Department of Physics,
School of Basic Sciences, CSJM University Campus Kanpur

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.

B.Sc. (Hons) in Physics (3 year duration)

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.

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

Semester wise- Distribution of Course

Total Credit: 140

Semester-I, Credit: 20

S.No.	Course No.	Name of the Course	Credit
1.	BPC-101	Mathematical Methods-I	6 (5 Th +1 T)
2.	BPC-102	Mechanics and General Properties of Matter+ Lab-102	6 (4 Th +2 Lab)
3.	GE-101	Mechanics & Thermal Physics	6 (4 Th +2 Lab)
4.	AECC1	English Communication	2

Semester-II, Credit: 20

S.No.	Course No.	Name of the Course	Credit
5.	BPC-201 BPC-201 Lab	Electricity and Magnetism-I + Laboratory-201	6 (4 Th+2 Lab)
6.	BPC-202	Waves and Geometrical Optics	6 (5 Th+1T)
7.	GE-201	General Properties of Matter & Optics	6 (4 Th +2 Lab)
8.	AECC2	Environmental Science	2

Semester-III, Credit: 26

S.No.	Course No.	Name of the Course	Credit
9.	BPC-301	Mathematical Methods-II	6 (5 Th +1 T)
10.	BPC-302 BPC-302 Lab	Electronics-I+ Laboratory-302	6 (4 Th+2 Lab)
11.	BPC-303	Computer Applications in Physics	6 (5 Th +1 T)
12.	GE-301	Electricity & Magnetism	6 (4 Th +2 Lab)
13.	SEC1	Vocational Course	2

Semester-IV, Credit: 26

S.No.	Course No.	Name of the Course	Credit
14.	BPC-401	Classical Mechanics	6(5 Th +1 T)
15.	BPC-402 BPC-402 Lab	Electricity and Magnetism-II + Laboratory-402	6 (4 Th+2 Lab)
16.	BPC-403 BPC-403 Lab	Thermal Physics+ Laboratory-403	6 (4 Th+2 Lab)
17.	GE-401	Modern Physics & Electronics	6 (4 Th+2 Lab)
18.	SEC2	Vocational Course	2

Semester-V, Credit: 24

S.No.	Course No.	Name of the Course	Credit
19.	BPC-501 BPC-501 Lab	Electronics-II+ Laboratory-501	6 (4 Th+2 Lab)
20.	BPC-502 BPC-502 Lab	Physical Optics+ Laboratory-502	6 (4 Th+2 Lab)
21.	BPE-01/BPE-02/BPE-03/BPE-04/BPE-05/BPE-06/BPE-07	General Elective (Department Elective)*	6 (5 Th +1 T)
22.	BPE-01/BPE-02/BPE-03/BPE-04/BPE-05/BPE-06/BPE-07	General Elective (Department Elective)*	6 (5 Th +1 T)

Semester-VI, Credit:24

Sl.No.	**Course No.**	**Name of the Course**	**Credit**
23.	BPC-601	Elementary Quantum Mechanics	6(5 Th +1 T)
24.	BPC-602 BPC-602 Lab	Statistical Mechanics and Solid State Physics + Laboratory-602	6(4 Th+2 Lab)
25.	BPE-01/BPE-02/BPE-03/BPE-04/BPE-05/BPE-06/BPE-07	General Elective (Department Elective)*	6(5 Th +1 T)
26.	BPE-01/BPE-02/BPE-03/BPE-04/BPE-05/BPE-06/BPE-07	General Elective (Department Elective)*	6(5 Th +1 T)

*Several Elective courses will be offered (BPE-01/BPE-02/BPE-03/BPE-04/BPE-05/BPE-06/BPE-07) 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: BPC-101 **Full Marks: 100, Credit: 6**
Course Name: MATHEMATICALMETHODS–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:

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.

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

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.

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.

5. **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 tools for Physics , J Nearing, Dover Publications, Revised edition, 2010**,** downloadable from www.physics.miami.edu/nearing/mathmethods
9. Mathematical Physics– PK Chattopadhyay, New Age International Private Limited, third edition , 2022.
10. Vector and Tensor Analysis with applications– Borisenko andTarapov, Dover Publications, New edition , 2003.
11. Vector Analysis–MR Spiegel (Schaum series), McGraw Hill Education, second edition , 2017.
12. Fourier Transform, M.R. Spiegel (Schaum series), McGraw-Hill Education, first edition, 1974.

SEMESTER-I

Course Code: BPC-102 **Full Marks: 100, Credit: 6**

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:

1. Reference frames: Inertial and non-inertial frames of references, Galilean transformation equations, applications to rotating frames, centripetal and Coriolis accelerations.

2. Rigid Bodies: 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.

3. 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.

4. Elasticity: 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.

5. Viscosity and fluid dynamics: Viscous fluids, definition of viscosity coefficient and Newton'slaw, 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.

