REVISED SYLLABUS OF PHYSICS

Curricular & Credit Framework

for

Three Years Honors

In

B.Sc. Hons. Physics

NATIONAL EDUCATION POLICY-2020

C.S.J.M. University, Kanpur

Chhatrapati Shahu Ji Maharaj University, Kanpur

Uttar Pradesh State University (Formerly Kanpur University, Kanpur)

Minutes of the Meeting of Board of Studies (held on 17 Jun 2025)

A Meeting of the Board of Studies (BOS) for the subject Physics was held on 17 June 2025 at 1:00 PM via online mode (Google-meet), with video conferencing at the CSJM University Campus Kanpur. The agenda was to discuss and approve the course structure and syllabus of the B.Sc., B.Sc. (Hons.) and M.Sc. Physics programs.

The detailed course structure and syllabus for both programs had already been shared with all BOS members. These programs have been designed in accordance with the Curricular & Credit Framework for the Four Year Undergraduate Programme (FYUP). During the meeting, a presentation on the course structure and syllabus was delivered. After thorough discussion on each aspect of the syllabus, the following suggestions and recommendations were made by the BOS members:

1. Corrections were suggested for the course B011006T - Laser Physics and Applications (X^{th} semester), and the syllabus has been revised accordingly.

2. Few corrections related to practicals were incorporated as per the members' suggestions.

3. All other minor recommendations were incorporated into the syllabus as advised by the Board members. The members unanimously approve the final syllabus.

The Meeting was attended by the Following BOS Members:

Convener

Prof. Rajesh Kumar Dwivedi, CSJM University, Kanpur

External Members

1. Prof. K.N. Uttam, Allahabad University, Allahabad
2. Prof. D.K. Dwivedi, MMMTU Gorakhpur
3. Prof. Manoj Kumar Sharma, Lucknow University, Lucknow

Internal Members

1. Prof. Preeti Dwivedi, VSSD College, Kanpur
2. Prof. Vivek Dwivedi, BND College, Kanpur
3. Prof.Anurag Saxena, DAV College,Kanpur
4. Dr Pradeep Gupta, DSN College, Unnao
5. Dr. Anju Dixit, CSJM University Campus, Kanpur — Anju Dixit

Invited Members

1. Prof. Rajiv Kumar, DAV College, Kanpur
2. Prof. P. S. Dobal, VSSD College Kanpur
3. Prof. S. P. Singh, Christ Church College, Kanpur
4. Dr. Prabal Pratap Singh, CSJM University Campus, Kanpur

DEPARTMENT OF PHYSICS,
SCHOOL OF BASIC SCIENCES, CSJM
UNIVERSITY CAMPUS, KANPUR 208024

Vision:

To excel in quality teaching and research by attracting the best of minds and keep pace with contemporary research in terms of infrastructure and facilities.

Mission:

The mission of this department is to teach and learn physics in a collaborative, performance- based pathway. We look to encourage the students towards observation and analysis of the natural phenomena of the world and to provide the tools and skills to the students to be the torch bearers of Physics by contributory effectively to the existing laws of nature.

BACHELOR OF SCIENCE HONORS PHYSICS
B.Sc. (Hons) in Physics
Duration: 3 years

Program Outcomes of B.Sc. (Hons.) in Physics, School of Sciences:

1. Physics is an exciting science subject that generates fundamental knowledge for advancement in technology and research.
2. The technology which are using today would not have been possible without traditional and modern physics. Physics plays an important role in the future progress of human kind globally.
3. B.Sc. (Hons.) in physics has offered 22 theoretical and experimental courses during six semesters.
4. This course emphasis on the concept of physics that includes modern physics, quantum physics, classical mechanics, relativity, thermodynamics, wave optics, etc.
5. The course is design to help students with good understanding of subjects and also offer them opportunities to work as professionals and researchers in the departments that demand a good understanding of physics at both local and national level.
6. Keeping in mind the application oriented training, this program aims to give students the competence in the methods and techniques of theoretical, experimental and computational aspects of physics. So as to achieve an overall understanding of the subject for holistic and regional development.
7. After completion of B.Sc. (Hons.) In physics, students can go for higher studies or they can get a job in relevant fields.
8. The course is so design that it trends the graduate to get entry level jobs in different private and government sectors.

Program Specific Outcomes:

1. To understand the basic laws and explore the fundamental concepts of physics
2. To understand the concepts and significance of the various physical phenomena.
3. To carry out experiments to understand the laws and concepts of Physics.
4. To apply the theories learnt and the skills acquired to solve real time problems.
5. To acquire a wide range of problem solving skills, both analytical and

technical and to apply them.

6. To enhance the student's academic abilities, personal qualities and transferable skills this will give them an opportunity to develop as responsible citizens.
7. To produce graduates who excel in the competencies and values required for leadership to serve a rapidly evolving global community.
8. To motivate the students to pursue PG courses in reputed institutions.
9. This course introduces students to the methods of experimental physics. Emphasis will be given on laboratory techniques specially the importance of accuracy of measurements.
10. Providing a hands-on learning experience such as in measuring the basic concepts in properties of matter, heat, optics, electricity and electronics.

Program Educational Objectives:

1. The 3 year B.Sc. (Hons.) in physics program offered by the department of physics, School of Sciences, has been designed to provide a strong foundation in fundamental physics concepts that form the very basis of advanced scientific inventions.
2. The curriculum presents a blend of science and technology, with the physics courses compliments by adequately equipped laboratory experiments and supplemented by lessons in advanced quantum mechanics, solid state physics, nuclear and particle physics, fiber optics and electronics.
3. Moreover, students are trained in computational techniques and computer programming providing a holistic education at the bachelor's level. The structure of the syllabus is so designed that in each semester the students will be able to learn about various topics of physics including laboratory work.
4. This program aims at inspiring students to pursue science further at postgraduate level and beyond.
5. Students completing this B.Sc. (Hons.) program become eligible to continue M.Sc. in physics in premier institutes and universities as well as they will be competent enough to join directly in integrated M.Sc.-Ph.D. program at reputed institutes like IITs and IISC Bangalore in India.
6. The rigorous training obtained during three year course work brings out students which are capable of pursuing higher education in regional/abroad universities also.
7. Besides higher education, this B.Sc. (Hons.) in Physics program opens up a wide range of job opportunities in the employment areas like civil services, power generating companies, applied electronics, research and development firms etc. students may also take up various other jobs like datalysts, research assistants, consulting physicist etc.

Revised Syllabus (2025) of B.Sc. (Hons) in Physics
Department of Physics,
School of Basic Sciences, CSJM University Campus Kanpur.

Semester wise- Distribution of Course

Total Credit: 130

Semester-I, Credits: 17				
S.No.	**Course Code**	**Course Type**	**Courses Name**	**Credits**
1.	BH010101T	Core Course - I	Mathematical Methods-I	4
2.	BH010102T	Core Course -II	Mechanics and General Properties of Matter	4
3.	BH010103P	Practical-I	Laboratory -I	4
4.	VOCxxx	Skill Enhancement course (SEC)	Vocational Skill Enhancement course	3
5.	Z011101	Co-curricular Course	First Aid and Basic Health	2
Semester-II, Credits: 23				
S.No.	**Course Code**	**Course Type**	**Courses Name**	**Credits**
1.	BH010201T	Core Course - I	Electricity and Magnetism-I	4
2.	BH010202T	Core Course -II	Waves and Geometrical Optics	4
3.	BH010203P	Practical-II	Laboratory -II	4
4.	BH010204TM	Minor Course	General properties of matter & optics (For other departments)	4
5.	BH010204PM	Minor Course-Practical	Minor Course Laboratory-I	2
6.	VOCxxx	Skill Enhancement course (SEC)	Vocational Skill Enhancement course	3
7.	Z021201	Co-Curricular Course	Human Values and Environment Studies	2

Semester-III, Credits: 17				
S.No.	**Course Code**	**Course Type**	**Courses Name**	**Credits**
1.	BH010301T	Core Course - I	Mathematical Methods-II	4
2.	BH010302T	Core Course -II	Electronics-I	4
3.	BH010303P	Practical-III	Laboratory -III	4
4.	VOCxxx	Skill Enhancement course (SEC)	Vocational Skill Enhancement course	3
5.	Z031301	Co-Curricular Course	Physical Education and Yoga	2
Semester-IV, Credits: 23				
S.No.	**Course Code**	**Course Type**	**Courses Name**	**Credits**
1.	BH010401T	Core Course - I	Classical Mechanics	4
2.	BH010402T	Core Course -II	Electricity and Magnetism-II	4
3.	BH010403P	Practical-IV	Laboratory -IV	4
4.	BH010405TM	Minor Course	Modern physics & electronics (For other departments)	4
5.	BH010405PM	Minor Course-Practical	Minor Course Laboratory-II	2
5.	BH010404R	Project	Research Project/Internship/Field Work	3
6.	Z041401/ Z041402	Co-Curricular Course	Social Responsibility and Community Engagement/Indian Language	2

