Scheme of Instruction & Syllabi

Of

Bachelor of Science (Honours)

Physics

(Effective from Session 2026-2027)

Third year

Department of Applied Sciences & Humanities

INVERTIS UNIVERSITY

Bareilly-243123 U.P.

B.Sc. Honours (Physics)

This program provides a specialized ability to identify and solve significant problems across a broad range of application areas concerned chiefly with knowledge of Physics as well as of cross-discipline nature, to develop the aptitude to apply the principles of Physics and related sciences to articulate an in-depth understanding of core knowledge on various areas of Physical Sciences. It is designed to help students understand the importance of the role of this knowledge in improving the quality of human life. It also helps students recognize and appreciate the contribution of great scientists in the field of Physics and related fields.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

This program acts as a specialized degree and helps to develop critical, analytical and problem-solving skills at a first level. This specialized degree makes the graduates employable in scientific organizations and also to assume expert administrative positions in various types of organizations. Further acquisition of higher-level degrees will help graduates pursue a career in academics or scientific organizations as researchers.

The Program Educational Objectives are to prepare the students to:

1. Work independently or in a team with engineering, medical, ICT professionals and scientists in scientific problem solving.
2. Act as expert administrators in public, private and government organizations, or as business administrators, with further training and education.
3. Pursue masters and doctoral research degrees to work in colleges, universities as professors, or as scientists in research establishments.

PROGRAM OUTCOMES (POs)

After undergoing this programme, a student will be able to execute the following successfully:

1. **Scientific knowledge**: Apply the knowledge of Physics, scientific fundamentals, and scientific specialization to the solution of complex scientific problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze scientific problems to arrive at substantiated conclusions using first principles of Physical sciences and nature.

3. **Design/development of solutions**: Design solutions for complex scientific problems and design system components and processes to meet specifications, with consideration for public health and safety, and cultural, societal and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern scientific tools including prediction and modeling to complex activities with an understanding of the limitations.

6. **Scientific temper and society**: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the practice.

7. **Environment and sustainability**: Understand the impact of professional scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for, sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the work practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively with their community and with society at large. Be able to comprehend and write effective reports and documentation. Make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of scientific and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in, independent and life-long learning and research in the broadest context of scientific and technological change.

B.Sc. (Honours) (Physics)
Scheme of Instruction

I Year

I Semester			Teaching Scheme			Marks Distribution			Credits
Paper	**Code**	**Subject**	**L**	**T**	**P**	**MSM**	**ESM**	**Total**	
DSC-1	BHP101	Mechanics & Properties of Matter	3	1	0	30	70	100	4
DSC-2	BHP102	Thermodynamics	3	1	0	30	70	100	4
DSC-3	BHC101	General Inorganic Chemistry	3	1	0	30	70	100	4
DSC-4	BHC102	General Organic Chemistry	3	1	0	30	70	100	4
DSC-5	BHM101	Differential Calculus & Matrix	3	1	0	30	70	100	4
DSC-6	BHM102	3-Dimensional Geometry	3	1	0	30	70	100	4
Lab-1	BHP151	Mechanics Lab I	0	0	4	15	35	50	2
Lab-2	BHC151	Organic Chemistry Lab	0	0	4	15	35	50	2
Lab-3	BHM151	MATLAB Programming	0	0	4	15	35	50	2
AECC	EPC001	AI Based English Proficiency Course - I	0	0	0	0	50	50	2
Total			**18**	**6**	**12**	**225**	**575**	**800**	**32**

II Semester			Teaching Scheme			Marks Distribution			Credits
Paper	**Code**	**Subject**	**L**	**T**	**P**	**MSM**	**ESM**	**Total**	
DSC-7	BHP201	Optics	3	1	0	30	70	100	4
DSC-8	BHP202	Waves and Oscillations	3	1	0	30	70	100	4
DSC-9	BHC201	General Physical Chemistry	3	1	0	30	70	100	4
DSC-10	BHC202	Inorganic Chemistry of Chemical Bonding	3	1	0	30	70	100	4
DSC-11	BHM201	Real Analysis	3	1	0	30	70	100	4
DSC-12	BHM202	Integral Calculus	3	1	0	30	70	100	4
Lab-4	BHP251	Optics Lab	0	0	4	15	35	50	2
Lab-5	BHC251	Inorganic Chemistry Lab	0	0	4	15	35	50	2
Lab-6	BHM251	Programming with C	0	0	4	15	35	50	2
AECC	EPC002	AI Based English Proficiency Course - II	0	0	0	0	50	50	2
Total			**18**	**6**	**12**	**225**	**575**	**800**	**32**