6. 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.Walker5thEd,John Wiley & Sons, Publisher – Wiley 10TH Edition 2013.
2. Berkley Physics, Vol.I, McGraw 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: BPC-102 (Lab) **Full Marks: 100, Credit: 6**
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. Determination of"g" by Kater's pendulum.
2. Determination of"g" by bar pendulum.
3. Determination of surface tension by capillary tube method and verification of Jurin's law.
4. Determination of coefficient of viscosity Poiseuille's method.
5. Determination of Youngs Modulus(Y),Rigidity Modulus(n)&Poisson's ratio of a wire by Searle's method.

SEMESTER-II

Course Code: BPC-201 **Full Marks: 100, Credit: 6**

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:

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.
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.
3. **Capacitance and Condensers**: Capacitance of parallel-plate, spherical and cylindrical capacitors with and without dielectrics, loss of energy in sharing charges.
4. **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.
5. **Electrical Images**: Point charge near a conducting plane, point charge near a conducting Sphere,Induced surface charge,Force and energy.
6. **Steady Current**: Current density, Electrical conduction in a metal, Ohm's law, Resistance and resistivity, Electromotive force, Kirchhoff's laws and their applications
7. **Magnetic effect of steady current**: Force exerted by a magnetic field on a moving Charge,Ampere'slaw,Biot-Savart law,CalculationsofMagneticInductionsforavariouscurrentconfigurations, Helmholtz double coil galvanometer, Force between long parallel current carrying conductors, Torque on a current loop.
8. **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: BPC-201 (Lab) **Full Marks: 100, Credit: 6**
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: BPC-202 **Full Marks: 100, Credit: 6**

Course Name: WAVES & 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:

OSCILLATIONS & WAVES:

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.

2. 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.

3. 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.

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

GEOMETRICALOPTICS:

a. Basic concept, Fermat‟s principle-proof of the laws of reflection,refraction and rectilinear propagation of light.

b. 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.

c. 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, VolII (Waves) - McGraw Hill Education 2017.
2. The physics of waves and oscillation,N.K.Bajaj, TataMcGraw-Hill,NewDelhi – 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

Ability Enhancement Compulsory Course (AECC2 – Environment Studies)

Course Code: AECC2 **Full Marks: 100, Credit: 2**
Course Name: Environment Studies
Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Gain knowledge on natural processes that sustain life and govern economy.
CO2	Predict the consequences of human actions on the web of life, global economy and quality of human life.
CO3	Acquiring values and attitudes towards understanding complex environmental-economic-social challenges, and participating actively in solving current environmental problems and preventing the future ones.

Unit 1 : Introduction to environmental studies
Multidisciplinary nature of environmental studies;
Scope and importance; Concept of sustainability and sustainable development.
Unit 2 : Ecosystems
What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :
Forest ecosystem
Grassland ecosystem
Desert ecosystem
Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)
Unit 3 : Natural Resources : Renewable and Non---renewable Resources
Land resources and landuse change; Land degradation, soil erosion and desertification.
Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
Water : Use and over---exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter---state).
Energy resources : Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.
Unit 4 : Biodiversity and Conservation
(Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
India as a mega---biodiversity nation; Endangered and endemic species of India
Threats to biodiversity : Habitat loss, poaching of wildlife, man---wildlife conflicts, biological invasions;
Conservation of biodiversity : In---situ and Ex---situ conservation of biodiversity.
Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.
Unit 5 : Environmental Pollution
Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
Nuclear hazards and human health risks
Solid waste management : Control measures of urban and industrial waste.
Pollution case studies.

Unit 6 : Environmental Policies & Practices
Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.
Unit 7 : Human Communities and the Environment
Human population growth: Impacts on environment, human health and welfare.
Resettlement and rehabilitation of project affected persons; case studies.
Disaster management : floods, earthquake, cyclones and landslides.
Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan.
Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).
Unit 8 : Field work
Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
Visit to a local polluted site---Urban/Rural/Industrial/Agricultural.
Study of common plants, insects, birds and basic principles of identification.
Study of simple ecosystems---pond, river, Delhi Ridge, etc.

Text and Reference Books:

1. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
2. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. *Principles of Conservation Biology*.Sunderland: Sinauer Associates, 2006.
3. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science,* 339: 36---37.
4. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29---64). Zed Books.
5. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
6. Odum, E.P., Odum, H.T. & Andrews, J. 1971. *Fundamentals of Ecology*. Philadelphia: Saunders.
7. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
8. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
9. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. *Environment*. 8th edition. John Wiley & Sons.
10. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India*. *Tripathi 1992*.

SEMESTER-III

Course Code: BPC-301 **Full Marks: 100, Credit: 6**

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:

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.

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.

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.

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: BPC-302 **Full Marks: 100, Credit: 6**
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:

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.

2. **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

3.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.

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, rectifier with filter (C, L and), diode characteristics and load line, diode clamping and clipping circuit. Zener diode,use of zener diode as a voltage regulator.

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 andAllied (P)Ltd, 2007.