Semester-V, Credits: 25				
S.No.	**Course Code**	**Course Type**	**Courses Name**	**Credits**
1.	BH010501T	Core Course - I	Electronics-II	4
2.	BH010502T	Core Course -II	Physical Optics	4
3.	BH010503T	Elective-I	Thermal Physics	4
	BH010504T		Material Science: Evolution And Applications	
4.	BH010505T	Elective-II	Solid State Physics	4
	BH010506T		Theoretical and Observational Aspects of Astronomy	
5.	BH010507P	Practical-V	Laboratory -V	4
6.	BH010508R	Research Project	Research Project on topics which are Inter/Intra faculty	5

Semester-VI, Credits: 25				
S.No.	**Course Code**	**Course Type**	**Courses Name**	**Credits**
1.	BH010601T	Core Course - I	Elementary Quantum Mechanics	4
2.	BH010602T	Core Course -II	Statistical Mechanics & Solid State Physics	4
3.	BH010603T	Elective-I	Quantum Computing	4
	BH010604T		Introduction to Nanoscience	
4.	BH010605T	Elective-II	Applied Optics	4
	BH010606T		Atomic, molecular, nuclear & particle physics	
5.	BH010607P	Practical-VI	Laboratory -VI	4
6.	BH010608R	Research Project	Research Project on topics which are Inter/Intra faculty	5

Note:

1. Total Credits 80 till semester IV
2. Student is entitled for Diploma in Faculty after successful completion of four semesters
3. Total Credits 130 till semester VI
4. Student is entitled for Three Year B.Sc. (Hons.) Physics UG Degree after successfully completion of six semesters.
5. Several Elective courses will be offered for semester-V and semester-VI. However the number of courses offered in each semester (V/VI) will be decided by the Physics Department. Out of the offered courses students have to select two courses for semester –V and another two courses for semester-VI. However final decision will be made by a committee with HOD as the convener.

SEMESTER-I

Course Code: BH010101T **Credit: 4**
Course Name: MATHEMATICAL METHODS–I

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the fundamental properties of vectors and scalar.
CO2	Apply the vector dot, cross, triple products in various physical systems.
CO3	Knowledge of various coordinate systems will help the students to solve difficult problems in electricity and magnetism.
CO4	Theory of ordinary differential equation is widely used in formulating many fundamental laws of physics.
CO5	Understand the fundamental properties of vectors and scalar.

Course Details:

Unit 1. **Vector Analysis**: Motivations, Definition of a vector, Dot and Cross Products; Scalar triple product; Vector triple product, Reciprocal vectors, Applications in Physical systems; Vector Differentiation and Integration; Line, surface and Volume Integrals; Gradient, Divergence and Curl; Gauss Green's and Stokes' Theorems and Applications.

Unit 2. **Coordinate Systems**: Curvilinear Coordinates, Differential Vector Operators; Orthogonal Coordinate Systems–Rectangular Cartesian Coordinates, Spherical Polar Coordinates, Cylindrical Coordinates, Jacobian of transformation, Gradient, Divergence, Curl and Laplacian in curvilinear coordinates

Unit 3. **Fourier Series**: Real and complex expansions, Odd and even functions, half-range expansions, Dirichlet condition, Gibb's phenomenon, Parseval's theorem, Convergence of Fourier series, Fourier integrals.

Unit 4. **Ordinary Differential Equations**: Basic Concepts and ideas, separable equations, equations reducible to separable form, exact differential equations, integrating factors, linear first-order differential equations, homogeneous linear equations of the second order, homogeneous second order equations with constant coefficients. Characteristic equations, SHM – free, forced and damped systems. Non-homogeneous equations, **Elements of partial differential equations**: Separation of variables, Laplace equation, Fourier equations for Heat conduction, wave equation.

Text and Reference Books:

1. Mathematical methods for Physicists: Arfken and Weber. Elsevier, seventh edition, 2013.
2. Mathematical methods of physics–J Mathews and RI Walker, Pearson Addison-Wesley, second edition, 1971.
3. Advanced Engineering Mathematics –Erwin Kreyszig, Wiley , tenth edition, 2010.
4. Mathematics for Physicists–Dennery and Krzywicki, Dover Publications Inc., new edition, 1996.
5. Introduction to mathematical physics: C.Harper., Prentice-Hall of India Pvt.Ltd, sixth edition ,1995.
6. Mathematical methods for physics and Engineering: Riley, Hobson, Bence , Cambridge University Press, third edition, 2006.
7. Mathematical Methods in the Physical Sciences: Mary L.Boas,, Wiley, third edition, 2005.
8. Mathematical Physics– PK Chattopadhyay, New Age International Private Limited,third edition , 2022.
9. Vector and Tensor Analysis with applications– Borisenko andTarapov, Dover Publications, New edition , 2003.
10. Vector Analysis–MR Spiegel (Schaum series), McGraw Hill Education, second edition , 2017.
11. Fourier Transform, M.R. Spiegel (Schaum series), McGraw-Hill Education, first edition, 1974.

SEMESTER-I

Course Code: BH010102T **Credit: 4**
Course Name: MECHANICS & GENERAL PROPERTIES OF MATTER

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Examine the basic principles of mechanics.
CO2	Understand the inertial and gravitational masses. Calculate the gravitational potential and field due to spherical bodies.
CO3	Able to explain various natural processes and related technological advances.
CO4	Solve problems encountered in everyday life.
CO5	Examine the basic principles of mechanics.

Course Details:

Unit 1. Reference frames and Rigid Bodies : Inertial and non-inertial frames of references, Galilean transformation equations, applications to rotating frames, centripetal and Coriolis accelerations. System of particles, center of mass, angular momentum, equations of motion, conservation theorems for energy, momentum and angular momentum of rigid bodies, degrees of freedom, Euler's equations, Moments and products of inertia, parallel and perpendicular axes theorem, equation of motion for rotation, moment of inertia of regular rigid bodies about different axes.

Unit 2. Gravitation: Inertial and Gravitational mass, Principle of equivalence and Einstein's thought experiments, Gravitational potential and intensity, Gauss's law, applications of Gauss's law, Poisson's equation, Laplace's equation, gravitational self-energy, gravitational field and potential due to spherical bodies.

Unit 3. Elasticity, Viscosity and fluid dynamics: Stress, strain and elastic constants for anisotropic solid, inter relationships between the various elastic constants, Torsion of a cylinder and torsional rigidity, bending of beams and cantilevers, flexural rigidity, geometrical moment of inertia, strain-energy relations. Viscous fluids, definition of viscosity coefficient and Newton's law, streamline and turbulent flow, flow through a capillary tube and Poiseullie’s equation, Reynold’s number, Stoke’s method and terminal velocity, Equation of continuity in differential form, Bernoulli's theorem and its applications, Toricelli’s theorem, velocity of flux.

Unit 4. Surface tension: Surface energy and surface tension, thermodynamic interpretation surface energy, molecular theory of surface tension, capillarity and rise of liquid in a tube of insufficient length, Jurin's law, excess pressure caused inside the curved surface of a liquid, work done for blowing of bubble, spreading and gathering of liquid.

Text and Reference Books:

1 Fundamentals of Physics, D. Halliday, R. Resnick and J.Walker 5thEd, John Wiley & Sons, Publisher – Wiley 10TH Edition 2013.
2. Berkley Physics, Vol. I, Mc Graw Hill Education – 2nd edition 2017.
3. Feynman Lectures in Physics Vol.I, Pearson Education; First edition 2012.
4. An Introduction to Mechanics, D. Kleppner and R. J. Kolenkov, McGraw Hill Education; 1st edition 2017.

SEMESTER-I

Course Code: BH010103P **Credit: 4**
Course Name: Laboratory -I

Course outcomes (CO): At the end of the lab course, the student will be able to:

CO1	Perform basic experiments related to Mechanics
CO2	Be familiar with various measuring instruments and also would learn the importance of accuracy of measurements.