L – Lecture
T – Tutorial
P – Practical
MSM – Mid Semester Marks
ESM – End Semester Marks

INVERTIS UNIVERSITY BAREILLY

B.Sc. (Honours) (Physics)
Scheme of Instruction

II Year

III Semester			Teaching Scheme			Marks Distribution			Credits
Paper	**Code**	**Subject**	**L**	**T**	**P**	**MSM**	**ESM**	**Total**	
DSC-13	BHP301	Electromagnetic Theory	3	1	0	30	70	100	4
DSC-14	BHP302	Semiconductor Physics	3	1	0	30	70	100	4
DSC-15	BHC301	Organic Chemistry of Functional Groups	3	1	0	30	70	100	4
DSC-16	BHC302	Thermodynamics and Chemical Equilibria	3	1	0	30	70	100	4
DSC-17	BHM301	Probability Theory & Statistics	3	1	0	30	70	100	4
DSC-18	BHM302	Differential Equations	3	1	0	30	70	100	4
Lab-7	BHP351	Thermal Physics Lab	0	0	4	15	35	50	2
Lab-8	BHC351	Synthesis in Chemistry Lab	0	0	4	15	35	50	2
Lab-9	BHM351	Aptitude and Reasoning	0	0	4	15	35	50	2
Total			**18**	**6**	**12**	**225**	**525**	**750**	**30**

IV Semester			Teaching Scheme			Marks Distribution			Credits
Paper	**Code**	**Subject**	**L**	**T**	**P**	**MSM**	**ESM**	**Total**	
DSC-19	BHP401	Digital Electronics	3	1	0	30	70	100	4
DSC-20	BHP402	Modern Physics	3	1	0	30	70	100	4
DSC-21	BHC401	Advanced Inorganic Chemistry	3	1	0	30	70	100	4
DSC-22	BHC402	Heterocyclic and Polycyclic Chemistry	3	1	0	30	70	100	4
DSC-23	BHM401	Integral Transform	3	1	0	30	70	100	4
DSC-24	BHM402	Numerical Analysis	3	1	0	30	70	100	4
Lab-10	BHP451	Semiconductor Lab	0	0	4	15	35	50	2
Lab-11	BHC451	Instrumentation in Chemistry Lab	0	0	4	15	35	50	2
Lab-12	BHM451	Numerical Analysis Lab	0	0	4	15	35	50	2
		Total	**18**	**6**	**12**	**225**	**525**	**750**	**30**

L – Lecture
T – Tutorial
P – Practical
MSM – Mid Semester Marks
ESM – End Semester Marks

B.Sc. (Honours) (Physics)
Scheme of Instruction

III Year

V Semester			Teaching Scheme			Marks Distribution			Credits
Paper	**Code**	**Subject**	**L**	**T**	**P**	**MSM**	**ESM**	**Total**	
DSC-25	BHP501	Electric and Magnetic Properties	3	1	0	30	70	100	4
DSC-26	BHP502	Atomic and Molecular Physics	3	1	0	30	70	100	4
DSC-27	BHP503	Quantum Mechanics	3	1	0	30	70	100	4
DSC-28	BHP504	Mathematical Physics	3	1	0	30	70	100	4
VAC-1	BHP505	Introduction to Data Science	2	0	0	15	35	50	2
Lab-13	BHP551	Electromagnetics Lab	0	0	4	15	35	50	2
Lab-14	BHP552	Data Science Lab	0	0	4	15	35	50	2
FW	BHP553	Internship/Field Work	0	0	0	30	70	100	4
Total			**14**	**4**	**8**	**195**	**455**	**650**	**26**