SEMESTER-III

Course Code: BPC-302 (Lab) **Full Marks: 100, Credit: 6**
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: BPC-303 **Full Marks: 100, Credit: 6**

Course Name: COMPUTER APPLICATIONS IN PHYSICS)

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

CO1	This course helps the students to understand how computers solve problems and how programmers design softwares
CO2	Learn about tools and concept including digital, computer arithmetic, networks, computer modeling and data driven compuyty.
CO3	Develop skills to solve the various problems in physics such as harmonic oscillator, planetary motion, projectile and scattering by using computer programming.
CO4	This course helps the students to understand how computers solve problems and how programmers design softwares

Course Details:

1. **Introduction to Computers**:

Brief History of modern computing: Mechanical and electronic computers; hand held devices– smart phones, PDA's, e-book readers, etc.; embedded computers.

Generic hardware components: CPU, RAM, hard drive; variety of I/O devices, peripherals.

Software structure: Operating Systems, daemons.

2. **Data representation Number Systems:** Decimal, binary, octal and hexa decimal systems; conversion from one system to another.

Data representation– integer, float, ASCII, unicode.

3. **Graphical Tools**:

Graphical representation of data

4. **Introduction to programming in C**:

Programming methodology: algorithms and flow charts.

Elements of C through simple problems: data types, operators, control statements, functions, pointers:

Finding maximum, minimum, average, standard deviation and sorting of a set of numbers.

Series of numbers: Fibonacciseries, exponential, sine and cosine;

Manipulation of matrices

Least Square Fit

5. **Numerical Methods:**

Integration: trapezoidal rule, Simpson's1/3rule.

Solution of differential equations: Euler's method, Runge- Kutta method (4^{th}order) Solution of transcendental equations: half-section method, Newton- Raphson method; Interpolation: Newton's differential formulae.

6.Application to Problems in Physics:

Harmonic oscillator, planetary motion, projectile and scattering, LCR circuits, etc.

Text and Reference Books:

1. Gottfried: Schaum's Outline Series 4^{th} edition, 2018.

SEMESTER-IV

Course Code: BPC-401 **Full Marks: 100, Credit: 6**

Course Name: CLASSICALMECHANICS

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:

1. Mechanics of a single particle and Mechanics of system of particles; Constraints of motion; Degrees of freedom; Generalized coordinate; some examples.

2. 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.

3. Cyclic coordinates Isotropy and Homogeneity of space, Lagrangian formulation of conservation laws of linear momentum, angular momentum and energy.

4. Hamilton formalism; Variational principles; Hamilton's principle; Derivation of Lagrange's equation from Hamilton's principle.

5. Hamilton's equation of motions; Hamiltonian; Applications of Hamilton's equation of motion to some simple cases.

6. 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 Virialtheorem.

7. Decay and scattering problems; Kinematics of decay of a particle; transformation between Cand L frames of reference; elastic collisions; angle of scattering and recoil; scattering cross-section; Rutherford scattering; som eproblem.

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: BPC-402 **Full Marks: 100, Credit: 6**

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:

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, Oscillating discharge, 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.

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

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, Poynting's vector ,propagation of electromagnetic waves in non-conductors, propagation in conducting media, reflection and refraction, Fresnel's equation.

4. **Special Theory of Relativity and electromagnetism**
   Galileantransformation,Lorentztransformationofspace-time,lengthcontractionandtimedilation,
   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: BPC-402 (Lab) **Full Marks: 100, Credit: 6**
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: BPC-403 **Full Marks: 100, Credit: 6**

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:

1. Kinetic theory of gases: Ideal gas equation, Pressure of a gas, Kinetic interpretation of temperature, Concept of probability, Total and compound probability, Maxwell's law of distribution of velocities – its verification, Mean free path and its experimental determination, Degrees of freedom, equipartition of energy and its application of specific heat, experimental study of isotherms of real gases, Vander Waal's equation of state, Virial coefficients.

2. Thermodynamics: Thermodynamic equilibrium, work, indicator diagram, state function, exact and inexact differentials, First law of thermodynamics – its applications, Reversible and irreversible processes, Isothermal and adiabatic changes of ideal and real gases, Second law of thermodynamics, Carnot's theorem, Kelvin scale of temperature, Concept of entropy, principle of increase of entropy, Maxwell's thermodynamic relations ,their applications and physical interpretation, Clausius-Clapeyron equation, Variation of latent heat with temperature, First-order phase transition, Triple point of water.

3. Transport properties: Viscosity,conductivity and diffusion, Brownian motion.

4. Conduction of heat: Conductivity and diffusivity, Fourier equation of propagation of heat in isotropic homogeneous medium, its solution for rectilinear and radial flow, periodic flow of heat,Weidemann-Franz law.

5. Radiation: Emission and absorption, Kirchhoff‟s law, Black-body, Stefan-Boltzmann law, Wien‟s law, Rayleigh-Jeans law, Ultraviolet catastrophe, Planck‟s theory of black body radiation,solar radiation and temperature of the sun.

6. Low temperature phenomena: Joule-Thomson effect, Principle of refrigeration, Principle of adiabatic cooling, Liquid helium and its properties, Second order phase transition, Nernst heat theorem and third law of thermodynamics.

Text and Reference Books:

1. Fundamentals of statistical and thermal physics: Frederick Reiff - Sarat Book Distributors 2010.
2. Thermodynamics: H.B.Callen – Wiley 2nd edition 2006.
3. A Treatise on Heat: Sahaand Srivastava – Sarat Book Distributors, 5th revised edition, 1973.