Name of Experiments:-

1. Use of Vernier callipers, Screw gauge and scale. To study the random error in observations.
2. Determination of ‘g’ by Kater's pendulum.
3. Determination of ‘g’ by bar pendulum.
4. To determine the Moment of Inertia of a Flywheel.
5. Determination of surface tension by capillary tube method and verification of Jurin's law.
6. Determination of coefficient of viscosity Poiseuille's method.
7. Determination of Young’s Modulus(Y), Rigidity Modulus(n) & Poisson's ratio of a wire by Searle's method.

SEMESTER-II

Course Code: BH010201T **Credit: 4**
Course Name: ELECTRICITY & MAGNETISM-I

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Gain knowledge about fundamental laws and concepts of electricity and magnetism, especially the properties of static electric and magnetic fields.
CO2	Apply knowledge of magnetism to explain natural physical processes and related technological advances.
CO3	Design experiments and acquire data in order to explore physical principles.

Course Details:

Unit 1. Electrostatics in Vacuum: Electric charge, conservation and quantization of charge, Coulomb's law, electric field, electric flux, Gauss's law and its application to field problems, mechanical force on a charged conductor. Electric Potential: Resume of vector algebra. Line integral of electric field, potential difference and the potential function, relation between field and potential, potential and field due to various charge distribution, electric dipole and quadrupole.

Unit 2. Electrostatics in dielectric media: Dielectrics, polarization, bound charges, Gauss's law in dielectric, electric susceptibility and electric displacement, Linear dielectrics, boundary conditions at the dielectric surface,energy density in electrostatic field, microscopic theory of dielectric polarizability, Clausius-Mossotti relation, atomic radius from dielectric constant, polar molecules and Langevin-Debye formula.

Unit 3. Capacitance and Condensers: Capacitance of parallel-plate, spherical and cylindrical capacitors with and without dielectrics, loss of energy in sharing charges. **Poisson's and Laplace's Equations**: Derivations, Earnshaw's Theorem, Application of Laplace's equation in spherical and cylindrically symmetric problem. Conducting sphere in uniform field. **Steady Current**: Current density, Electrical conduction in a metal, Ohm's law, Resistance and resistivity, Electromotive force, Kirchhoff's laws and their applications.

Unit 4. Magnetic effect of steady current : Force exerted by a magnetic field on a moving Charge, Ampere's law, Biot-Savart law, Calculations of Magnetic Inductions for a various current configuration, Helmholtz double coil galvanometer, Force between long parallel current carrying conductors, Torque on a current loop. **Electromagnetic Induction**: Faraday's law, Lenz's law, Self Inductance and mutual inductance-calculations in simple cases, measurement of magnetic flux, energy stored in a magnetic field.

Text and Reference Books:

1. Electricity and Magnetism (vol-I)- J. H. Fewkesand and John Yarwood - University Tutorial Press, London, 1965.
2. Berkeley Physics Course (Vol-II) - McGraw Hill Education; 2nd edition 2017.
3. Introduction to electrodynamics-David J.Griffiths Pearson Education India Learning Private Limited; 4th edition 2015.
4. Physics (Vol-II)-Halliday and Resnick 5th edition, 2017.

SEMESTER-II

Course Code: BH010202T **Credit: 4**
Course Name: WAVES AND GEOMETRICAL OPTICS

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Solve wave equations and understands significance of transverse waves.
CO2	Understand the physical characteristics of SHM and obtaining solutions of the harmonic oscillators using differential equations.
CO3	Develop knowledge about Fermat's principle, laws of reflection, refraction and rectilinear propagation of light.

Course Details:

Group A: Oscillations & Waves:

Unit 1. Free oscillation of simple system with one degree of freedom, general equation of motion, longitudinal and transverse oscillation of a mass between two springs, slinky approximation, small oscillations approximation. Composition of simple harmonic motion vibration, interference, beat, Linearity and superposition principles, Lissajous figures; Theory of free vibrations with damping, critical damping, Q of an oscillator, Forced oscillator with one degree of freedom, Transient and steady state oscillators resonance, sharpness of resonance; Free oscillations of system with two degrees of freedom, coupled pendulum, Longitudinal and transverse oscillations of coupled masses.

Unit 2. Fourier analysis, Fourier series and Fourier coefficients, Fourier transform, progressive and standing waves, phase and group velocity, Dispersive waves, energy and intensity of plane waves, relative and absolute intensity, Decibel and phonon, classical wave equation, boundary conditions and normal modes vibration of stretched strings-plucked, struck and bowed strings, non-linear oscillations, combination ones.

Shock waves, Doppler effect, Supersonic sound waves, Ultrasonics and application of ultrasonic waves, Acoustics of building, reverberations, Sabine's formula.

Group B: Geometrical Optics:

Unit 3. Basic concept, Fermat's principle-proof of the laws of reflection, refraction and rectilinear propagation of light. Refraction at spherical surfaces, a planatic surface, a planatic foci, Helmholtz's relation of magnification, theory of thin lens, Two thin lenses separated by a distance, Matrix method in paraxial optics, Matrix description of image formation, thick lens, cardinal point, nodal slide.

Unit 4. Aberration of light, spherical aberration and other monochromatic defects, causes and corrections, chromatic aberration, dispersive power, achromatic doublet, case of two separated lenses, Ramsden and Huygens eye pieces.

Text and Reference Books:

1. Berkeley Physics Course, Vol II (Waves) - McGraw Hill Education 2017.
2. The physics of waves and oscillation, N.K.Bajaj, Tata McGraw-Hill,New Delhi – 2017.
3. A text book on waves and acoustic, P.K.Chakrabarty and S.Choudhury (New Central Book Agency, Kolkata)New Central Book Agency; 4th Revised edition 2010.
4. Optics, A. Ghatak (Tata McGraw-Hill, New Delhi) McGraw Hill; Seventh edition 2010.
5. Geometrical and Physical Optics, R. S. Longhurst Longman; 3rd edition 1974.
6. The Feynman Lectures on Physics, Vol. I - Pearson Education; First edition 2012.

SEMESTER-II

Course Code: BH010203P **Credit: 4**

Course Name: Laboratory -II

Course outcomes (CO): At the end of the lab course, the student will be able to:

CO1	Calibrate Ammeter
CO2	Determine resistance experimentally

Name of Experiments:

1. Calibration of ammeter by potential drop method.
2. Comparison of two low resistances by potential drop method.
3. Calibration of ammeter by copper deposition method.
4. Calibration of ammeter by potential drop method.
5. Determine the specific resistance by using Carey-Foster Bridge.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-II

Course Code: BH010204TM **Credit: 4**
Course Name: GENERAL PROPERTIES OF MATTER & OPTICS

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Study the elastic behavior and working of torsional pendulum
CO2	Study of bending behavior beams and analyze the expression for young's modulus
CO3	Understand the surface tension and viscosity of fluid
CO4	Analyze waves and oscillations
CO5	Study the basic properties and production of ultrasonic's by different methods

Group-A: General Properties of Matter

Elasticity: Stress and strain, Hook's law, elastic constant and their interrelations, work done in stretching a wire, torsion of a cylinder, determination of Y, determination of η (static and dynamical method)

Surface Tension: Surface tension and surface energy, theory of surface tension, angle of contact, capillary, excess pressure of a curved liquid surface, factors affecting Surface Tension.

Viscosity: Coefficient of viscosity, streamline and turbulent motion, Reynolds number, Bernoulli‟s equation, flow of liquid through a capillary tube, Poiseuille's equation and determination of viscosity of a liquid, Stokes' law, factors affecting viscosity, application to blood flow.

Wave Motion: Different types of waves, Longitudinal/Transverse waves and progressive/stationary waves, Period, Amplitude, Frequency, Wavelength, Velocity, Phase etc., Forced Vibrations and Resonance, Resonance column method of finding velocity of sound waves, Transverse waves in a string, Laws of vibration of strings, Characteristics of musical sound, Doppler effect, Ultrasonics, Ultra sonography, Intensity, decibel.

Group-B: Optics

Fermat's Principle: Fermat's principle, Laws of reflection and refraction from Fermat's principle.

Prism: Dispersion, Dispersive power, Deviation, dispersion by raindrop, rainbow.

Thin Lenses: Equivalent focal length of two lenses in contact, Equivalent focal length of two lenses separated by a distance, chromatic aberration in lens, achromatic combination of lenses, spherical aberration in a lens and its remedy.

Velocity of Light: Introduction, Determination of velocity of light: Fizeau (Terrestrial), Foucault‟s and Michelson's method, Constancy of velocity of light in all frames of references.

Wave Theory of Light: Huygen's principle, the laws of reflection and refraction.

