principles of a Q- Meter, Digital LCR bridges. Digital Instruments: Principle and working of digital meters, comparison of analog & digital instruments. Digital Multimeter: Block diagram and working of a digital multimeter. Hands on Training: CRO as a versatile measuring device, Use of digital multimeter/VTVM for measuring voltages, circuit tracing of laboratory electronic equipment, winding a coil/transformer, trouble shooting a circuit, balancing of bridges. Brief idea about instrumentation of the various spectroscopic techniques: UV-Vis spectroscopy, IR and FTIR spectroscopy.

References:

1. B. L. Thereja, A text book in Electrical Technology, S Chand, 2010.
2. Venugopal, Digital Circuits and systems, Tata McGraw-Hill, 2011.
3. S. Ghoshal, Digital Electronics, Cengage Learning, 2012.
4. S. Salivahanan, N. S. Kumar, Electronic Devices and circuits, Tata McGraw-Hill, 2012.
5. U. Tietze, Ch. Schenk, Electronic circuits: Handbook of design and applications, Springer, 2008.

Fourth Semester

PHY2201: Basic Electronics [L T P C – 2 1 0 3]

Fundamentals of Diode, forward bias, reverse bias and V-I characteristics, Zener diode, half wave rectifier, full wave rectifier, bridge rectifier, RC and LC filters, Design of un-regulated DC power supply, Clipping circuit, Clamping circuit **Bipolar junction transistors and its biasing** BJT operation, BJT voltages and currents, CE, CB and CC characteristics, DC load line and bias point, base bias, emitter feedback bias, collector feedback bias, voltage divider bias, Thermal stability, biasing BJT switching circuits, transistor power dissipation and switching time **Special purpose diodes and transistors** Light emitting diode (LED). Zener diode, Zener diode circuit for voltage regulation, Photo diode, Solar cell, PIN diode, Varactor, Schottky diode, Varistors, Tunnel diode, Seven Segment display, Sixteen segment display, Identify segments on pin using multi-meter, Dot-matrix LED display, Phototransistor, Opto-coupler, **AC Analysis of BJT circuits and small signal amplifier** Coupling and bypass capacitors, AC load lines, Transistor models and parameters, Common emitter circuit analysis, common base circuit analysis, common collector circuit analysis, Comparison of CE, CB and CC circuits, Transistor as a switch. **Digital Circuits** Basic gates AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR, Building AND, OR Gate with diodes, Digital logic families RTL, DTL, TTL, CMOS, Comparison of logic families

References:

1. David A. Bell, “Electronic Devices and Circuits”, Oxford University Press, Fifth edition, 2008
2. Albert Malvino & David, “Electronic Principles”, Tata McGraw-Hill, Seventh edition, 2017
3. R. L. Boylestad and L. Nashelsky, “Electronic Devices and Circuit Theory”, Pearson Education, Eleventh Edition, 2015
4. Jaccob Millman, Chritos Halkias, Chetan D Parikh, “Integrated Electronics”, Tata McGraw-Hill, Second edition, 2010
5. Albert Malvino & David, “Problems and Solutions in Basic Electronics, McGraw Hill Education, First Edition, 2010

PHY2230: Basic Electronics Lab [L T P C – 0 0 2 1]

To verify the characteristics of Zener diode and voltage regulation, FET and MOSFET characteristics and application as amplifier. To design and implementation of Basic Logic Gates Using NAND and NOR Gates and combinational Logic Systems and sequential Circuits like flip-flop circuits (RS, Clocked RS, D-type, and JK Flip-Flops). To learn the basic circuits of operational amplifiers (OP-AMPs). To build the building Wien Bridge and Phase Shift Oscillators. Design of regulated power supply, common emitter transistor amplifier and stable multivibrator.

References:

1. D. Chattopadhyay & P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, BSc Practical Physics, S. Chand Publication, 2012.

3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002

PHY2202: Fundamentals of Thermodynamics [L T P C – 2 1 0 3]

Thermodynamics: Thermodynamic equilibrium, Zeroth law of thermodynamics and concept of temperature, work and heat energy, state functions. Laws of Thermodynamics: First law of thermodynamics, differential form of first law, internal energy, first law and various processes and applications of first law, heat engines, Carnot cycle, Carnot engine, second law of Thermodynamics-Kelvin-Planck and Clausius statements and their equivalence, Carnot Theorem. Applications of second law of thermodynamics: thermodynamic scale of temperature and its equivalence to perfect gas scale. Entropy: Change in entropy, entropy of a state, Clausius theorem, second law of thermodynamics in terms of entropy, entropy of a perfect gas, entropy of the universe, entropy changes in reversible and irreversible processes, principle of increase of entropy. Impossibility of attainability of absolute zero: third law of thermodynamics, temperature-entropy diagrams, first and second order phase transitions. Thermodynamic Potentials: Extensive and Intensive thermodynamic variables, thermodynamic potentials U, H, F and G: their definitions, properties and applications, surface films and variation of surface tension with temperature, magnetic work, cooling due to adiabatic demagnetization, approach to absolute zero. Maxwell's Thermodynamic Relations: Derivations of maxwell's relations. Applications of maxwell's relations: Clausius-Clapeyron equation, Joule-Kelvin coefficient for ideal and Van der Waal gases. Kinetic Theory of Gases: Distribution of velocities, Maxwell-Boltzmann law of distribution of velocities in an ideal gas and its experimental verification, mean, RMS and most probable speeds, degrees of freedom, law of equipartition of energy, specific heats of gases, molecular collisions, mean free path, collision probability, estimates of mean free path. transport phenomenon in ideal gases: viscosity, thermal conductivity and diffusion, Brownian motion and its significance; Real gases: Behavior of real gases, Van der Waal's equation of state for real gases, values of critical constants, Joule's experiment, free adiabatic expansion of a perfect gas, Joule-Thomson porous plug experiment, Joule-Thomson effect for real and Van der Waal gases, temperature of inversion, Joule-Thomson Cooling.

References:

1. M. W. Zemansky, R. Dittman, Heat and Thermodynamics, McGraw-Hill, 2017.
2. S. C. Garg, R. M. Bansal, C. K. Ghosh, Thermal Physics: with Kinetic Theory, Thermodynamics and Statistical Mechanics, McGraw-Hill, 2017.
3. E. Fermi, Thermodynamics, Snow Ball Publications, 2010.
4. F. W. Sears, G. L. Salinger, Thermodynamics Kinetic Theory and Statistical Thermodynamics, Narosa Publications, 1998.
5. M. Alonso, E. Finn, Physics, Addison-Wesley, 2000.

PHY2231: Thermodynamics Lab [L T P C – 0 0 2 1]

To determine J by Callender and Barne's constant flow method, to determine the coefficient of thermal conductivity of copper by Searle's apparatus, to determine the coefficient of thermal conductivity of copper by Angstrom's method, to determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method, to determine the temperature coefficient of resistance by platinum resistance thermometer, to calibrate a resistance temperature device to measure temperature in a specified range using Null Method/Off-Balance Bridge with Galvanometer based measurement, to study the variation of Thermo-emf of a thermocouple with difference of temperature of its two junctions, to calibrate a thermocouple to measure temperature in a specified range using null method.