SEMESTER-IV

Course Code: BPC-403 (Lab) **Full Marks: 100, Credit: 6**
Course Name: Laboratory -IV

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

CO1	Learn basics of thermal physics through experiments

Name of Experiments:-

1. Determination of thermal conductivity of a bad conductor
2. Determination of melting point of a solid using thermocouple.
3. To study thermos e.m.f. vs. temperature diagram of a thermocouple and hence to find the thermos electric power at a given temperature.
4. Verification of Stefan's law by electrical method.
5. Determination of (a) specific rotation of a given substance, and hence (b) the unknown concentration of a solution.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-V

Course Code: BPC-501 **Full Marks: 100, Credit: 6**

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:

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.
2. **Feedback in amplifier**: Principal of feedback, negative and positive feedback, voltage and current feedback, advantages and disadvantages of feedback.
3. **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.
4. **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)
5. **Number systems and Boolean algebra**: Decimal, binary, octal and hexadecimal number and conversion of one system to another,1‟sand2‟scomplements of a binary number, Basic postulates and theorems of Boolean algebra, De-Morgan‟s theorem, binary addition, subtraction and multiplication.
6. **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: BPC-501 (Lab) **Full Marks: 100, Credit: 6**
Course Name: Laboratory -IV

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-V

BPC-502

(PHYSICALOPTICS)

Course Code: BPC-502 **Full Marks: 100, Credit: 6**

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:

1. Theories of Light: Wave Theory, Huygens' Principle, laws of reflection and refraction.
2. Interference: Coherent and incoherent sources, spatial and temporal coherence, constructive and destructive interference.Young'sdouble-slitexpt.,Divisionofwavefront-Lloyd'smirror,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.
3. 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.
4. 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.
5. 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: BPC-502(Lab) **Full Marks: 100, Credit: 6**
Course Name: Laboratory -IV

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

CO1	Learn optics through various experiments
CO2	Verify Optics law through experiments

Name of Experiments:-

1. Determination of radius of curvature of a plano-convex lens by Newton‟s ring method.
2. Determination of wavelength of a monochromatic source by Newton‟s ring method.
3. Determination of wavelength of a monochromatic source by Fresnel‟s bi-prism.
4. Determination of thickness of a film by Fresnel‟s bi-prism.
5. Determination of slit width by studying the single slit diffraction pattern.
6. Determination of slit width and width of obstacle by studying the double slit diffraction pattern.
7. Determination of grating constant using a standard source, and hence determination of unknown wavelength of a source.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-VI

Course Code: BPC-601 **Full Marks: 100, Credit: 6**

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 Schroedinger wave mechanics and operator formalism
CO6	Solve the Schroedinger equation for simple 1D time-independent potentials

Course Details:

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.

2.**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.

3.**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.

4.**Wave functions and energies in one dimension with idea of barrier penetration:** infinite square well potential, delta function potential, finite square well potential, step function potential,free particle(illustrating uncertainty principle).

5.**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.

6.**Harmonic oscillator problem:** algebraic and analytic solutions and their correspondence; ground and excited states, zero point energy; comparison with classical oscillator.

7.**Schrodinger equation in three dimensions:** Cartesian coordinates, particle in a rectangular box, degeneracy; spherical coordinates, angular and radial equations, spherical harmonics; hydrogen atom problem; Orbital angular momentum, Cartesian components, raising and lowering operators, commutation relations, eigen values; electron spin,explanationofobservationsfromSternandGerlach'sexperiment,Pauli matrices.

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: BPC-602 **Full Marks: 100, Credit: 6**

Course Name: STATISTICAL MECHANICS & SOLID STATE PHYSICS

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.
CO5	Understand the basic concepts of force between atoms and bonding between molecules.
CO6	Understanding of diffraction experiment and reciprocal lattice

Course Details

GROUP–A: STATISTICALMECHANICS:

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.
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.
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 Fermisystem, Fermi energy, Thermionic emission.

Text and Reference Books:

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

GROUP–B: SOLID STATE PHYSICS

1. Crystalline and Amorphous Solids, Lattice, Basis and Crystal, Miller Indices, Interatomic Forces, Types of Bonding of Solids, Cubic Structures(SC,FCC,BCC) of Crystals.
2. Origin of X-Rays, Continuous and Characteristic Spectra, Mosley‟s law and Periodic Table, Explanation from Bohr‟s theory.
3. X-Ray Diffraction, Laue spots, Braggs Law, Reciprocal Lattice.
4. 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,E instein and Debye Model.
5. Basic idea of diamagnetism, paramagnetism, ferromagnetism and anti ferromagnetism.
6. Superconductivity, Meissner effect, Mössbauer effect (idea only)

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-VI

Course Code: BPC-602 (Lab) **Full Marks: 100, Credit: 6**
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 find mutual conductance (M) between two coils by direct method.
4. 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.
5. Study the characteristics of a CE amplifier.
6. Study of an OPAMP and its application as a Non-Inverting Amplifier and as a Unity gain buffer.
7. Study of an OPAMP and its application as an Inverting Amplifier.
8. Study of an OPAMP and its application as an Inverting Adder.
9. Study of the performance of a simple voltage comparator using OPAMP.
10. 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.
11. Study the characteristics of a feedback amplifier.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

ELECTIVECOURSES INPHYSICS

SEVERAL ELECTIVE COURSES WILL BE OFFERED FOR SEMV &SEMVI. HOWEVER, THE NUMBER OF COURSES OFFERED IN EACH SEMESTER WILL BE DECIDED BY THE DEPARTMENT OUT OF THE OFFERED COURSES STUDENTS HAVE TO SELECT ONE COURSE FOR SEM-V AND ANOTHER FOR SEM-VI.