Text and References Books:

1. Optics by Ajoy Ghatak, McGraw Hill Education (India) Private Limited,7th Edition,2020
2. A textbook of Optics by Subrahmanyam, Brijlal and Avadhanulu, Schand; 23rd Rev. Edition. 2006.

SEMESTER II

Course Code: BH010204PM (Lab) **Credit: 2**
Course Name: Minor Course Laboratory-I

Course outcomes (CO): At the end of the lab course, the student will be able to:

CO1	Understand the experiments related to Optics
CO2	Understand the experiments related to mechanics

Name of Experiments:

1. Determination the rigidity modulus of a material taken in the form of wire by stastical method.
2. Determination the rigidity modulus of a material taken in the form of wire by dynamical method.
3. Determination of the focal length of a convex mirror.
4. Determination of the focal length of a convex lens by combination method.
5. Determination of the focal length of a convex lens by displacement method.
6. Determination of the refractive index of the material of a prism by spectrometer.
7. Determination of the refractive index of a liquid by lens and mirror.
8. Determination of the refractive index of a liquid by travelling microscope.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-III

Course Code: BH010301T **Credit: 4**
Course Name: MATHEMATICAL METHODS–II

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Have a good grasp of the basic elements of complex analysis, including the important integral theorems.
CO2	Understand the applications of vector space, matrix algebra, probability and statistics.
CO3	Gain knowledge about different important distributions like binomial distribution, Poisson's and Gaussians distributions.
CO4	Able to solve challenging and critical problem in physics

Course Details:

Unit 1. Matrices: Special types of Matrices – Unitary, Hermitean, orthogonal, symmetric and skew symmetric,matrices as operators –rotation matrix, Eigen values and eigen vectors of matrices.

Unit 2. Linear Vector Spaces: Definitions, subspaces, Linear independence, bases of vector spaces,dimensions, linear transformations, the algebra of transformations, function space, space of infinite dimensionality.

Unit 3. Probability and Statistics: Introduction, statistical distributions, Second moment and standard deviation, definitions of probability, fundamental laws of probability, discrete probability distributions, combinations and permutations, Stirling's approximations for the factorial, continuous distributions, expectation. The binomial distribution, the Poisson and Gaussian distribution.

Unit 4. Complex Analysis: Complex Number System, Fundamental operations and the axiomatic foundations of complex algebra, graphical representation, polar form, De Moivre's theorem, roots of complex numbers, Euler's formula, n-throot of unity, polynomial equations, variables and functions, single and multiple valued functions, inverse functions, elementary functions. Functions of a complex variable, analytical functions, Cauchy Riemann conditions, Taylor and Laurent Series, Singularities and zeros – pole, branch point, and branch cut. Calculus of residue and evaluation of integrals, Mapping, Conformal mapping

Text and Reference Books:

1. Matrices and Tensors in Physics–A W Joshi, New Age International Limited, 2005.
2. An introduction to Probability Theory & its Applications,William Feller,VolumeI,Wiley Eastern Limited - Wiley; 3rd edition 1968.
3. Theory and problem of probability and statistics–M R Spiegel (Schaumseries) - McGraw Hill Education; 3rd edition, 2017.

4. The world is built on probability, Lev Tarasov, Mir Publishers, Moscow – Reprint edition, 1990.
5. Schaum's outline of theory and problems of complex variables with an introduction to conformal mapping and its applications, Murray R. Spiegel, McGraw-Hill 1964.
6. Complex Variables and Applications:R V Churchill and J W Brown, (McGraw-Hill) - McGraw Hill Higher Education; 9th edition 2013.
7. Complex analysis for mathematics and Engineering, J.H. Mathews, R.W. Howell, Jones and Bartlett Publishers 5th edition 2006.
8. Complex analysis, L.V. Ahlfors, McGraw-Hill International 3rdEdition, 2017.
9. Foundations of Complex Analysis S.Ponnusamy, Narosa Publishing House 2011.
10. Complex Variables: Theory and Applications, H.S.Kasana, Prentice Hall of India Pvt Ltd. 2nd edition, 2005.
11. Complex variables–Ablowitz and Fokas(CUP) - Cambridge University Press; 2nd edition 2003.

SEMESTER-III

Course Code: BH010302T **Credit: 4**
Course Name: ELECTRONICS-I

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the basic characteristics of semiconductor diodes and its applications.
CO2	Gain knowledge about network, superposition theorem, Norton's theorem and how to apply them in technology.
CO3	Design bipolar junction transistors.
CO4	Understand the basic characteristics of semiconductor diodes and its applications.

Course Details:

Unit 1. Network: Definition, mesh and nodal methods, two port network, T and circuits and their transformations, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem.
Thermionic emission and vacuum tubes: Electron emission from solid, Richardson-Dushman equation, Space charge effects and Child-Langmuir law, structure and characteristics of vacuum diode and triode

Unit 2. Semiconductor physics: Electrical conductivity of materials, metal, insulator and semiconductor, elemental and compound semiconductor, intrinsic and extrinsic semiconductor, concept of hole, law of mass action, density of majority and minority carriers, effective mass and mobility of holes and electrons, energy band concept, band diagram, direct and indirect band-gap semiconductor.

Unit 3. Semiconductor diodes: Formation of p-n junction, electric field distribution at junctions, contact potential and depletion layer, Derivation of diode equation, forward and reverse biased junction, half wave, full-wave and bridge rectifiers, diode characteristics and load line, diode clamping and clipping circuit. Zener diode, use of Zener diode as a voltage regulator.

Unit 4. Transistors: Bipolar Junction transistor: n-p-n and p-n-p transistors, Mechanism of current flow, current gains α and the relations, Characteristics in CE, CB and CC mode, Load line analysis of transistor, DC and AC load line, Q point, Active, cut-off and saturation region, amplifying action of a transistor. Junction field effect transistor: Structure of JFET and their characteristics, pinch-off, structure of MOSFET and their characteristics.

Text and Reference Books:

1. J. Millman and A. Grabel, Microelectronics', McGraw-Hill 2nd edition 2016.
2. Streetman B.G., Solid State Electronic Devices' Prentice Hall. Publisher PHI 2014.
3. Electronics fundamental and application, J.Ryder - Prentice-Hall of India Pvt. Ltd 5th edition 2009.

4. Malvino, Electronic Principles ' Tata McGraw-Hill 9th edition 2021.
5. J. Nagrath, Electronics (AnalogandDigital), Prentice Hall 2013.
6. T. Chattopadhyay, Analog and Digital Electronics' CBS publishers,NewDelhi 2010.
7. R. K Kar, Electronics (Classical & Modern), Books and Allied (P)Ltd, 2007.

SEMESTER-III

Course Code: BH010303P **Credit: 4**
Course Name: Laboratory -III

Course outcomes (CO): At the end of the lab course, the student will be able to:

CO1	Understand the basic characteristics of semiconductor diodes through experiments
CO2	Learn to calculate band gap and Planck's constant experimentally

Name of Experiments:-

1. To study static characteristics of a triode.
2. To study the characteristics of a junction diode.
3. To study the characteristics of a Zener diode.
4. Determination of Planck's constant.
5. Determination of Bandgap by four probe method.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-IV

Course Code: BH010401T **Credit: 4**
Course Name: CLASSICAL MECHANICS

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Define and understand basic mechanical concepts related to advanced problems involving the dynamic motion of classical mechanical systems.
CO2	Describe and understand the differential equations and other advanced mathematical in the solution of problems of mechanical systems.
CO3	Describe and understand the motion of a mechanical system using Lagrange-Hamilton formalism.
CO4	Define and understand basic mechanical concepts related to advanced problems involving the dynamic motion of classical mechanical systems.

Course Details:

Unit 1. Mechanics of a single particle and Mechanics of system of particles; Constraints of motion; Degrees of freedom; Generalized coordinate; some examples. Lagrangian formalism; Virtual displacement and virtual work done; D'Alembert's principle and derivation of Euler-Lagrange equations; Lagrange's equations for velocity-dependent potential;Application to Lagrange's equation to some simple cases. Cyclic coordinates Isotropy and Homogeneity of space, Lagrangian formulation of conservation laws of linear momentum, angular momentum and energy.

Unit 2. Hamilton formalism; Variational principles; Hamilton's principle; Derivation of Lagrange's equation from Hamilton's principle. Hamilton's equation of motions; Hamiltonian; Applications of Hamilton's equation of motion to some simple cases.

Unit 3. Two body central force systems; reduction to the equivalent one body problem; The equation of motions and the first integrals; The equivalent one-dimensional problem and classification of orbits; The Kepler's Problem: Inverse-square law of force; Runge Lenz vector; The Virial theorem.