References:

1. D. Chattopadhyay & P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, BSc Practical Physics, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

PHY2203: Classical Mechanics [L T P C – 3 1 0 4]

System of Particles: Centre of mass, total angular momentum and total kinetic energies of a system of particles, conservation of linear momentum, energy and angular momentum. Lagrangian Formulation: Constraints and their classification, degrees of freedom, generalized co-ordinates, example of a disk rolling on the horizontal plane, virtual displacement, D'Alembert's principle, Lagrange's equations of motion of the second kind, uniqueness of the Lagrangian, Simple applications of the Lagrangian formulation, Single free particle in Cartesian Co-ordinates, Plane polar co-ordinates, Atwood's machine, A bead sliding on a uniformly rotating wire in a force-free space, motion of block attached to a spring, Simple Pendulum, symmetries of space and time, conservation of linear momentum energy and angular momentum; Hamiltonian formalism: Generalized momenta, canonical variables, Legendre transformations and the Hamilton's equation of motion, Examples of the Hamilton of a particle in a central force field, the simple harmonic oscillator, Cyclic co-ordinates and conservation theorems, derivation of Hamilton's equations from variational principle. Central forces: Reduction of two particle equations of motion to the equivalent one-body problem, reduced mass of the system, conservation theorems (First integrals of the motion), equations of motion for the orbit, classification of orbits, conditions for closed orbits, The Kepler problem; Scattering in a central force field: General description of scattering, cross-section, impact parameter, Rutherford scattering, center of mass and laboratory co-ordinate systems, their transformations of the scattering angle and cross-section.

References:

1. H. Goldstein, C. Poole, J. Safko, Classical Mechanics, Pearson Education, 2011.
2. N. C. Rana, P. S. Joag, Classical Mechanics, McGraw-Hill. 2017.
3. R. G. Takwale, P.S. Puranic, Classical mechanics, McGraw-Hill. 2017.
4. S. N. Biswas, Classical Mechanics, Books & Allied Ltd, 2000.
5. pA. Ray Choudhary, Classical Mechanics, Oxford University Press, 1983.
6. J. C. Upadhyaya, Classical Mechanics, Himalaya Publishing House, 2017.

PHY2270: Internship/Project [L T P C – 0 0 0 2]

Students will work under the supervision of a faculty member to apply theoretical concepts to real-world problems for their internship/project. The course emphasizes skill development, professional ethics, documentation, and scientific communication. Students are required to submit a brief project report and make a presentation summarizing their work and learning outcomes. This course aims to bridge the gap between classroom learning and practical application, and to prepare students for higher studies and professional careers.

AEC-4: PHY2240: Scientific Translation and Linguistic Competence [L T P C – 2 0 0 2]

Basics of Linguistic Competence: Nature and functions of language, Parts of speech and sentence patterns, Tenses, voice, and reported speech, Common grammatical errors, Academic and scientific vocabulary. Introduction to Translation: Meaning, scope, and importance of translation, Types of translation: literal, free, communicative, technical, Concept of equivalence and fidelity, Problems and limitations of translation, Translation ethics and accuracy, Applied Translation Practice: Translation of general prose (English ↔ Indian language), Translation of academic and basic scientific texts, Terminology, collocations, and expressions, Cohesion, coherence, and tone, Editing and proofreading translated texts. Scientific and Professional Communication: Reading and interpreting scientific passages, Summarizing and paraphrasing, translating instructions, reports, and abstracts, Oral interpretation and short presentations, writing emails, reports, and short technical notes. Pedagogy: Interactive and participatory lectures, Activity-based translation practice, Group discussions and collaborative learning, Experiential learning through real academic/scientific texts, Continuous formative assessment

References:

1. Newmark, P. *A Textbook of Translation*. 1st ed., Prentice-Hall International, London/New York, 1988.
2. Baker, M. *In Other Words: A Coursebook on Translation*. 3rd ed., Routledge, London & New York, 2018. (Original first published 1992)
3. Thomson & Martinet, A. V. *A Practical English Grammar*. 4th ed., Oxford University Press, Oxford/New York, 1986.
4. Murphy, R. *English Grammar in Use*. 5th ed., Cambridge University Press, Cambridge, 2019.
5. Day & Gastel. *How to Write and Publish a Scientific Paper*. 7th ed., Cambridge University Press, Cambridge, 2012.

THIRD YEAR

Fifth Semester

PHY3101: Electromagnetic Theory [L T P C – 3 1 0 4]

Maxwell's Equations: Maxwell equations, displacement current, vector and scalar potentials, Lorentz and Coulomb gauge, boundary conditions at interface between different media, Poynting theorem and Poynting vector, electromagnetic energy density, physical concept of electromagnetic field energy density, momentum density and angular momentum density. Reflection and Refraction of Electromagnetic Waves: Reflection and refraction of a plane wave, Fresnel formulae, total internal reflection, Brewster's angle, waves in conducting media, skin depth, Maxwell's equations in microscopic media (plasma), characteristic plasma frequency, refractive index, conductivity of an ionized gas, propagation of e.m. waves in ionosphere. Polarization of Electromagnetic Waves: Description of linear, circular and elliptical polarization, propagation of EM waves in anisotropic media, symmetric nature of dielectric tensor, Fresnel's formula, uniaxial and biaxial crystals, double refraction, polarization by double refraction, Nicol prism, production and detection of plane, circularly and elliptically polarized light, phase retardation babinet compensator and its uses, Biot's sevart Laws for rotatory polarization, Fresnel's theory of optical rotation, calculation of angle of rotation, specific rotation, Laurent's half-shade polarimeter. Optical Fibers: Numerical aperture, step and graded indices, single and multiple mode fibers.

References:

1. D. J. Griffith, Introduction to Electrodynamics, Pearson Education India Learning, 2015.
2. M. N. O. Sadiku, S. V. Kulkarni, Elements of Electromagnetics, Oxford University Press, 2015.
3. J. D. Jackson, Classical Electrodynamics, Wiley, 2007.
4. L. D. Landau, M. Lifshitz, Classical Theory of Fields, Butterworth-Heinemann, 1987.
5. T. L. Chow, Introduction to Electromagnetic Theory, Jones & Bartlett Learning, 2005

PHY3130: Electromagnetic Lab [L T P C – 0 0 4 2]

To verify the law of Malus for plane polarized light, to determine the specific rotation of sugar solution using Polarimeter, to analyze elliptically polarized light by using a Babinet's compensator, to study dependence of radiation on angle for a simple dipole antenna, to determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating, to study the reflection, refraction of microwaves, to study polarization and double slit interference in microwaves, to determine the refractive index of liquid by total internal reflection using Wollaston's air-film, to determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece, to study the polarization of light by reflection and determine the polarizing angle for air-glass interface.

References:

1. D. Chattopadhyay, P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, BSc Practical Physics, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

PHY3102: Modern Physics [L T P C – 3 1 0 4]

Particles and Waves: Inadequacies in classical physics, blackbody radiation, photoelectric effect, Compton effect, Franck-Hertz experiment, wave nature of matter, wave packets, group and phase velocities, two-slit experiment with electrons, probability, wave functions, Heisenberg's uncertainty principle, derivation from wave packets, γ-ray microscope. Quantum Mechanics: Basic postulates and formalism, energy, momentum and Hamiltonian operators, time-independent Schrödinger wave equation for stationary states, conditions for physical acceptability of wave functions, expectation values, wave function of a free particle. Applications of Schrödinger Wave Equation: Eigen functions and eigenvalues for a particle in a one dimensional box. bound state problems: general features of a bound particle system, (1) one dimensional simple harmonic oscillator, scattering problems in one dimension: (1) finite potential step: reflection and transmission, stationary solutions, probability current, attractive and repulsive potential barriers (2) quantum phenomenon of tunneling: tunnel effect, tunnel diode (qualitative description) (3) finite potential well (square well). Operators in Quantum Mechanics: Hermitian operator, commutator brackets-simultaneous Eigen functions, commutator algebra, commutator brackets using position, momentum and angular momentum operator, concept of parity, parity operator and its Eigen values.