PRESENTLY, THERE ARE SEVEN ELECTIVE COURSES IN THE SYLLABUS.

SEMESTER-V/VI

Course Code: BPE-01 **Full Marks: 100, Credit: 6**

Course Name: GROUP THEORY & TENSOR ANALYSIS

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

CO1	Recognize the mathematical objects called groups
CO2	Link the fundamental concepts of groups and symmetries of geometrical objects
CO3	Explain the significance of the notions of cosets, normal subgroups, and factor groups;
CO4	Analyse consequences of Lagrange's theorem;
CO5	Describe about structure preserving maps between groups and their consequences.

Course Details

Group Theory: Symmetries in nature; Definition of group; Explanation of abstract ideas related to group theory using simple examples. Continuous group: O(2) and O(3) Rotation in two and three dimensions; Generators of rotation group angular momentum; Representation of O(3)and the spherical harmonics; SU(2) and spin;Lorentzgroupin3+1dimensions;Generators and their algebra; Origin of Thomas Precession; Solving quantum Coulomb and/or the oscillator problem using group theory. Discrete group: Parity and time reversal symmetry in physics and the consequences (parity selection rule, Kramer‟s degeneracy etc.); Permutation symmetry of identical objects; Symmetry of a regular configuration like a square and/or triangular sheet; Symmetry of different types of lattices; Symmetry of molecules; Normal mode calculations using group theory.

Tensor Analysis and differential geometry: Scalar, vector, pseudo scalar and pseudo vector; Outer product of two vectors as a tensor; Pseudo tensor; A few examples; General definition of a tensor; Rank of a tensor; Brief overview of dual vector space; Covariant, Contra variant and mixed tensors; Kronecker delta as a tensor; Levi Civita tensor in 3 and higher dimensions; Contraction of tensors by using Kronecker delta and Levi Civita tensors; Maxwell's equations and tensor; Metric on a space as a rank two tensor; Derivative of tensors; Christoffel symbol; Riemann curvature tensor; Elements of GTR.

Text and Reference Books:

1. Introduction to Tensor Analysis by H. D. Block, Cornell University Press, 1978.
2. An Introduction to Group Theory by Nadeer Jeevan Ji, Springer New York , 2011.

1.

SEMESTER-V/VI

Course Code: BPE-02 **Full Marks: 100, Credit: 6**

Course Name: THE PHYSICS OF ENERGY

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

CO1	Learn about the different form of energy
CO2	Learn about the utilization of enegy
CO3	Learn about the applications

Course Details

1. Energy and its Uses
2. Units and scales of energy use
3. Mechanical energy and transport
4. Heat energy: Conversion between heat and mechanical energy
5. Electromagnetic energy: Storage, conversion, transmission and radiation
6. Intro to the quantum, energy quantization
7. Energy in chemical systems and processes, flow of CO_2
8. Entropy and temperature
9. Heat engines, efficiency
10. Conversion: Phase change energy conversion, refrigeration and heat pumps
11. Internal combustion engines
12. Sterling engine
13. Conversion: Steam and gas power cycles, the physics of power plants
14. Sources of Energy
15. Fundamental forces in the universe

Text and Reference Books:

1. Theory, Design and Application‟,by J.F.Manwell, J.G.McGowanand A.L. Rogers; John Wiley& Sons Ltd., UK(2004).
2. The Solar Economy: Renewable energy for sustainable global future‟by Hernamm Scheer; Earth scan, London, UK (2004).
3. Introductory Nuclear Physics by KannethS.Krane;JohnWiley&SonsLtd.(1988).

SEMESTER-
V/VIBPE-03

Course Code: BPE-03 **Full Marks: 100, Credit: 6**

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 basic ideas of bonding in materials
CO2	Describe crystalline and non crystalline materials
CO3	Understand the types of imperfections and diffusion mechanisms in solids
CO4	Describe the different properties of ceramics and polymers
CO5	Describe the different types of material analysis techniques

Course Details

I. Classification of Materials, Metals, Polymers, Semiconductor materials and other modern materials
II. 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
III. Polymers :A Modern Class of Materials
IV. The Discovery of Polymerization, Mechanisms and Properties:
V. Polymer Structures
VI. Polymer molecules – mers , chemistry, common polymers, molecular structure and configuration, Crystallinity
VII. The Semiconductor Revolution :The Information Age
VIII. Other Modern Materials (Nano Materials etc):
IX. Nano structural Characterization Techniques, Nano systems.
X. Electrical Behavior: Basic Concepts, Band Structure and Material Behavior: Conductors, Semiconductors, ionic conductors, passive and active dielectrics
XI. Applications of Materials: Traditional metal, semiconductors and polymer applications, Nano composites