Unit 4. Decay and scattering problems; Kinematics of decay of a particle; transformation between C and L frames of reference; elastic collisions; angle of scattering and recoil; scattering cross-section; Rutherford scattering; some problem.

Text and Reference Books:

1. Classical Mechanics: H. Goldstein, C.Poole, J.Stafko - Pearson Education; 3rd edition 2011.
2. Mechanics: L.D. Landau and E.M.Lifshitz Butter worth-Heinemann; 3rd edition 1982.
3. Classical Mechanics:N.C.Ranaand, P.S.Joag, McGraw Hill Education 2017.
4. Theoretical mechanics: Murray R.Spiegel-Schaum's outline series - McGraw Hill Education 2017.

SEMESTER-IV

Course Code: BH010402T **Credit: 4**
Course Name: ELECTRICITY & MAGNETISM II

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Gain knowledge about varying and oscillating currents and can apply them to understand the decay and growth of currents in L-R, L-C-R circuits, also know about the working principles of AC generators transformers.
CO2	Analyze different problems in electromagnetism using mathematical methods involving vectors and simple differential and integral calculus.
CO3	Solve Maxwell's equations know about electromagnetic waves and their properties.

Course Details:

Unit 1. Varying Currents & Alternating Currents: Growth and decay of current in L-R circuit, Charging and discharging of capacitor in C-R and L-C-R circuits, Moving coil ballistic galvanometer, damping , Measurement of high resistance by leakage, Mechanical analogues of LR, CR and LCR circuits. Resonance, Q-value, power factor, AC networks, AC generators and transformers.

Unit 2. Thermoelectricity: Thermoelectric effects, thermoelectric power and thermoelectric diagram, application of thermodynamics to thermoelectric circuits.

Unit 3. Maxwell's equations: Displacement current and equation of continuity, plane electromagnetic waves in free space, vector and scalar potentials, gauge transformation, energy and momentum conservation, Maxwell's equations in free space and matter, Poynting's vector, propagation of electromagnetic waves in non-conductors, propagation in conducting media, reflection and refraction, Fresnel's equation.

Unit 4. Special Theory of Relativity and electromagnetism: Galilean transformation, Lorentz transformation of space-time, length contraction and time dilation, Doppler effect for E.M waves, transformation of mass and energy, transformation of force, transformation of an element of volume, transformation of an electric charge density and current density. The electric and magnetic fields of moving electric charge: Magnetism as a relativistic effect from constant fields of a charge moving at a constant velocity, transformation of electric and magnetic fields.

Text and Reference Books:

1. Berkeley physics course, Vol. I & II. McGraw Hill 2nd edition, 2017.
2. Feynman Lectures in physics, Vol I&II - Pearson Education India, 1st edition 2012.
3. Introduction to electrodynamics-David J. Griffiths Pearson Education India Learning Private Limited 4th edition 2015.
4. Electromagnetic Fields-Ritz, Milford, Christy - Pearson India, 4th edition, 2010.
5. Introduction to special relativity-Robert Resnick – Wiley, 1st edition, 2007.

SEMESTER-IV

Course Code: BH010403P **Credit: 4**
Course Name: Laboratory -IV

Course outcomes (CO): At the end of the lab course, the student will be able to:

CO1	Learn the technical specification of B-H Curve
CO2	Learn the basics of Ballistic Galvanometer

Name of Experiments: -

1. To draw I-H curve using a search coil and integrating measurement system
2. To draw B-H curve using search coil and integrating measurement system.
3. Measurement of high resistance by the method of leakage of charge of a charged condenser.
4. To find mutual conductance (M) between two coils by direct method.
5. To determine the mutual inductance by Carey Foster's method using dc source and ballistic galvanometer.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-IV

Course Code: BH010405TM **Credit: 4**

Course Name: MODERN PHYSICS & ELECTRONICS

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Analyze the intensity variation of light due to Polarization, interference and diffraction
CO2	Explain working principle of lasers
CO3	Explain fundamentals of quantum mechanics and apply to one dimensional motion of particles
CO4	Calculate Q-value of nuclear reactions and describe particle detectors and accelerators

Course Details
Group A: Modern Physics

1. Atomic Physics: Discharge of electricity through rarefied gas, cathode ray and their properties; Ionization of gases by radiation, measurement of e/m (specific charge) by Thomson's method, determination of' e'(electronic charge) by Millikan's oil drop experiment; Aston's mass spectrograph, Frank-Hertz expt.
2. Quantum theory of radiation: Planck's concept---radiation formula (statement only) qualitative discussion of photo-electric effect and Compton effect in support of quantum theory; Raman effect.
3. Basic Quantum Mechanics: Wave nature of material particles, wave-particle duality, wave length of de Broglie waves, Heisenberg uncertainty principle, Bohr's theory of hydrogen spectra ---concept of quantum number, Schrödinger equation, particle in a one dimensional infinite well--
   Energy Eigen values, wave function and its probabilistic interpretation. Pauli exclusion principle.
4. Solid State Physics: Crystalline nature of solid, diffraction of X-ray, Bragg's law; Moseley's law, Explanation from Bohr's theory.
5. Nuclear Physics: Binding energy of nucleus, binding energy curve and stability; Radioactivity, successive disintegration, radioactive equilibrium, radioactive dating, radioisotopes and their uses, nuclear trans mutation, fission and fusion, nuclear reactor.
6. Special Theory of Relativity: Postulates of STR, formulae of (i) Length contraction; (ii) Time dilation;(iii) Velocity addition;(iv) Mass variation, and(v)Mass-energy equivalence.

Group B: Electronics

Diodes and Transistors: Introduction to semiconductors, P-N junction diode, bridge rectifier, capacitance input filter, Zener diode, voltage regulator, Transistors α and β and their interrelations; output characteristics in CE mode, single stage CE amplifier --- approximate expressions of current and voltage gain with the help of' Load Line'.

Digital electronics: binary systems, binary numbers. Decimal to binary and reverse conversions; binary addition and subtraction.
Logic gates: OR, AND, NOT gates --- truth tables. Statement of de Morgan's theorem, NOR and NAND universal gates.

Text and References Books:

1. Optical Electronics by A.Ghatak and K.Thygrajan, 1E, Cambridge University Press, 2012.
2. Introduction to semiconductor materials and devices by M.S.Tyagi, 2E, John Wiley & Sons 2008.
3. Physics and Technology of Semiconductor Devices by S.M.Sze, 3E, John Wiley &Sons, 2008.
4. Quantum Mechanics by L.I. Schiff, McGraw-Hill Education (India) Pvt Limited, 2017.
5. A Textbook of Quantum Mechanics by P.M. Mathews and K. Venkatesan,
6. McGraw-Hill Education (India) Pvt Limited,2010.
7. Introduction to Quantum Mechanics by D.J.Griffiths, 3E, Cambridge University Press, 2018.

SEMESTER-IV

Course Code: BH010405PM **Credit: 4**

Course Name: Minor Course Laboratory-II

Course outcomes (CO): At the end of the lab course, the student will be able to:

CO1	Learn basics of semiconductor
CO2	Learn applications of semiconductors in electronics

Name of Experiments:-

1. To draw the characteristic curve of a p-n junction diode
2. To draw the forward and reverse characteristic curves of a Zener diode.
3. To construct OR, AND, NOT and NAND gates using discrete circuit components and to verify their truth table.
4. To verify the truth tables of OR, AND and NOT gates and to verify De Morgan's theorem by using NAND gates.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-V

Course Code: BH010501T **Credit: 4**
Course Name: ELECTRONICS –II

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understanding and ability to analyze the characteristics of transistor and transistor biasing and stabilizing circuits.
CO2	Understanding and ability to work with of single stage and multistage amplifier.
CO3	Gain knowledge about the fabrication of simple circuits.
CO4	Understand the relationship between amplifier and oscillators.
CO5	Understand the number systems and Boolean algebra

Course Details:

Unit 1. Transistor amplifier: Transistor biasing and stabilization circuit, typical

biasing circuit- fixed bias, collector to base bias, self bias, Graphical analysis of transistor amplifier for large signal, voltage and power amplifier, class-A, class-B, class-AB and class-C operation of amplifier. Small-signal analysis of transistor amplifier using hybrid model, current gain, voltage gain, input and output impedance. Multistage amplifiers- RC coupled amplifier, direct coupled amplifier and their frequency responses.

Unit 2. Feedback in amplifier: Principal of feedback, negative and positive feedback, voltage and current feedback, advantages and disadvantages of feedback.