References:

1. A. Ghatak, S. Lokanathan, Quantum Mechanics: Theory and Applications, Laxmi Publications, 2016.
2. D. J. Griffith, Introduction to Quantum Mechanics, Pearson Education, 2015.
3. L. I. Schiff, J. Bandhyopadhyay, Quantum Mechanics, McGraw-Hill Book, 2010.
4. E. Merzbacher, Quantum Mechanics, John Wiley & Sons, Inc, 2007.
5. J. L. Powell, B. Crasemann, Quantum Mechanics, Addison-Wesley Pubs. Co., 2010.

PHY3131: Modern Physics lab [L T P C – 0 0 4 2]

To determine the value of Boltzmann constant by studying forward characteristics of a diode, to determine the value of Planck's constant by using a photoelectric cell, to determine the value of Planck's Constant by using LEDs of at least 4 different wavelengths, to determine the value of e/m by bar magnet, to determine the wavelength and the angular spread of a He-Ne laser, to determine the value of Stefan's constant, to determine the wavelength and the velocity of ultrasonic waves in a liquid by studying the diffraction of light through an ultrasonic grating, to study the characteristics of a photo-diode.

References:

1. D. Chattopadhyay & P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, BSc Practical Physics, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

PHY3103: Plasma Physics [L T P C – 3 1 0 4]

Definition and characteristics of plasmas, Debye shielding, charged-particle motion in electromagnetic fields, elementary drift phenomena, plasma waves, and plasma instabilities, using both particle-based and fluid-based descriptions. Students will explore the theoretical foundations of these phenomena and examine their practical relevance through illustrative examples drawn from advanced energy and technology applications, including nuclear fusion, plasma confinement devices such as tokamaks and magnetic mirrors, laser-driven fusion, and fusion reactor concepts, as well as plasma applications in semiconductor and materials processing. A broad overview of plasma processes in space and astrophysical environments, covering the Sun, solar wind, Sun–Earth interaction, planetary magnetospheres, the heliosphere, and auroral phenomena.

References:

1. F. F. Chen, Introduction to Plasma Physics and Controlled Fusion, Plenum Press, 1983.
2. Donald A. Gurnett and Amitava Bhattacharjee, *Introduction to Plasma Physics: With Space, Laboratory, and Astrophysical Applications*, Cambridge University Press, 2nd Edition, 2017.
3. W. L. Kruer, The Physics of Laser Plasma Interaction, Addision-Weseley, 1988.
4. H. Hagler and M. Kristiansen, Introduction to Controlled Thermonuclear Fusion, Lexington, 1977.
5. T. H. Stix, The Theory of Plasma Waves, McGraw-Hill, 19624.
6. pA. Simon and W. B. Thompson, Advances in Plasma Physics, John Wiley and Sons, 1976.
7. W. M. Stacey, Fusion: An Introduction to the physics and technology of magnetic Confinement Fusion, Wiley-VCH Publication, 2010.
8. K. Miyamoto, Plasma Physics for Nuclear Fusion, MIT Press, 1980

Sixth Semester

PHY3201: Solid State Physics [L T P C – 3 1 0 4]

Crystal Structure: Solids, amorphous and crystalline materials, lattice translation vectors, primitive unit cell, symmetry operations, different types of lattices, Bravais lattices, Miller indices, SC, BCC and FCC structures, lattice with a basis, unit cell, reciprocal lattice, Brillouin Zones. X-Ray Diffraction Technique: Introduction, crystal as a grating, Bragg's law and Bragg's diffraction condition, Ewald's construction, Debye Scherrer method, analysis of cubic structure by powder. Elementary Lattice Dynamics: Lattice vibrations and phonons, linear monoatomic and diatomic chains, acoustical and optical phonons, qualitative description of the phonon spectrum in solids, Einstein and Debye theories of specific heat of solids, T^3 Law. Electrical Properties of Materials: Band theory of solids, Bloch theorem, Kronig-Penney Model, effective mass of electron, concept of holes, band gaps, energy band diagram, law of mass action, insulators, and semiconductors. Magnetic Properties of Matter: Dia-, Para-, Ferri- and ferromagnetic materials, classical Langevin theory of dia– and paramagnetic domains, Curie's law, Weiss's theory of ferromagnetism and ferromagnetic domains, B-H curve, hysteresis and energy loss, Curie temperature. Dielectric Properties of Materials: Polarization, local electric field at an atom, depolarization field, dielectric constant, electric susceptibility, polarizability, classical theory of electric polarizability, Clausius-Mosotti equation, normal and anomalous dispersion, complex dielectric constant. Superconductivity: Experimental results, critical temperature, critical magnetic field, Meissner effect, Type-I, Type-II superconductors, London's equation and penetration depth, isotope effect, idea of BCS theory, Cooper Pair and coherence length, Josephson effect.

References:

1. C. Kittel, Introduction to Solid State Physics, John Wiley, 2016.
2. A. J. Dekkar, Solid State Physics, Laxmi Publications, 2008.
3. S. O. Pillai, Solid State Physics, New Age International; Eighth edition, 2018.
4. M. Ali Omar, Elementary Solid State Physics: Principles and Applications, Pearson Education, 2015.
5. N. W. Ascroft, N. D. Mermin, Solid State Physics, Harcourt Asia, 2003

PHY3230: Solid Sate Physics Lab [L T P C – 0 0 4 2]

To measure the field strength B and its variation in a Solenoid (Determination of dB/dx), to draw the B-H curve of iron by using a Solenoid and to determine the energy loss due to Hysteresis, to measure the Resistivity of a Ge Crystal with Temperature by Four-Probe Method (from room temperature to 200^{0}C) and to determine the Band Gap E_g, to determine the Hall Coefficient and the Hall angle of a semiconductor, to study the PE Hysteresis loop of a ferroelectric crystal, to measure the magnetic susceptibility of solids and liquids, to determine the characteristics of p-n junction of a solar cell, to determine the coupling coefficient of a piezoelectric crystal.