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/VI

PHYSICS IN EVERYDAY LIFE

Course Code: BPE-04 **Full Marks: 100, Credit: 6**

Course Name: PHYSICS IN EVERYDAY LIFE

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

CO1	Understand the physics behind house hold objects
CO2	Understand the physics in terms of medical filed
CO3	Understand the physics in terms of data communication

Course Details

Basics: Units and dimensions; Dimensional analysis and estimation of energy scales for different physical processes; Order of magnitude calculations; The Fermi problem.

Physics of Earth: Estimating the radius and mass of earth by elementary methods; Age of the earth; Other Physical parameters of the earth; Earth's interior; Thermal structure of Earth; Gravity and magnetic field

Atmospheric Physics: Composition and structure of the atmosphere; Radiation scattering of radiation by atmosphere; Emission & absorption of terrestrial radiation; Greenhouse effect; global warming and climate change; Atmospheric thermodynamics and role of water vapour;

Human body and medical physics: Eye and the vision; working principles of spectacles, contact lenses, binoculars, telescopes, microscopes etc.; Ear and sound; working principles of hearing aid device; How the lungs and the heart work? Physics of rotator cuff and the skeleton; Non invasive probe inside the body: Sound waves and working principles of stethoscope, ultra sonography;

Communication Physics: Use of electromagnetic waves for telecommunication; from J. C. Bose to present day technology; Working principles of cell phone, GPS, internet etc.; physics of fiber optics based communication; difficulty with faster signal transmissions and possible remedies; elementary ideas on possible next generation telecommunication modes and devices.

Text and Reference Books:

1.Physics of the Earth, 4thedition, F.D. Stacy,and P. M.Davis, Cambridge University Press, 2018.

SEMESTER-V/VI

Course Code: BPE-05 **Full Marks: 100, Credit: 6**

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

(a) What is astronomy?-An introduction the prospects of astronomy.
An overview on spherical trigonometry.
Geodesics, small circles and great circles.

(a) Earth and the related terrestrial astronomy.
Celestial Sphere and related topics.
Three systems of celestial coordinates and their transformations.

(a)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.

Course Code: BPE-06 **Full Marks: 100, Credit: 6**
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

Introduction: Fundamental phenomena as a function of size and reduced dimensionality; the role of surfaces; Emphasis on uses of new materials.
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.
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).
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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-
V/VIBPE-07

Course Code: BPE-07 **Full Marks: 100, Credit:6**

Course Name: ELECTRICAL & ELECTRONIC INSTRUMENTS

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

CO1	Develop the knowledge of theoretical and mathematical principles of electrical measuring instruments.
CO2	Examine various real life situations in domestic or industrial scenario where measurements of electrical quantities are essential
CO3	Choose the proper type and specification of measuring procedure and measuring instruments for different industrial/commercial/domestic applications.
CO4	Assess fault conditions in electrical installations and identify necessary remedial measures.
CO5	Design new sensing and measuring schemes for various electrical and electronic applications.

Course Details

1. Voltmeters and Ammeters: Analog Voltmeters: DC Voltmeter, AC Voltmeter, Vacuum Tube Voltmeter (VTVM), Field Effect Transistor Voltmeter(FET-VM);Analog Ammeters.
2. Digital Voltmeters: General Characteristics, Ramp Type, Integrating Type, Continuous Balance, Digital Multimeters.
3. Power Supply: Rectifiers with/without Filter, Principle of Regulation, Regulated Power Supply using Zener, Transistor and ICs, Fixed and Variable Voltage Source(s) using ICs, Constant current supplies, Power Supply using SCRs, Fabrication of Regulated Power Supply, Switched Mode Power Supply(SMPS),

Text and Reference Books:

1. Modern Electronic Instrumentation & Measurement Techniques, Helfrick &Cooper, Prentice-Hall, old edition 1992.
2. Electronic Measurement, Terman &Petit, McGraw Hill, 2006.
3. Electricity & Magnetism by Michael A. Di Spezio, Sterling Juvenile; New edition 2000.

SEMESTER-V/VI

BPE-08

Course Code: BPE-08 **Full Marks: 100, Credit: 6**

Course Name: ATOMIC, MOLECULAR, NUCLEAR & PARTICLE PHYSICS

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

CO1	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

GROUPA: ATOMIC & MOLECULAR PHYSICS

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-Jcoupling.

2. **Molecular Spectra:**

   Classification of molecular spectra - electronic, vibrational and rotational spectra of diatomi c molecules, fluorescence, phosphorescence, Raman spectra, optical pumping.

Group B: Nuclear Physics

1.**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.