Oscillator: Sinusoidal oscillator: Barkhausen's criterion for self-sustained oscillation, tuned collect or oscillator, Hartley, Colpitt's, phase-shift and Wien-bridge oscillators. Non-sinusoidal oscillator: Monostable multivibrator. **Integrated circuits**: Steps for the development of IC, fabrication of simple circuits, simple monolithic circuit layout. Scales of integration-SSI, MSI, LSI, VLSI (basic idea only)

Unit 3. Number systems and Boolean algebra: Decimal, binary, octal and hexadecimal number and conversion of one system to another,1's and 2'scomplements of a binary number, Basic postulates and theorems of Boolean algebra, De-Morgan's theorem, binary addition, subtraction and multiplication.

Unit 4. Logic gates and digital circuits: Fundamental gates-OR, AND, NOT, Universal gates-NOR, NAND, Ex-OR and Ex-NOR gates, design of gates using discrete components like transistor, diode and resistances, simplification of Boolean expression, Karnaugh mapping.

Text and Reference Books:

1. J. Millmanand A. Grabel, Microelectronic, McGraw-Hill. 2nd edition, 2009.
2. Streetman B.G. "Solid State Electronic Devices" Prentice Hall 6th edition, 2005.
3. Malvino "Electronic Principles" Tata McGraw-Hill 9th edition, 2021.
4. Malvino and Leach "Digital principles and applications", Tata McGraw-Hill 8th edition, 2014.
5. J. Nagrath "Electronics (Analog and Digital)", Prentice Hall - PHI Learning 2nd edition, 2013.
6. T. Chottopadhyay "Analog and Digital Electronics" CBS publishers, New Delhi – 1st edition,2010.
7. R.K. Kar, "Electronics (Classical & Modern),Books and Allied (P) Ltd 4th edition, 2007

SEMESTER-V

Course Code: BH010502T **Credit: 4**
Course Name: PHYSICAL OPTICS

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the event like interference, diffraction and polarization of light.
CO2	Understand the applications of interference, diffraction and polarization.
CO3	Understand the resolving power of different optical instruments.

Course Details:

Unit 1. Theories of Light: Wave Theory, Huygens' Principle, laws of reflection and refraction. **Interference:** Coherent and incoherent sources, spatial and temporal coherence, constructive and destructive interference. Young's double-slit expt., Division of wavefront -Lloyd's mirror, Fresnel bi-prism, Fresnel bi-mirror. Division of Amplitude-fringes with plane parallel plate, fringes with wedge shaped film. Fringes of equal inclination and fringes of equal thickness. Michelson interferometer, Rayleigh refractometer. Multiple beam interference, Newton's ring, Fabry Perot interferometer, Lummer Gehrcke interferometer.

Unit 2. Diffraction: Huygens-Fresnel principle, rectilinear propagation of light. Fresnel diffraction-construction of zones, zone plate, Cornu's spiral, diffraction by straight edge, single slit, circular aperture and circular obstacle. Fraunhofer diffraction-single slit, double slit, rectangular aperture, circular aperture, plane transmission grating, concave grating, echelon grating. Resolving power of telescope and microscope. Babinet's principle.

Unit 3. Polarization: Linear, circular and elliptic polarization, double refraction, Huygens' theory of double refraction through uniaxial crystal, Nicol prism, quarter and half wave plates, polaroids, optical activity and polarimeter, Interference of polarized light.

Unit 4. Electromagnetic Nature of Light: Polarization, Dispersion (normal & anomalous), Rayleigh scattering, Kerr effect, Faraday effect.

Text and Reference Books:

1. Optics-Hecht & Zajac - Pearson India; 4th edition, 2008.
2. Physical and Geometrical optics-Longhurst - Longman; 3rd edition, 1974.
3. Fundamentals of Optics-Jenkins &White - McGraw Hill Education; 4th edition. 2017.
4. Principles of Optics – Born &Woolf - Cambridge University Press; 7th edition, 2019.

SEMESTER-V

Course Code: BH010503T **Credit: 4**
Course Name: THERMAL PHYSICS

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Gain knowledge in kinetic theory of gases, thermal conductivity and viscosity.
CO2	Understand the nature of thermodynamic properties of vector like internal energy, enthalpy, entropy, etc.
CO3	Will gain deeper knowledge in radiation specifically in black body radiation and solar radiation

Course Details:

Unit 1. Introduction to Thermodynamics: Zeroth and First Law of Thermodynamics: Extensive and intensive thermodynamic variables, thermodynamic equilibrium, zeroth law of thermodynamics & concept of temperature, first law & various processes, **Second Law of Thermodynamics:** Reversible and irreversible process with examples. Conversion of work into heat and heat into work. Heat engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius statements and their equivalence. Carnot's Theorem. Applications of second law of thermodynamics: thermodynamic scale of temperature and its equivalence to perfect gas scale.

Unit 2. Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.

Unit 3. Kinetic Theory of Gases: Distribution of Velocities: Maxwell-Boltzmann law of distribution of velocities in an ideal gas and its experimental verification. Doppler broadening of spectral lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of equipartition of energy (no proof required). Specific heats of Gases. **Molecular Collisions:** Mean Free Path. collision probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal conductivity and (3) diffusion. Brownian motion and its significance.

Unit 4. Real Gases: Behavior of real gases: Deviations from the Ideal gas equation. The virial equation. Andrew's experiments on CO_2 gas. critical constants. Continuity of liquid and gaseous state. Vapour and gas. Boyle temperature. Van der Waal's equation of State for real gases. Values of critical constants. Law of corresponding states. Comparison with experimental Curves. P-V diagrams. 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.

Text and Reference Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
5. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
6. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
7. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

SEMESTER-V

Course Code: BH010504T **Credit: 4**
Course Name: MATERIAL SCIENCE: EVOLUTION AND APPLICATIONS

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the discovery of materials
CO2	Describe the different types of materials
CO4	Describe the different properties and characterization of materials
CO5	Describe the Applications of different materials

Course Details:

Unit 1. Historical Development of Materials: The first materials: Stone and Clay, The first metals: Copper and Bronze, Gold and Silver and the basis of wealth, Mechanisms and Properties of Metals, The basics of structure, the basics of mechanical properties, The Discovery of Iron, Glass, Steel: The Modern Metal

Unit 2. Classification & Properties of Materials: Metals, Polymers, Ceramics, Composite and other modern materials

Unit 3. Characterization of Material: Thermal, Surface , Structural Optical and Electrical Characterizations

Unit 4. Applications of Materials: Traditional metal, semiconductors and polymer applications, Nano composites applications

Text and Reference Books:

1. R. Abbaschian, R.E. Reed-Hill, Physical Metallurgy Principles, 4th ed., Cengage Learning, 2009.
2. D.R. Askeland, P.P. Phule, W.J. Wright, The Science and Engineering of Materials, 6th ed., Cengage Learning, 2010.
3. W.D. Callister, D.G. Rethwisch, Materials science and Engineering: An Introduction, 8th ed., Wiley, 2010.
4. B.S. Mitchell, An Introduction to Materials Engineering and Science for Chemical and Materials Engineers, 1st ed., Wiley- Inter science, 2003.
5. C. Kittel, Introduction to Solid State Physics, 8th ed., Wiley, 2005.
6. V. Singh, Physical Metallurgy, 1st ed., 2008.

SEMESTER-V

Course Code: BH010505T **Credit: 4**

Course Name: Solid State Physics

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Describe various crystal structures and identify symmetry elements such as rotation axes, mirror planes, inversion centers, screw axes, and glide planes.
CO2	Differentiate between different Bravais lattices and understand concepts like close-packed structures, Wigner-Seitz cells, and Miller indices.
CO3	Explain the principles of X-ray, electron, and neutron diffraction and their suitability for crystal structure determination.
CO4	Explain the formation of energy bands in periodic potentials using Bloch theorem, nearly free electron approximation, and tight-binding models.

Course Details:

Unit 1. Crystalline and Amorphous Solids, Lattice, Basis and Crystal, Miller Indices, Interatomic Forces, Types of Bonding of Solids, Mosley's law and Periodic Table, Explanation from Bohr's theory. Drude theory, DC conductivity, magneto-resistance, thermal conductivity, thermoelectric effects, thermal properties of an electron gas, Wiedemann- Franz law

Unit 2. Free Electron Theory of Metals, Bloch theorem, Energy Bands in Solids, Kronig-Penny model, Distinction between Metals, Insulators and Semiconductors, Fermi-Dirac Distribution and Energy Spectrum of Solids, Electron in Magnetic Field, Hall Effect. Lattice Vibrations, Specific Heats, Einstein and Debye Model.