References:

1. D. Chattopadhyay, P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, BSc Practical Physics, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

PHY3202: Nuclear and Particle Physics [L T P C – 3 1 0 4]

Structure of Nuclei: Basic properties of nuclei, mass, radii, charge, angular momentum, spin, magnetic moment (μ), stability, binding energy. Radioactivity: Law of radioactive decay, half-life, theory of successive radioactive transformations, radioactive series, binding energy, mass formula. α-decay, range of α-particles, Geiger-Nuttal law and α-particle spectra, Gamow theory of alpha decay, β-decay, energy spectra and Neutrino hypothesis, γ-decay, Origin of γ-rays, nuclear isomerism and internal conversion; Nuclear Reactions: Types of reactions and conservation laws, concept of compound and direct reaction, compound nucleus, fission and fusion; Nuclear Models: Liquid drop model, mass formula, Shell model, Meson theory of nuclear forces and discovery of Pion; Accelerators: Van de Graaff generator, linear accelerator, cyclotron, betatron, and light and heavy ion synchro-cyclotron, idea of large hadron collider; Detectors of Nuclear Radiations: Interaction of energetic particles with matter, ionization chamber, GM Counter, cloud chambers, Wilson cloud chamber, bubble chamber, scintillation detectors, semiconductor detectors, detectors used in large hadron collider; Elementary Particles: Fundamental interactions, classification of elementary particles, particles and antiparticles, Baryons, Hyperons, Leptons, and Mesons, elementary particle quantum numbers, Baryon Number, Lepton Number, strangeness, electric charge, hypercharge and isospin. supermultiplets of Mesons and Baryons, conservation laws and symmetry, different types of Quarks and Quark- Contents of Spin ½ Baryons, photons, gravitons, gluons, charms and intermediate vector bosons, idea of standard model, Higg's Boson and Baryons.

References:

1. S. N. Ghoshal, Nuclear Physics, S. Chand, 2010.
2. I. Kaplan, Nuclear Physics, Narosa Publications, 2002.
3. D. C. Tayal, Nuclear Physics, Himalaya Publishing House, 2005.
4. A. Beiser, S. Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill, 2017.
5. B. L Cohen, Concepts of Nuclear Physics, McGraw-Hill, 2017.
6. D. J. Griffith, Introduction to Elementary Particle Physics, Wiley-VCH, 2008

PHY3231: Nuclear Physics Lab [L T P C – 0 0 4 2]

Study of the characteristics of GM tube by single source method, to plot plateau region, to calculate % slope, to determine plateau length, to determine operating voltage, to study the nuclear counting statistics, to determine the standard deviation and the variance, to illustrate that the number of counts recorded being high, Poisson's distribution follows closely normal or Gaussian distribution, characteristics of scintillation counter.

References:

1. S. N. Ghoshal, Nuclear Physics, S. Chand, 2010.
2. I. Kaplan, Nuclear Physics, Narosa Publications, 2002.
3. D. C. Tayal, Nuclear Physics, Himalaya Publishing House, 2005.
4. A. Beiser, S. Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill, 2017.
5. L Cohen, Concepts of Nuclear Physics, McGraw-Hill, 2017.
6. J. Griffith, Introduction to Elementary Particle Physics, Wiley-VCH, 2008.

PH3203: Nanomaterials, Thin Films & Applications [L T P C – 3 1 0 4]

Nanoscale systems: Length scales in physics, nanostructures, 1d, 2d and 3d nanostructures, band structure and density of states of materials at nanoscale, size effects in nano systems, quantum confinement, applications of Schrödinger equation-infinite potential well, potential step, potential box, quantum confinement of carriers in 3d, 2d, 1d nanostructures and its consequences. Synthesis of Nanostructure Materials: Top down and bottom up approach, photolithography, ball milling, gas phase condensation, physical vapor deposition, thermal evaporation, e-beam evaporation, pulsed laser deposition, chemical vapor deposition (CVD), sol-gel, electro deposition, spray pyrolysis, hydrothermal synthesis, preparation through colloidal methods, molecular beam epitaxy. Characterization: x-ray diffraction, optical microscope, scanning electron microscopy, transmission electron microscopy, atomic force microscopy, scanning tunneling microscopy. Optical Properties: Coulomb interaction in nanostructures, concept of dielectric constant for nanostructures and charging of nanostructure, quasi-particles and excitons. excitons in direct and indirect band gap semiconductor nanocrystals, quantitative treatment of quasi-particles and excitons, charging effects; Radiative Processes: general formalization-absorption, emission and luminescence, optical properties of heterostructures and nanostructures. Electron Transport: carrier transport in nanostructures, coulomb blockade effect, thermionic emission, tunneling and hoping conductivity, defects and impurities, deep level and surface defects. Applications: applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices, single electron devices. CNT based transistors. Thin film deposition techniques: Basics of vacuum science, creation of vacuum, Deposition of thin film by various PVD techniques such as evaporation, sputtering, MBE as well as chemical coating methods (CVD and ALD), Plasma technologies for thin films, Nucleation, growth and microstructural evolution during thin film formation: Fundamental physical and chemical processes, Effect of the substrate on the film growth and techniques for surface modification, Models for nucleation and film growth, morphology and texture and their impact on material properties. Thin film characterization: XRD, XRR, AFM, MFM and TEM techniques. Properties and applications of thin film materials: mechanical, electrical, magnetic and optical properties of films, applications in information storage, integrated circuits, micro-electromechanical systems, optoelectronics and photovoltaics.

References:

1. C. P. Poole, Jr., F. J. Owens, Introduction to Nanotechnology, Wiley 2016.
2. S. K. Kulkarni, Nanotechnology: Principles & Practices, Capital Publishing Company, 2000.
3. K. K. Chattopadhyay, A. N. Banerjee, Introduction to Nanoscience and Technology, PHI Learning Private Limited 2005.
4. R. Booker, E. Boysen, Nanotechnology, John Wiley, 2000.
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook, Elsevier, 2007.
6. B. Bhushan, Springer Handbook of Nanotechnology, Springer-Verlag, 2004.
7. M. Ohring, The materials science of thin films- Deposition and Structure, Elsevier 2012.
8. A. Goswami, Thin Film Fundamentals, New Age International, 2010.
9. K. Seshan, Handbook of Thin Film Deposition, William Andrew, 2012.
10. K. L. Chopra, Thin Film Phenomena, McGraw-Hill Inc., 1995.
11. L. I. Maissel, R. Glang, Handbook of Thin Film Technology, McGraw-Hill, 1970.

FOURTH YEAR

Seventh Semester

PHY4101: Statistical Mechanics [L T P C – 3 1 0 4]

Classical Statistics: Entropy and thermodynamic probability, Maxwell-Boltzmann distribution law, ensemble concept, partition function, thermodynamic functions of finite number of energy levels, negative temperature, thermodynamic functions of an ideal gas, classical entropy expression, Gibbs Paradox, law of equipartition of energy–applications to specific heat and its limitations. Classical Theory of Radiation: Properties of thermal radiation, blackbody radiation, pure temperature dependence, Kirchhoff's Law, Stefan-Boltzmann law and Wien's displacement law, Saha's ionization formula. quantum theory of radiation, Bose-Einstein statistics, Application to radiation – Planck's law, Rayleigh Jeans and Wien laws as limiting cases, Stefan's law. Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a Completely Degenerate Bose Gas, Bose-Einstein condensation, properties of liquid He (qualitative description), Radiation as photon gas, Bose's derivation of Planck's law. Fermi-Dirac Statistics: Fermi-Dirac distribution law, thermodynamic functions of an ideal completely degenerate Fermi gas, Fermi energy, electron gas in a metal, specific heat of metals, white dwarf stars, Chandrasekhar mass limit.