VI Semester			Teaching Scheme			Marks Distribution			Credits
Paper	**Code**	**Subject**	**L**	**T**	**P**	**MSM**	**ESM**	**Total**	
DSC-29	BHP601	Solid State Physics	3	1	0	30	70	100	4
DSC-30	BHP602	Nuclear & Particle Physics	3	1	0	30	70	100	4
DSC-31	BHP603	Statistical Mechanics	3	1	0	30	70	100	4
DSC-32	BHP604	Nanomaterials and Applications	3	1	0	30	70	100	4
VAC-2	BHP605	Environment and Climate Change	2	0	0	15	35	50	2
Lab-15	BHP651	Material Science Lab	0	0	4	15	35	50	2
Project	BHP652	Project Work	0	0	0	50	100	150	6
Total			**14**	**4**	**4**	**200**	**450**	**650**	**26**

L – Lecture
T – Tutorial
P – Practical
MSM – Mid Semester Marks
ESM – End Semester Marks

Detailed Syllabus

for

Bachelor of Science (Honours)
in
Physics

Third year
(w.e.f. 2026-27)

BHP501: Electric and Magnetic Properties	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test - 12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 Marks

Course Objectives:

1. **Develop a fundamental understanding of dielectric and magnetic properties of materials**, including polarization, dielectric dispersion, magnetization, susceptibility, and magnetic ordering.
2. **Familiarize students with ferro-, antiferro-, and ferrimagnetism**, along with the principles of superconductivity and their technological applications.
3. **Develop knowledge of experimental techniques** used to measure dielectric and magnetic properties and interpret the physical behaviour of materials.

Detailed Syllabus:

Unit-1: Dielectric Properties of Materials
Recapitulation of polarization P, the electric displacement D and electric susceptibility (BHP301); microscopic mechanisms of polarization - electronic, ionic and orientational (dipolar) polarizability; internal (Lorentz) field in a dielectric; the Clausius-Mossotti relation; frequency dependence of polarizability and dielectric dispersion, Debye's theory of dielectric relaxation, dielectric loss; qualitative treatment of piezoelectricity and pyroelectricity; ferroelectricity - spontaneous polarization, ferroelectric domains, the Curie-Weiss law, and typical ferroelectric materials such as barium titanate (BaTiO3).

Unit-2: Diamagnetism and Paramagnetism
Recapitulation of magnetization M, the auxiliary field H and magnetic susceptibility (BHP301); classification of magnetic materials on the basis of susceptibility; atomic origin of magnetic moment - orbital and spin contributions; Langevin's classical theory of diamagnetism; Langevin's theory of paramagnetism and Curie's law; Curie-Weiss law; elementary quantum-mechanical treatment of paramagnetism, Brillouin function (qualitative).

Unit-3: Ferro-, Antiferro- and Ferrimagnetism
Weiss's molecular-field theory of ferromagnetism, exchange interaction, spontaneous magnetization and the Curie temperature; domain theory of ferromagnetism, Bloch walls, the process of magnetization, hysteresis and hysteresis (energy) loss, soft and hard magnetic materials; antiferromagnetism - the Neel temperature and sub-lattice model (elementary); ferrimagnetism and ferrites, and their technological applications.

Unit-4: Measurement of Dielectric and Magnetic Properties, and Superconductivity
Experimental methods for the determination of dielectric constant and dielectric loss of a material; experimental methods for the determination of magnetic susceptibility of dia-, para- and ferromagnetic materials (Gouy's method and Quincke's method - principle and working);

Superconductivity - critical temperature, the Meissner effect, critical magnetic field, Type-I and Type-II superconductors, elementary idea of the BCS theory, and applications of superconductivity.

Textbooks:

1. C. Kittel, Introduction to Solid State Physics, Wiley.
2. S. O. Pillai, Solid State Physics, New Age International Publishers.

Reference Books:

1. A. J. Dekker, Electrical Engineering Materials, Prentice-Hall of India.
2. J. P. Srivastava, Elements of Solid State Physics, Prentice-Hall of India.
3. D. C. Tayal, Electricity and Magnetism, Himalaya Publishing House Pvt. Ltd.