2. **Radioactivity**: α, β, γ decay and internal conversion

Group C: Particle Physics

Full Marks: 15

1. 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
2. Quantum numbers: quantum numbers associated with 'elementary' particles, their conservation and violation
3. 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. Theoretical Nuclear Physics, Blatt & Weisskopf, John Wiley & Sons -Dover Publications; New edition2010, downloadable - https://books.google.sh/books?id=W7vCAgAAQBAJ&printsec=copyright#v=onepage&q&f=false
5. Introduction to Elementary Particles, David Griffiths, John Wiley & Sons 2nd edition 2010.
6. IntroductiontoParticlePhysics,M.P.Khanna,Prentice-HallofIndiaPrivateLimited 1999.
7. Concepts of Modern Physics, A. Beiser, McGraw-Hill Education 6th edition 2002.
8. http://public.web.cern.ch/public/en/Science/Science-en.htmL
9. Introduction to Atomic Spectra, Harvey Elliot White - MCGRAWHILL EXCLUSIVE (CBS) 2019
10. Molecular Spectroscopy, Banwell - McGraw Hill Education; Fourth edition 2017.

SEMESTER-V/VI

BPE-09

(MATHEMATICALMETHODS–III)

Course Code: BPE-09 **Full Marks: 100, Credit: 6**

Course Name: MATHEMATICALMETHODS–III

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

CO1	Solve the linear system of equations analytically and compute the Eigen values and Eigen vectors of a square matrix.
CO2	2. Extend the concept of integration of two and three dimensions and support it through applications in engineering
CO3	Generalize calculus to vector functions and interpret vector integral theorems.
CO4	Extend the concept of integration of two and three dimensions and support it through applications in engineering
CO5	Appraise the Laplace Transform technique and use it to solve various engineering problems

Course Details

1. Second order differential equations: – Singular points, series solutions, Frobenius method, Legendre, Bessel and Hermite equations
2. Special Functions – Legendre, Bessel, Hermite and Laguerre functions – recurrence relations, orthogonality, generating functions, Rodrigues formula. Beta and Gamma functions, Dirac Delta function.
3. Non-linear differential equations – Non-linearity in some simple dynamical systems, fixed points and their classification, stability, linear stability analysis, Bifurcations. Examples, phase planeand phase portrait, limit cycle Lorenz equation, Chaos.
4. Tensors: Introduction, coordinate transformation, scalars, covariant and contravariant tensors, ranks, Symmetric and Anti-symmetric tensors, Einstein summation rule, Kronecker delta, metric tensors, contraction, inner product and outer product.
5. Integrals transforms: Fourier transforms, convolution theorems, short-comings of Fourier transforms,

Text and Reference Books:

1. Mathematical methods for Physicists: Arfken and Weber – Elsevier 7th edition 2012
2. Mathematical methods of physics–J Mathews and R.I.Walker - Pearson Addison-Wesley; 2nd edition 1971
3. Advanced Engineering Mathematics –Erwin Kreyszig, Wiley 10thedition, 2010.
4. Mathematics for Physicists–Dennery and Krzywicki, Dover New edition, 1996.
5. Mathematical Methods in the Physical Sciences: Mary L.Boas, Wiley; 3rd edition 2005.
6. Mathematical Physics– PK Chattopadhyay New Age International Private Limited; Third edition 2022

7. Vector and Tensor Analysis with applications– Borisenko and Tarapov - Dover Publications Inc.; New edition 2003
8. Vector Analysis– MR Spiegel (Schaum series) - McGraw Hill Education; 2nd edition 2017.
9. Fourier Transform–M.R .Spiegel(Schaum series)McGraw-Hill Education 1974.
10. Mathematical Physics –Ajoy Ghatak, Goyaland Chua(McMillan) - Laxmi Publications Private Limited; First edition 2017.
11. Differential equations– MR Spiegel(Schaum series) - McGraw Hill; First edition 2020

GEBERIC ELECTIVE/INTERDISCIPLINARY COURSES IN PHYSICS

SEMESTER- I

Course Code: GE-101 **Full Marks: 50, Credit: 4**

Course Name: MECHANICS & THERMAL PHYSICS

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

CO1	identify the relationship and correct usage of work
CO2	compute entropy for simple systems such as the ideal gas
CO3	compute the value of selected thermo dynamical variables at thermal
CO4	compute the efficiency of idealized engines such as the Carnot cycle

Course Details

Group A **(**Mechanics) Marks: 20

Vectors: Axial and polar vectors, dot and cross product, scalar triple product and vector triple product. Gradient, divergence and curl, statement of divergence theorem and Stokes‟ theorem.

Rotational motion: Angular velocity, angular acceleration, angular momentum, torque, fundamental equations of rotational motion, principle of conservation of angular momentum.

Dynamics of rigid bodies: Moment of inertia and radius of gyration, their physical significance, theorem of parallel and perpendicular axes. Rotational kinetic energy, calculation of moment of inertia of some simple systems.

Gravitation: Law of universal gravitation, gravitational potential and intensity, calculation of potential and intensity of thin uniform spherical shell and solid sphere, escape velocity.