References:

1. F. Reif, Statistical Physics: Berkeley Physics Course, Vol.5, McGraw-Hill, 2017.
2. B. B. Laud, Fundamentals of Statistical Mechanics, New Age Publisher, 2014.
3. B. K. Agarwal, M. Eisner, Statistical Mechanics, New Age Publisher, 2007.
4. B. Lal, N. Subrahmanyan, P. S. Hemne, Heat Thermodynamics and Statistical Physics, S. Chand, 2017.
5. K. Huang, Statistical Mechanics, Wiley, 1987.
6. R. K. Pathria, P. D. Beale, Statistical Mechanics, Academic Press, 2011.

PHY4102: Atomic, Molecular & Laser Physics [L T P C – 3 1 0 4]

Emission and absorption spectra of X-rays: Bohr's atomic model, ionizing power, critical potentials, X-Rays-Spectra, continuous and characteristic X-rays, Moseley Law. Atoms in Electric and Magnetic Fields: Electron angular momentum, space quantization, electron spin and spin angular momentum, Larmor's theorem, spin magnetic moment, Stern-Gerlach experiment. Zeeman Effect: electron magnetic moment and magnetic energy, gyromagnetic ratio and Bohr magneton. Atoms in External Magnetic Fields: Normal and anomalous Zeeman effect, Paschen back and Stark effect, Pauli's exclusion principle, fine structure, spin-orbit coupling, spectral notations for atomic states, total angular momentum, vector model, L-S and J-J couplings, Hund's rule, term symbols, spectra of hydrogen. Molecular Spectra: Rotational energy levels, selection rules and pure rotational spectra of a molecule, vibrational energy levels, selection rules and vibration spectra. Raman Effect: Quantum theory of Raman Effect, Characteristics of Raman Lines, Stoke's and Anti-Stoke's Lines, complimentary character of Raman and infrared Spectra. Lasers: Einstein's A and B coefficients, metastable states, spontaneous and stimulated emissions, optical pumping and population inversion, three-level and four-level lasers, Ruby laser and He-Ne laser, semiconductor laser.

References:

1. J. B. Rajam, Atomic Physics, S. Chand, 2008.
2. B. H. Bransden, J. C. Joachein, Physics of Atoms and Molecules, Prentice Hall India 2003.
3. C. N. Banwell, E. M. McCash, Molecular Spectroscopy, McGraw-Hill 2017.
4. A. Beiser, Concepts of Modern Physics, Tata McGraw-Hill, 2015.
5. J. H. Fewkes, J. Yarwood, Atomic Physics. Oxford University Press, 1991.
6. Raj Kumar, Atomic and Molecular Spectra: Laser, Kedarnath Ram Nath publication, 2007.

PHY4130: Atomic and Molecular Physics Lab [L T P C – 0 0 4 2]

Interpretation of XRD data, to determine the wavelengths of hydrogen spectrum and hence to determine the value of Rydberg's Constant, to determine the Wavelength of H-alpha emission line of hydrogen atom, to determine the absorption lines in the rotational spectrum of iodine vapour, to determine wavelength of neon spectra, to determine wavelength of mercury spectra, to study of splitting of spectral lines in magnetic field, interpretation of recorded IR spectra, interpretation of recorded FTIR spectra, interpretation of recorded UV-Vis spectra.

References:

1. D. Chattopadhyay & P. C. Rakshit, An Advanced Course in Practical Physics, New Central Book Agency (P) Ltd., 2012.
2. C. L Arora, BSc Practical Physics, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, Practical Physics, New Age Publisher, 2006.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi, 2000.
5. G. Sanon, B. Sc. Practical Physics, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, Advanced Practical Physics, Asia Publishing House, 2002.

PHY4103: Advance Quantum [L T P C – 3 1 0 4]

Perturbation Theory: Time independent (degenerate and non-degenerate) perturbation theory and its applications, time dependent perturbation theory, transition amplitude, transition probability, Fermi's Golden rule. Approximation Methods: Variation methods and its applications, WKB approximation and its applications. Scattering Theory: Scattering in laboratory and centre of mass frame of references, Partial wave analysis, Phase shifts, Applications of scattering and optical theorem, Born approximation and its applications, exchange operator, symmetric and anti-symmetric wave function, collision of identical particles and their scattering amplitude. Klein-Gordon Equation: Klein-Gordon equation, Plane wave solutions, probability current density and equation of continuity, difficulties due to existence of negative energy states, relativistic expression for probability density, Klein-Gordon equation in electromagnetic field and its applications. Dirac Equation: Derivation of Dirac equation, ß-matrices, their anti-commutation relations and their representations, Plane wave solutions of Dirac Equation (Positive energy and Negative energy solutions), Existence of electron spin for a Dirac particle, Covariance of Dirac Equation, γ-matrices and their properties. Heisenberg Representation in Dirac Theory: Dirac operators in the Heisenberg representation, spin of Dirac particle, Velocity in Dirac theory, Zitterbewegung and negative energy solutions, Presence of negative energy components, Hole theory and charge conjugation. Relativistic Dirac Equation: Dirac Equation, relativistic Hamiltonian, probability density, expectation values, Dirac matrices, and their properties, non-relativistic limit of Dirac equation, plane wave solution, energy spectrum of hydrogen atom, electron spin and magnetic moment, negative energy sea. Field Quantization: The procedure for quantization of fields, quantization of non-relativistic Schrodinger equation, second quantization, N-representation creation and annihilation operators.

References:

1. L.I. Schifff, Quantum Mechanics, McGraw-Hill, 2017.
2. P. M. Mathews and K. Venkatesan, A Text Book of Quantum Mechanics, Tata McGraw Hill, 2010.
3. J. J. Sakurai, Modern Quantum Mechanics, Pearson, 2014.
4. N. Zettili, Quantum Mechanics: Concepts & Applications, Wiley India, 2017.

PHY4104: Numerical Methods and Programming [L T P C – 3 1 0 4]

Interpolation: Lagrange's Newton interpolation method, Least square line fitting, Numerical differentiation, Numerical Integration (Gaussian Quadrature method, Newton-cotes Integration formula, Trapezoidal rule and Simpson's and Romberg rules) Numerical methods for ordinary differential equations, Euler's method & Runge-Kutta method (second & fourth order). Solution of Simultaneous Algebraic Equations: Back substitution Gauss Elimination method, Gauss-Jordan Elimination method, Pivoting, Jacobi methods & Gauss-Seidel iterative methods Comparison of direct and iterative methods, Root-finding Algorithms, Bisection method, successive bisection method, method of false position, Newton-Raphason method, Secant method, method of Successive approximations. Introduction to Programming in C++: Then input and output operator, comments, Data types, Variables, objects and their declarations, keywords and identifiers chained assignments Integer types, simple arithmetic operators, operator precedence and associativity, the increment and decrement operators, compound assignment expressions, In tiger overflow and underflow, simple programs. Conditional Statements and Integer Types: The if statement, the if-else statement, Relational operators, Compound Statements, Compound Conditions Nested Conditions, the Switch Statement, Enumeration types. Iteration and Floating Types: The while statement, the do-while statement, for statement break statement, continue statement, the go to statement. Function & Arrays:

Function declaration & definitions, local variables & functions, void functions, passing by reference and passing by value, passing by constant reference, inline functions, overloading, main, exit functions, Array declaration and initializing, processing Arrays, passing an Array to a function, the Linear search and Bubble sort algorithm, binary search algorithm, using arrays with enumeration types, Multidimensional Arrays. Pointers and References: Pointers declaration, pointer operator, address operator, pointer arithmetic's References, Derived types, Arrays & pointers, the new operator, the delete operator, dynamic arrays, Arrays of pointers and pointers to Arrays, Pointers to Pointers. Pointers functions, call by value, call by References. Classes: Introduction, class declaration, constructor, constructor initialization, Private member function, class constructor, copy constructor, Pointers to object. Stream I/O: Stream classes, the ios class, ios format flags, ios state variables, the istream & o stream classes, unformatted input functions.