Unit 3. Choice of x-ray, electron and neutron for crystal structure determination, Bragg's diffraction, Reciprocal lattice, The Braggs condition and Ewald construction, Brillouin zones of SCC, BCC and FCC lattices, Atomic Scattering factor, Geometrical structure factor, Laue method, Rotating crystal method, Powder method.

Unit 4. Basic idea of diamagnetism, paramagnetism, ferromagnetism and anti ferromagnetism. Superconductivity, Meissner effect.

Text and Reference Books:

1. Solid State Physics, Kittel - Wiley; Standard, Ist Edition, 2019.
2. Elementary Solid State Physics, M. Ali Omar - Pearson India; 1st edition, 2002.
3. Solid State Physics, Ashcroft & Mermin - Cengage; 1st edition, 2003.
4. Concepts of Modern Physics, Beiser and Mahajan - McGraw Hill Education; 6th edition, 2009.

SEMESTER-V

Course Code: BH010506T **Credit: 4**

Course Name: THEORETICAL AND OBSERVATIONAL ASPECTS OF ASTRONOMY

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Learn and use new vocabulary words (great circle, spherical angle, spherical triangle, Euclidean geometry).
CO2	Discover facts about spherical triangles.
CO3	To understand the different coordinated systems to locate the celestial object in space.
CO4	Effect of the refraction phenomena for the celestial objects
CO5	Understand Kepler's Three Laws of Planetary Motion.
CO6	Visualize the effect of the three laws on the orbits of planets, asteroids, and comets

Course Details

Unit 1. Introduction: An introduction the prospects of astronomy, Units and scales in astronomy (AU, parsec, light-year) An overview on spherical trigonometry. Geodesics, small circles and great circles.

Unit 2. Observational Techniques and Instruments: Optical telescopes: refracting and reflecting types, Telescope mounting systems (alt-azimuth, equatorial), Resolution, magnification and light-gathering power Detectors: CCDs, photometers, spectrographs, Radio, infrared, X-ray and space-based observatories

Unit 3. Celestial Mechanics and Positional Astronomy: Kepler's laws of planetary motion, Newtonian gravitation in astronomy, Orbital elements and perturbations

Unit 4. Time associated with astronomy, Astronomical refraction, parallax, aberration precession and nutation.

Text and Reference Books:

1. Text book of astronomy and astro physics with elements of cosmology, V.B.Bhatia, Narosa publishing house, 2001.
2. Astrophysics-stars and galaxies, K. D. Abhyankar, University press, 2001

SEMESTER-V

Course Code: BH010507P **Credit: 4**
Course Name: Laboratory -V

Course outcomes (CO): At the end of the lab course, the student will be able to:

CO1	Learn the basics of Electronics
CO2	Learn the basics of amplifiers

Name of Experiments:-

1. Construction of basic logic gates (OR, AND, NOT, NAND and NOR) using discrete components on a bread board, and hence verification of (i) the truth tables by measuring the voltages, (ii)Demorgan's theorem and (iii) universal nature of NAND and NOR gates.
2. Study the characteristics of a CE amplifier.
3. Study of an OPAMP and its application as a Non-Inverting Amplifier and as a Unity gain buffer.
4. Study of an OPAMP and its application as an Inverting Amplifier.
5. Study of an OPAMP and its application as an Inverting Adder.
6. Study of the performance of a simple voltage comparator using OPAMP.
7. Construction of a Phase-shift oscillator on a bread board using transistor. Study of the wave form of the oscillator and calibrate it using a CRO.
8. Study the characteristics of a feedback amplifier.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-VI

Course Code: BH010601T **Credit: 4**
Course Name: ELEMENTARY QUANTUM MECHANICS

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the origins of quantum mechanics
CO2	Understand and explain the differences between classical and quantum mechanics
CO3	Understand the idea of wave function
CO4	Understand the uncertainty relations
CO5	Understand the Schrodinger wave mechanics and operator formalism
CO6	Solve the Schrodinger equation for simple 1D time-independent potentials

Course Details:

Unit 1. Role of experiment and theory in physics. Quantum mechanics as paradigm shift from Classical Mechanics: determinism-equation of motion to probability density-expectation-uncertainty. Failure of classical physics: black body radiation, photo-electric effect; Planck's quantum hypothesis; Einstein's photo-electric equation; Bohr's atomic model and quantization of angular momentum and atomic spectra; Franck and Hertz's experiment; Stern and Gerlach's experiment; de Broglie's hypothesis, Davisson and Germer's experiment, Young's double slit experiment in the light of quantum hypothesis, wave-particle duality and complementarity.

Unit 2. **Wave-function:** Interpretation of wave function; Schrodinger Equation – time dependent and time independent forms; conditions to be satisfied by wave functions; observables, expectation value, operator representation, and measurements; stationary states; Ehrenfest's theorem; superposition of states and dynamism. Particle in a box

Unit 3. Formalism: Operators, eigen values and eigen functions; linear operators, product of two operators, commutation relations, simultaneous eigen functions, orthogonal functions; Dirac notation, dual space, inner and outer products of wave functions, projection and identity operators; Hermitian adjoint of an operator, Hermitian operators, their eigen values, expectation values; generalized uncertainty principle.

Unit 4. Harmonic oscillator: Classical harmonic oscillator: equation of motion and energy, Importance of harmonic oscillator in quantum physics, Schrödinger Equation for Harmonic Oscillator

Text and Reference Books:

1. Introduction to Quantum Mechanics, D. Griffiths – Cambridge University Press 3rd edition, 2018
2. Quantum Mechanics, Gasiorowich - John Wiley & Sons Inc; 3rd edition, 2003.
3. Quantum Mechanics, Mathews & Venkatasnan - McGraw Hill Education; 2nd edition, 2017.

SEMESTER-VI

Course Code: BH010602T **Credit: 4**
Course Name: STATISTICAL MECHANICS

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understanding of basic concept of equilibrium theory, Macroscopic and microscopic states of system and statistical basis of thermodynamics.
CO2	Define and understand basics of ensemble theory.
CO3	Analysis the limitations of Limitations of Maxwell-Boltzmann statistics.
CO4	Gain knowledge about the Bose -Einstein, Fermi-Dirac statistics.

Course Details

Unit 1. Random walk and statistical basis of thermodynamics: Basic concept of equilibrium theory, Macroscopic and microscopic states of system, Probability and thermodynamic probability, Principle of equal a priori probability, Probability distribution, its narrowing with increasing n, Average properties, Accessible and in accessible states.

Unit 2. Elements of ensemble theory: Phase space of classical system, Micro canonical ensemble, Quantum states and phase space, Canonical ensemble, Equipartition of energy, Partition function, Entropy of an ideal gas, Gibbs paradox, Sackur -Tetrode equation, A system of harmonic oscillators, Statistics of paramagnetism, Langevin- Brillouin theory, Grand canonical ensemble, fluctuations in different ensembles.

Unit 3. Introductory quantum statistics: Limitations of Maxwell-Boltzmann statistics, Bose-Einstein and Fermi-Dirac statistics, statistics of occupation numbers, Thermodynamical behavior of an ideal Bose gas, Bose –Einstein condensation, Black-body radiation, Specific heat of solids at low temperature, Ideal Fermi system, Fermi energy, Thermionic emission.