Group B (**Thermal Physics)** **Marks: 30**

1. **Kinetic theory of gases**: Perfect gas, pressure exerted by gas, Maxwell‟s law of distribution of molecular velocities (statement only) – r.m.s., mean and most probable velocities, degrees of freedom, principle of equipartition of energy
2. **Thermal conductivity of solids**: Different processes of transmission of heat,thermal conductivity and diffusivity, Fourier equation in 1-Dimension for heat flow
3. **Thermodynamics**: Specific heat, Internal energy, Isothermal and adiabatic processes, first law of thermodynamics; Indicator diagram, reversible and irreversible processes, cyclic process; Second law of thermodynamics,Carnot cycle, Carnot theorem
4. **Radiation**: Radiation of heat, emissive and absorptive power, Kirchhoff‟s law, black body Radiation, Stefan‟s law, Planck‟s law (statement only), Wien‟s displacement law, Rayleigh-Jean‟slaw.

Text and Reference Books:

1. Introduction to Mechanics: R. D. Kleppner and J. Kolenkow, Cambridge University Press, 2nd edition, 2014.
2. A textbook of Mechanics by J. C. Upadhyay,Ram Prasas Publications; 1st edition, 2017.
3. Mechanics by D. S. Mathur, S. Chand; New edition, 2000
4. Theory & Problems of Theoretical Mechanics by M. R. Spiegel, Schaum's Outline Series, 2017.

SEMESTER-I

Course Code: GE-102 (Lab) **Credit: 2 Full Marks: 25**
Course Name: Laboratory -I

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

CO1	Learn to determine specific gravity of granular solid experimentally
CO2	Learn to determine moment of inertia of metallic cylinder/rectangular bar experimentally

Name of Experiments:-

1. Determination of specific gravity of granular solid in soluble in water.
2. Determination of moment of inertia of metallic cylinder/rectangular bar.
3. Verification of Boyle‟s law.

(NEWEXPERIMENTSMAYBEADDEDINPHASES)

SEMESTER-II

Course Code: GE-201 **Full Marks: 50, 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

Course Details

Group-A: General Properties of Matter Marks: 25

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 acapillarytube,Poiseuille'sequationanddeterminationofviscosityofa 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 Marks: 25

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: GE-202 (Lab) **Credit: 2 Full Marks: 25**
Course Name: Laboratory -II

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: GE-301 **Full Marks: 50, Credit: 4**

Course Name: ELECTRICITY & MAGNETISM

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

CO1	Study the electric field using coulombs' inverse square law in electrostatics of current
CO2	Analyse the chemcial and heating effect of current
CO3	Understand the faradays laws of electromagnetic induction by rayleigh's method
CO4	Analyse the value of maxwell equation- boundary conditions

Course Details

Electrostatics: Electric charge, Coulomb‟s law, electrostatic potential and intensity, intensity and potential due to a point charge,; Induction, lines of force, Gauss‟ theorem and its application, capacity of condenser, parallel-plate, spherical and cylindrical condensers; Loss of energy due to charge sharing,; Dielectrics, electric polarization.

Magnetostatics: Magnetic pole, pole strength, magnetic potential and intensity, potential due to a bar magnet and magnetic shell, moment of a magnet, forces between two magnets, couple on a magnet, work done in deflecting a magnet, magnetometers – deflection and vibration; Terrestrial magnetism, magnetic elements of earth, determination of H.

D.C.Circuit: Kirchhoff‟s law and its application, potentiometer and its application, measurement of e.m.f., current and resistance by potentiometer, Wheatstone‟s bridge and its sensitivity.

Electro- magnetic induction: Self and mutual inductances, calculation of inductance in solenoid.

Varying current : Growth and decay of current in L-R and C-R circuits, time constant and log decrement; Induction coil.

Text and References 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 5^{th} edition, 2017.

SEMESTER-III

Course Code: GE-302 (Lab) **Credit: 2 Full Marks: 25**
Course Name: Laboratory -III

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

CO1	Understand the experiments related to magnetism
CO2	Understand the experiments related to Electricity

Name of Experiments:-

1. Determination of the resistance per unit length of ammeter bridge wire by Carey Foster's method.
2. Determination of the value of low resistance by drop of potential method.
3. To measure the e.m.f. of a cell by a potentiometer using a milli-ammeter.
4. Determination of specific resistance by meter bridge with end correction.
5. Determination of the electro chemical equivalence of copper using an ammeter (single deposit necessary).
6. Determination of the moment of a bar magnet and the horizontal component of earth's magnetic field by magnetometer.

(NEWEXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-IV

Course Code: GE-401 **Full Marks: 50, 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
(EACH GROUP HAS TO BE ANSWERED IN SEPARATE SCRIPT)

Group A: Modern Physics Marks: 35

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-energyequivalence.

Group B: Electronics Marks: 15

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'.

SEMESTER-IV

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,
5. 2017.
6. A Textbook of Quantum Mechanics by P.M. Mathews and K. Venkatesan,
7. McGraw-Hill Education (India) Pvt Limited,2010.
8. Introduction to Quantum Mechanics by D.J.Griffiths, 3E, Cambridge University
9. Press, 2018.

SEMESTER-IV
(LABORATORYCOURSE)

Course Code: GE- 402 (Lab) **Credit: 2 Full Marks: 25**
Course Name: Laboratory -IV

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)