References:

1. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall, 2006.
2. W. H. Press, A. S. Teukolskly, T. W. Vertterling, and P. B. Flannery, Numerical Recipes, Cambridge University Press, 2007.
3. R. L. Burden, J. D. Faires, Numerical Analysis, Cengage Learning, 2010.
4. R. Pratap, Getting started with MATLAB, Oxford University Press, 2010.
5. H. John, Programming in C++, McGraw-Hill, 2005.
6. J. R. Hubbard, Schaum's Outline Series, Programming in C++, McGraw-Hill, 1996.
7. R. Lafore, Object Oriented Programming in Turbo C++, SAMS Indiana 46240 USA, 2002.

PHY4131: Advance Spectroscopy Lab [L T P C– 0 0 4 2]

Hydrogen spectra - determination of Rydberg constant, Absorption spectrum of iodine- determination of dissociation energy of I_2, Study of the arc spectra of iron, copper, Zinc and brass, Identification of elements by spectroscopic method, Study of normal Zeeman effect, Measurements of wavelength of He-Ne laser light using ruler, Hyperfine structure of spectral lines using Fabry-Perot etalon/Lummer-Gehrcke plate, GM counter characteristics, Analysis of the given vibration-rotation spectrum, Interpretation of a Raman and IR spectra of simple triatomic molecules, Dissociation energy of diatomic molecules- comparison of different Spectroscopic methods, Analyses and, Identification of substances using XRD-patterns using ASTM cards, Identification of elements from stellar spectra, Gaussian power distribution law using lasers, Determination of Curie temperature, Compton spectrometer using microwave and " Tennis ball " model.

References:

1. H. E. White, Atomic Spectra, Tata McGraw-Hill, 1999.
2. C. N. Banwell and E. M. Mccash, Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill, 2002.
3. E. U. Condon and G. H. Shortley, The Theory of Atomic Spectra, Cambridge University Press, 1992.
4. G. Hertzberg, Atomic Spectra and Atomic Structure, Dover Publication, New York, 2010.

Eighth Semester

PHY4270: Research Project [L T P C– 0 0 0 12]

The Research Project is a capstone component of the program, designed to provide students with hands-on experience in independent scientific investigation. Under the supervision of a faculty mentor, students will identify a research problem in experimental, theoretical, or computational physics, conduct a systematic literature review, and apply appropriate methodologies to analyze data or develop models. The course emphasizes research ethics, scientific communication, critical thinking, and problem-solving skills. Students are required to maintain proper documentation of their work, submit a written dissertation/report, and present their findings through an oral presentation or poster.

PHY4220: Low Temperature Physics [L T P C – 3 1 0 4]

Production of Low Temperature Introduction, Joule Thomson effect, regenerative cooling, vacuum pumps, liquefaction of air, hydrogen, helium, maintenance of low temperature, production of temperature below 1 K, adiabatic demagnetization, evaporative cooling of He-3, dilution refrigeration, laser cooling nuclear demagnetization, Measurement of Low Temperature The gas thermometer and its corrections, secondary thermometers, resistance thermometers, thermocouples, vapour pressure thermometers-magnetic thermometers; Liquid and Solid Cryogens: liquid nitrogen, liquid oxygen, liquid hydrogen, liquid he -4 and he -3, solid he– 4 and he -3, lamda point, superfluidity, density, compressibility factor viscosity and thermal properties, velocity of sound in liquid helium. Electrical and Magnetic Properties: experimental observations, theories of Sommerfield and block, superconductivity, magnetic properties of superconductors, thermal properties of superconductors, penetration depth and high frequency resistance, ferromagnetism, diamagnetism, paramagnetism, paramagnetic saturation, Specific Heats, Spectroscopic And Hyperfine Properties specific heats, rotational specific heat of hydrogen, Einstein's and Debye's theories, Schottky effect, anomalies in specific heats at low temperature, infrared, visible spectra, Zeeman spectra at low temperature.

References:

1. C. Jacobus Gorter, D. F. Brewer, Progress in Low Temperature Physics, Elsevier Ltd, 2011.
2. E. Christian and Siegfried H, Low Temperature Physics, Springer, 2010.
3. J. Ekin, Experimental Techniques for Low-Temperature Measurements, OUP Oxford, 2006.
4. C. P. Poole Jr., H. A. Farach, R. J. Creswick, R. Prozorov, Superconductivity, Elsevier, 2007.
5. J. Wilks, Properties of Liquid and Solid Helium, Oxford University Press, 2007.
6. L. C. Jackson, Low Temperature Physics, Methuen and Company, 2002.

PHY4221: Nuclear Fuel and Reactor [L T P C – 3 1 0 4]

Nuclear Structure and Reactions: Basic nuclear properties, binding energy, nuclear forces, mass defect, stability of nuclei. Radioactivity and radioactive decay laws. Nuclear reactions and reaction cross-section. Nuclear Fission and Fusion: Mechanism of nuclear fission. Fissile and fertile materials. Chain reaction and criticality. Nuclear fusion and fusion reactions (basic concepts). Nuclear Fuel Cycle: Nuclear fuels and fuel materials. Uranium enrichment methods. Fuel fabrication. Fuel burnup. Spent fuel management. Reprocessing and waste disposal. Nuclear Reactor Physics: Neutron life cycle. Moderation and neutron diffusion. Reactor criticality. Reactor control methods. Reactor kinetics (qualitative). Nuclear Reactors: Basic components of a nuclear reactor. Types of nuclear reactors: PWR, BWR, PHWR, fast breeder reactor. Safety systems and shielding (introductory). Radiation Detection and Safety: Radiation detectors (GM counter, scintillation detector—basic principles). Radiation units and dosimetry. Radiation hazards and safety measures.

References:

1. S. Glasstone & A. Sesonske. *Nuclear Reactor Engineering: Reactor Design Basics / Reactor Systems Engineering*, 4th ed., Springer, 1994.
2. J. R. Lamarsh & A. J. Baratta. *Introduction to Nuclear Engineering*, 3rd ed., Pearson Edition, 2013.
3. G. R. Keepin. *Physics of Nuclear Kinetics*, 1st ed., Addison-Wesley Publishing Company, 1965.
4. K.S. Krane. *Introductory Nuclear Physics*, 3rd ed., Wiley (John Wiley & Sons), 2022
5. R. R. Roy & B.P. Nigam. *Nuclear Physics*, 1st ed., Wiley-Eastern, 1979.