Text and Reference Books:

5. Fundamentals of statistics and thermal physics: Reif - Sarat Book Distributors, 2010
6. A Treatise on Heat: Sahaand Srivastava – publisher unknown 5th revised edition, 1973,
7. Heat and thermodynamics: Zemansky and Dittman - McGraw Hill Education; 8th edition, 2017
8. Statistical Physics: Reif (Berkeley physics course-V) - Sarat Book Distributors, 2010.
9. Statistical thermodynamics: Lee,Sears and Turcotte – Narosa, Publishing House, 1998
10. Thermal Physics: Gupta and Roy Books & Allied Ltd; 3rd Revised edition, 2010

SEMESTER-VI

Course Code: BH010603T **Credit: 4**

Course Name: Quantum Computing

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand basic terms of quantum mechanics, quantum computation quantum entanglement, quantum algorithms and quantum channels.
CO2	Gain knowledge of IBM quantum computer and programming a quantum computer

Course Details:

Unit 1. Introduction to Quantum Computing : Elementary quantum mechanics: linear algebra for quantum mechanics, Classical vs quantum computing, Qubits, Superposition, Entanglement and measurement

Unit 2. Quantum logic gates and algorithms: Classical logic vs quantum logic, Universal set of gates, quantum circuits, Solovay-Kitaev theorem, Deutsch-Jozsa algorithm, factoring Module

Unit 3. Physical Realizations of Quantum Computers; Superconducting qubits, Trapped ions, Topological qubits, Photonic systems, Quantum annealers (e.g., D-Wave)

Unit 4. Applications of Quantum Computing: Cryptography and Cybersecurity

Text-Books & References

1. Phillip Kaye, Raymond Laflamme et. al., An introduction to Quantum Computing, Oxford University press, 2007.
2. Chris Bernhardt, Quantum Computing for Everyone, The MIT Press, Cambridge, 2020
3. David McMahon-Quantum Computing Explained-Wiley-Interscience, IEEE Computer Society (2008) References
4. Quantum Computation and Quantum Information, M. A. Nielsen & I. Chuang, Cambridge University Press (2013).
5. Quantum Computing, A Gentle Introduction, Eleanor G. Rieffel and Wolfgang H. Polak MIT press (2014)

SEMESTER-VI

Course Code: BH010604T **Credit: 4**
Course Name: INTRODUCTION TO NANOSCIENCE

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the essential role of nanoscience
CO2	Understand the various properties of nano materials

Course Details

Unit 1. Introduction: Fundamental phenomena as a function of size and reduced dimensionality; the role of surfaces; Emphasis on uses of new materials.
Unit 2. Nano materials and Nano composites: Metal nano particles, nano-rod and nano-tube: Preparation and characterization, Electronic properties, metal-non-metal transition, Quantum size effect, core-shell structure,quantum conductance in metal nano wires.
Unit 3. **Nano composites**: Synthesize of nano clusters (metal/semiconductor) inside a medium, such as glass, and ceramic media, Important nanoscale systems and their novel properties (clusters, dots, films).
Unit 4. Applications: Industrial and structural Applications, Electronics and Computing
.

Text and References:

1. S.M. Lindsay, "Introduction to nano-science", Oxford University Press, 2010.
2. Richard Martin, 'Electronic Structure: Basic theory and practical methods', Cambridge University Press, 2004.
3. A. A. Balandin & K. L Wong, Eds Handbook of semiconductor nanostructures and nanodevices-American Scientific Publishers; 1st edition 2006.
4. H.S.Nalwa, Handbook of nano structured biomaterials and their application in nano biotechnology- American Scientific Publishers 2006
5. H.S.Nalwa, Nano clusters and nano crytals - American Scientific Publishers; illustrated edition 2003.

SEMESTER-VI

Course Code: BH010605T **Credit: 4**
Course Name: Applied Optics
Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand basic lasing mechanism qualitatively, types of lasers, characteristics of laser light and its application in developing LED, Holography.
CO2	Gain concepts of Fourier optics and Fourier transform spectroscopy.
CO3	Grasp the idea of total internal reflection and learn the characteristics of optical fibers.

Course Details:

Unit 1. **Photo-sources and Detectors Lasers:** an introduction, Planck's radiation law (qualitative idea), Energy levels, Absorption process, Spontaneous and stimulated emission processes, Theory of laser action, Population of energy levels, Einstein's coefficients and optical amplification, properties of laser beam, Ruby laser, He-Ne laser, and semiconductor lasers; Light Emitting Diode (LED) and photo-detectors.

Unit 2. **Fourier Optics and Fourier Transform Spectroscopy (Qualitative explanation)** Concept of Spatial frequency filtering, Fourier transforming property of a thin lens, Fourier Transform Spectroscopy (FTS): measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry, and forensic science.

Unit 3. Holography Introduction: Basic principle and theory: recording and reconstruction processes, Requirements of holography- coherence, etc. Types of holograms: The thick or volume hologram, Multiplex hologram, white light reflection hologram; application of holography in microscopy, interferometry, and character recognition.

Unit 4. Photonics: Fibre Optics Optical fibres: Introduction and historical remarks, Total Internal Reflection, Basic characteristics of the optical fibre: Principle of light propagation through a fibre, the coherent bundle, The numerical aperture, Attenuation in optical fibre and attenuation limit; Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating.

Text-Books & References

1. Introduction to Fourier Optics, Joseph W. Goodman, The McGraw- Hill, 1996. 151
2.Introduction to Fiber Optics, A. Ghatak & K. Thyagarajan, Cambridge University Press.
3.Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
4.Optical Electronics, Ajoy Ghatak and K. Thyagarajan, 2011, Cambridge University Press
5.Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.

SEMESTER-VI

Course Code: BH010606T **Credit: 4**
Course Name: ATOMIC, MOLECULAR, NUCLEAR & PARTICLE PHYSICS

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand Fine and hyperfine structure, Interactions of one-electron atoms with static external electric field, magnetic field and electromagnetic radiation.
CO2	Two and many electron atoms: finding the least energy configurations and the corresponding energies.
CO3	Molecular physics: Diatomic molecules-rotation, vibration and electronic spectra, configuration of diatomic molecules. Lasers and its application
CO4	The different nuclear interactions and the corresponding nuclear potentials and its dependence on the couplings are learned

Course Details

Group A: Atomic & Molecular Physics

Unit 1. Atomic Spectra: Bohr atom model, Somerfield's elliptical orbits and space quantization, spin quantization, Larmours theorem, magnetic moment, Bohr magneton. Alkali spectra, Explanation of the doublet nature from vector atom model, selection rules for transition, Pauli's exclusion principle and periodic table. Effect of magnetic field on the spectral lines-Zeeman effect (normal and anomalous), Lande g-factor, Paschen Bach effect, effect of electric field on the spectral lines-Stark effect, L-S coupling, Lande interval rule, J-J coupling.

Unit 2. Molecular Spectra: Classification of molecular spectra - electronic, vibrational and rotational spectra of diatomic molecules, fluorescence, phosphorescence, Raman spectra, optical pumping.

Group B: Nuclear and Particle Physics

Unit 3. .Introduction to Nuclear Physics: Composition of nucleus, nuclear size, nuclear force and other forces of nature, binding energy curve.; properties of nuclear force, range and depth of potential: deuteron , saturation of nuclear force, meson theory of nuclear force, Yukawa theory. Radioactivity

Unit 4. Introduction to particles and interactions: source of 'elementary' particles: cosmic ray, nuclear reactors, particle accelerators; discovery of neutron, positron, neutrinos, anti-proton and anti-neutron, baryons, mesons, leptons and 'strange' particles; fundamental forces of nature; quarks, leptons and mediators, Quantum numbers: quantum numbers associated with 'elementary' particles, their conservation and violation, Quark Model: The Eight fold Way, quark model, multiplets.

Text and Reference Books:

1. Nuclear Theory (Vol.-I), Eisenberg & Greiner, North-Holland - North-Holland Pub. Co.; 2nd Revised edition 1975.
2. Concepts of Nuclear Physics, B. Cohen, North-Holland McGraw Hill Higher Education; 1st edition 1974.
3. Nuclear Physics (Theory and Experiment), Roy &Nigam, Wiley & Sons - New Age International Pvt Ltd; Second edition 2014.
4. Introduction to Elementary Particles, David Griffiths, John Wiley & Sons 2nd edition 2010.
5. Introduction to Particle Physics, M.P.Khanna, Prentice-Hall of India Private Limited 1999.
6. Concepts of Modern Physics, A. Beiser, McGraw-Hill Education 6th edition 2002.
7. http://public.web.cern.ch/public/en/Science/Science-en.htmL
8. Introduction to Atomic Spectra, Harvey Elliot White - MCGRAWHILL EXCLUSIVE (CBS) 2019
9. Molecular Spectroscopy, Banwell - McGraw Hill Education; Fourth edition 2017.

SEMESTER-VI

Course Code: BH010607P **Credit: 4**
Course Name: Laboratory -VI

Course outcomes (CO): At the end of the lab course, the student will be able to:

CO1	Learn OPAMP and its application as Inverting and Non-Inverting Amplifier
CO2	Learn Construction of basic logic gates (OR, AND, NOT, NAND and NOR)

Name of Experiments:-

1. To determine the mutual inductance by Carey Foster's method using dc source and ballistic galvanometer.
2. Measurement of high resistance by the method of leakage of charge of a charged condenser.
3. To show the tunneling effect in tunnel diode using I-V characteristics.
4. To determine charge to mass ratio (e/m) of an electron by Thomson method.
5. Study of excitations of a given atom by Franck Hertz set up.
6. To determine the Hall coefficient and mobility of given semiconductors.
7. To find conductivity of given semiconductor crystal using four probe method.
8. Study the characteristics of a feedback amplifier.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)