PHY4222: Introduction to Ceramics [L T P C – 3 1 0 4]

Introduction to Ceramics: Definition and classification of ceramic materials. Traditional and advanced ceramics. Crystal structures and bonding in ceramics. Structure–property relationships. Structure and Properties of Ceramics: Ionic and covalent bonding. Point defects and diffusion in ceramics. Mechanical properties: hardness, brittleness, fracture toughness. Thermal properties: thermal expansion, thermal conductivity. Electrical and dielectric properties. Processing of Ceramics: Raw materials and powder preparation. Forming techniques: pressing, extrusion, slip casting. Drying and sintering. Grain growth and densification. Glasses and glass–ceramics (introductory). Functional and Engineering Ceramics: Dielectric and ferroelectric ceramics. Piezoelectric and pyroelectric materials. Magnetic ceramics (ferrites). Optical and bioceramics. Refractory and structural ceramics. Applications of Ceramics: Ceramics in electronics, energy, aerospace, biomedical, and environmental applications. Ceramic coatings and composites (introductory). Recent trends in ceramic materials.

References:

1. Kingery, W. D., Bowen, H. K., & Uhlmann, D. R. *Introduction to Ceramics* (2nd ed.). John Wiley & Sons, New York, 1976.
2. Barsoum, M. W. *Fundamentals of Ceramics* (2nd ed.). CRC Press (Taylor & Francis Group), Boca Raton, 2020.
3. Reed, J. S. *Principles of Ceramics Processing* (2nd ed.). John Wiley & Sons, New York, 1995.
4. Carter, C. B., & Norton, M. G. *Ceramic Materials: Science and Engineering* (2nd ed.). Springer, New York, 2013.
5. West, A. R. *Solid State Chemistry and Its Applications* (2nd ed.). John Wiley & Sons, 2014

List of Minor and Multidisciplinary Courses Offered by the Department of Physics

Minor Courses

PHY2190: Electromagnetism [L T P C– 3 1 0 4]

Electrostatics: Coulomb's law. Electric field and electric field lines. Electric flux. Gauss's law and its applications. Electric potential and potential gradient. Equipotential surfaces. Poisson's and Laplace's equations (statement and simple applications). Electrostatic energy and energy density. Dielectrics and polarization. Bound and free charges. Electric displacement vector **D**. Gauss's law in dielectric media. Linear dielectrics, susceptibility, and dielectric constant. Boundary conditions for electric fields. Energy in dielectric media. Magnetostatics: Magnetic force and Lorentz force law. Motion of a charged particle in electric and magnetic fields. Biot–Savart law and its applications. Ampère's circuital law and applications. Magnetic vector potential. Magnetic dipole moment. Magnetization and magnetic field intensity **H**. Boundary conditions for magnetic fields. Electromagnetic theory: Faraday's law of electromagnetic induction. Lenz's law. Self and mutual inductance. Energy stored in a magnetic field. Displacement current. Maxwell's equations in integral and differential forms. Physical significance of Maxwell's equations. Continuity equation. Electromagnetic waves: wave equation in free space (qualitative derivation). Speed of electromagnetic waves. Electromagnetic spectrum (overview). Energy and momentum of electromagnetic waves (qualitative).

References / Textbooks

1. D. J. Griffiths, *Introduction to Electrodynamics*, Pearson Education, 4th ed., 2013.
2. E. M. Purcell and D. J. Morin, *Electricity and Magnetism*, Cambridge University Press, 3rd ed., 2013.
3. J. D. Jackson, *Classical Electrodynamics*, 3rd ed., John Wiley & Sons, New York, 1999.
4. W. H. Hayt and J. A. Buck, *Engineering Electromagnetics*, McGraw-Hill, 8th ed., 2010.
5. A. Zangwill, *Modern Electrodynamics*, Cambridge University Press, 1st ed., 2013.

PHY2290: Heat and Thermodynamics [L T P C– 3 1 0 4]

Thermodynamics: Thermodynamic systems and equilibrium. Zeroth law and temperature. Work, heat, and state functions. Laws of Thermodynamics: First law and its applications to thermodynamic processes. Heat engines and Carnot cycle. Second law: Kelvin–Planck and Clausius statements, Carnot theorem, thermodynamic temperature scale. Entropy and Third Law: Entropy as a state function. Clausius theorem. Entropy changes in reversible and irreversible processes. Principle of increase of entropy. Third law of thermodynamics and unattainability of absolute zero. T–S diagrams. Phase transitions. Thermodynamic Potentials and Maxwell Relations: Extensive and intensive variables. Thermodynamic potentials (U, H, F, G) and their applications. Surface tension and magnetic work. Adiabatic demagnetization. Maxwell's relations and applications: Clausius–Clapeyron equation, Joule–Thomson coefficient. Kinetic Theory of Gases: Maxwell–Boltzmann velocity distribution. Mean, RMS, and most probable speeds. Equipartition theorem. Specific heats. Molecular collisions and mean free path. Transport phenomena: viscosity, thermal conductivity, diffusion. Brownian motion. Real Gases and Joule–Thomson Effect: Deviation from ideal behavior. van der Waals equation. Critical constants. Joule's experiment. Joule–Thomson effect, inversion temperature, and cooling.

References:

1. M. W. Zemansky, R. Dittman, Heat and Thermodynamics, McGraw-Hill, 2017.
2. S. C. Garg, R. M. Bansal, C. K. Ghosh, Thermal Physics: with Kinetic Theory, Thermodynamics and Statistical Mechanics, McGraw-Hill, 2017.
3. E. Fermi, Thermodynamics, Snow Ball Publications, 2010.
4. F. W. Sears, G. L. Salinger, Thermodynamics Kinetic Theory and Statistical Thermodynamics, Narosa Publications, 1998.
5. M. Alonso, E. Finn, Physics, Addison-Wesley, 2000.

PHY 3190: Basic Quantum Mechanics [L T P C– 3 1 0 4]

Limitations of classical physics. Blackbody radiation, photoelectric effect, Compton effect, and Franck–Hertz experiment. Wave nature of matter and de Broglie hypothesis. Wave packets; group and phase velocities. Two-slit experiment with electrons. Probability interpretation and wave functions. Heisenberg's uncertainty principle and its derivation using wave packets. Postulates of quantum mechanics. State vectors and observables. Operators for energy, momentum, and Hamiltonian. Time-independent Schrödinger equation for stationary states. Conditions for physical acceptability of wave functions. Expectation values and probability current. Free particle wave function. Eigen functions and eigenvalues for a particle in a one-dimensional infinite potential box. Bound-state problems: general features of bound systems. One-dimensional simple harmonic oscillator. Finite potential step: reflection and transmission coefficients. Stationary solutions and probability current density. Finite potential barriers: attractive and repulsive cases. Quantum tunneling: tunneling effect and qualitative description of tunnel diode. Hermitian operators and their properties. Commutator brackets and simultaneous eigenfunctions. Commutator algebra involving position, momentum, and angular momentum operators. Concept of parity. Parity operator and its eigenvalues.

References:
1. A. Ghatak, S. Lokanathan, Quantum Mechanics: Theory and Applications, Laxmi Publications, 2016.
2. D. J. Griffith, Introduction to Quantum Mechanics, Pearson Education, 2015.
3. L. I. Schiff, J. Bandhyopadhyay, Quantum Mechanics, McGraw-Hill Book, 2010.
4. E. Merzbacher, Quantum Mechanics, John Wiley & Sons, Inc, 2007.
5. J. L. Powell, B. Crasemann, Quantum Mechanics, Addison-Wesley Pubs. Co., 2010.

PHY3290: Condensed Matter Physics [L T P C– 3 1 0 4]

Classification of solids: crystalline and amorphous materials. Lattice translation vectors, primitive and conventional unit cells, symmetry operations, and crystal systems. Types of lattices and Bravais lattices. Miller indices. Simple cubic (SC), BCC and FCC structures. Lattice with a basis. Reciprocal lattice and its construction. Brillouin zones and their significance. Introduction to X-ray diffraction. Crystal as a diffraction grating. Bragg's law and Bragg diffraction condition. Ewald's construction. Debye–Scherrer powder method. Analysis of cubic crystal structures using powder diffraction data. Band theory of solids. Bloch theorem. Kronig–Penney model (qualitative). Effective mass of electrons. Concept of holes. Energy band gaps and band diagrams. Law of mass action. Classification of materials as conductors, insulators, and semiconductors. Diamagnetic, paramagnetic, ferrimagnetic, and ferromagnetic materials. Classical Langevin theory of dia- and paramagnetism. Curie's law. Weiss theory of ferromagnetism. Ferromagnetic domains. B–H curve, hysteresis, and energy loss. Curie temperature. Electric polarization. Local electric field at an atom. Depolarization field. Dielectric constant and electric susceptibility. Polarizability. Classical theory of electric polarizability. Clausius–Mossotti equation. Normal and anomalous dispersion, Critical temperature and critical magnetic field. Meissner effect. Type-I and Type-II superconductors. London equations and penetration depth. Isotope effect. Basic idea of BCS theory. Cooper pairs and coherence length. Josephson effect.

References:
1. C. Kittel, Introduction to Solid State Physics, John Wiley, 2016.
2. A. J. Dekkar, Solid State Physics, Laxmi Publications, 2008.
3. S. O. Pillai, Solid State Physics, New Age International; Eighth edition, 2018.
4. M. Ali Omar, Elementary Solid State Physics: Principles and Applications, Pearson Education, 2015.
5. N. W. Ascroft, N. D. Mermin, Solid State Physics, Harcourt Asia, 2003

PHY4290: Nanomaterials and Applications [L T P C – 3 1 0 4]

Nanoscale systems: Length scales in physics, nanostructures, 1d, 2d and 3d nanostructures, band structure and density of states of materials at nanoscale, size effects in nano systems, quantum confinement, applications of Schrödinger equation-infinite potential well, potential step, potential box, quantum confinement of carriers in 3d, 2d, 1d nanostructures and its consequences. Synthesis of Nanostructure Materials: Top down and bottom up approach, photolithography, ball milling, gas phase condensation, physical vapor deposition, thermal evaporation, e-beam evaporation, pulsed laser deposition, chemical vapor deposition (CVD), sol-gel, electro deposition, spray pyrolysis, hydrothermal synthesis, preparation through colloidal methods, molecular beam epitaxy. Characterization: x-ray diffraction, optical microscope, scanning electron microscopy, transmission electron microscopy, atomic force microscopy, scanning tunneling microscopy. Optical Properties: Coulomb interaction in nanostructures, concept of dielectric constant for nanostructures and charging of nanostructure, quasi-particles and excitons. excitons in direct and indirect band gap semiconductor nanocrystals, quantitative treatment of quasi-particles and excitons, charging effects; Radiative Processes: general formalization-absorption, emission and luminescence, optical properties of heterostructures and nanostructures. Electron Transport: carrier transport in nanostructures, coulomb blockade effect, thermionic emission, tunneling and hoping conductivity, defects and impurities, deep level and surface defects. Applications: applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices, single electron devices. CNT based transistors.

References:
1. C. P. Poole, Jr., F. J. Owens, Introduction to Nanotechnology, Wiley 2016.
2. S. K. Kulkarni, Nanotechnology: Principles & Practices, Capital Publishing Company, 2000.
3. K. K. Chattopadhyay, A. N. Banerjee, Introduction to Nanoscience and Technology, PHI Learning Private Limited 2005.
4. R. Booker, E. Boysen, Nanotechnology, John Wiley, 2000.
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook, Elsevier, 2007.
6. B. Bhushan, Springer Handbook of Nanotechnology, Springer-Verlag, 2004.

PHY4291: Semiconductors and Optoelectronics [L T P C– 3 1 0 4]

Elemental and compound semiconductors. Epitaxy of Semiconductors: bulk and epitaxial semiconductor growth techniques and their comparison. Semiconductor Physics: Introduction to basic physics of semiconductors, carrier transport phenomena, introduction to schottky barrier, ohmic contacts and P-N junction, overview of the factors affecting the optical and electronic properties of semiconductors (carrier scattering, non-radiative recombination, defect levels), semiconductor quantum structures

(QWs and QDs). Characterisation: electrical and optical characterization of semiconductor materials and nanostructures (CV, PL, Hall, I-V, EL etc.). Devices: semiconductor optoelectronic devices (LED, photodetector, lasers, solar cells) with a special focus on the application of nanostructures in optoelectronics.

References:

1. P. Bhattacharya, Semiconductor optoelectronic Devices; Pearson, 2017.
2. B. Streetman, S. Banerjee, Solid State Electronic Devices, PHI, 2014.
3. P. Y. Yu, M Cardona, Fundamentals of Semiconductors, Springer, 2010.
4. D. K. Schroder, Semiconductor Material and Device Characterization, Wiley, 2015.

Multidisciplinary Course

PHY2140: Introduction to Astrophysics [L T P C– 2 1 0 3]

Astronomical Scales: Astronomical distance, mass and time, radiant flux and luminosity, measurement of astronomical quantities, basic concepts of positional astronomy: celestial sphere, geometry of a sphere, astronomical coordinate systems, geographical coordinate systems, horizon system, equatorial system, diurnal motion of the stars, conversion of coordinates, measurement of time, sidereal time, apparent solar time, mean solar time, equation of time, calendar. basic parameters of stars: determination of distance by parallax method; brightness, radiant flux and luminosity, apparent and absolute magnitude scale, distance modulus, determination of temperature and radius of a star, determination of masses from binary orbits, Stellar spectral classification. The Sun: Solar parameters, solar photosphere, solar atmosphere, chromosphere, corona, solar activity, basics of solar magneto-hydrodynamics, helioseismology. solar system: facts and figures, origin of the solar system, The Nebular Model, tidal forces and planetary rings, extra-solar planets, stellar spectra and classification structure, atomic spectra revisited, stellar spectra, spectral types and their temperature dependence, black body approximation, H R diagram, luminosity classification. The Milky way: Basic structure and properties of the milky way, nature of rotation of the milky way, star clusters of the milky way, properties of and around the galactic nucleus. Galaxies: Galaxy morphology, Hubble's classification of galaxies, elliptical galaxies, spiral and lenticular galaxies.

References:

1. K.D. Abhyankar, Astrophysics: Stars and Galaxies, Universities Press, India 2001.
2. V.B. Bhatia, Astronomy and Astrophysics with elements of cosmology, Narosa Publication, India 2001.
3. B. Basu, An introduction to Astrophysics, Prentice Hall of India Private limited, India, 2001.
4. M. Zeilik and S.A. Gregory, Introductory Astronomy and Astrophysics, Saunders College Publishing, 1997.
5. H. Karttunen, Fundamental of Astronomy, Springer 2007.
6. K.S. Krishnasamy, Astro Physics a modern perspective, Reprint, New Age International (p) Ltd, New Delhi, 2002.
7. B.W. Carroll & D.A. Ostlie, Modern Astrophysics, Addison-Wesley Publishing Co, 2006.

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