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** the fundamental concepts and terminology related to dielectric polarization, magnetization, magnetic susceptibility, ferroelectricity, magnetism, and superconductivity.
CO2.	**Explain** the microscopic mechanisms of polarization, theories of dia- and paramagnetism, magnetic ordering, ferroelectricity, and superconducting phenomena.
CO3.	**Apply** appropriate theoretical principles and relations, including Clausius-Mossotti, Curie's law, and Curie-Weiss law, to describe the properties of materials.
CO4.	**Analyse** dielectric dispersion, magnetic domains, hysteresis, magnetic ordering, and the behaviour of different classes of magnetic and superconducting materials.
CO5.	**Evaluate** experimental methods for determining dielectric constant, dielectric loss, and magnetic susceptibility, and interpret the obtained results.
CO6.	**Develop** conceptual understanding of material-based applications by relating dielectric, magnetic, ferroelectric, ferrite, and superconducting properties to technological applications.

BHP502: Atomic and Molecular Physics	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. **Develop a fundamental understanding of atomic and molecular spectroscopy**, including atomic structure, angular momentum, spin, electronic transitions, and molecular spectra.
2. **Familiarize students with important spectroscopic phenomena**, including Zeeman and Stark effects, X-ray spectra, Raman effect, and selection rules.
3. **Introduce the principles and applications of lasers and spin-resonance spectroscopy**, including NMR and ESR techniques.

Detailed Syllabus:

Unit-1 Atoms in electric and magnetic fields:
Space quantization, electron spin, spin magnetic moment, Stern--Gerlach experiment, gyromagnetic ratio and Bohr magneton, Normal and anomalous Zeeman effect, Lande g-factor, Paschen--Back effect, Stark effect (qualitative).

Unit-2 Many-Electron Atoms and X-ray Spectra:
Pauli's exclusion principle, Fine structure, spin-orbit coupling, L-S and j-j coupling, Hund's rule, term symbols, Hyperfine structure, Spectra of hydrogen and alkali atoms, Continuous and characteristic X-ray spectra, Moseley's law.

Unit-3 Molecular Spectra and the Raman Effect:
Rotational, vibrational and rotation-vibration energy levels, selection rules and spectra, electronic spectra and the Franck--Condon principle, Quantum theory of the Raman effect, Stokes and anti-Stokes lines.

Unit-4 Lasers and Spin-Resonance Spectroscopy:
Spontaneous and stimulated emission, Einstein A and B coefficients, population inversion, Ruby laser and He-Ne Laser, Principles and applications of nuclear magnetic resonance (NMR) and electron spin resonance (ESR).

Text Books:

1. Arthur Beiser, Concepts of Modern Physics, (McGraw-Hill Book Company, 1987)
2. J. H. Fewkes & John Yarwood, Atomic Physics Vol. II (Oxford Univ. Press, 1991)

Reference Books:

1. J. B. Rajam & foreword by Louis de-Broglie, Atomic physics, (S. Chand & Co., 2007) 2. B. H. Bransden and C. J. Joachein, Physics of Atoms and Molecules (Prentice Hall) 3. C. N. Banwell, Molecular Spectroscopy (McGraw Hill)

Course Outcomes:
After completing the course, students will be able to:

CO1.	**Recall** the fundamental concepts and terminology related to atomic structure, electron spin, magnetic moments, atomic spectra, molecular spectra, lasers, NMR, and ESR.
CO2.	**Explain** space quantization, spin-orbit coupling, atomic coupling schemes, X-ray spectra, molecular energy levels, Raman effect, laser action, and spin-resonance phenomena.
CO3.	**Apply** appropriate principles and selection rules to interpret atomic, molecular, X-ray, and Raman spectra.
CO4.	**Analyse** atomic and molecular spectra using concepts such as Zeeman and Stark effects, term symbols, coupling schemes, rotational and vibrational transitions, and Raman scattering.
CO5.	**Evaluate** the physical principles and characteristics of laser systems and spectroscopic techniques such as NMR and ESR.
CO6.	**Develop** conceptual models and identify suitable applications of spectroscopy, lasers, NMR, and ESR in scientific and technological fields.

BHP503: Quantum Mechanics	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. **Develop a fundamental understanding of quantum mechanics**, including quantum theory, wave-particle duality, matter waves, and uncertainty principle.
2. **Familiarize students with the mathematical formalism of quantum mechanics**, including wave functions, operators, eigenvalues, and expectation values.
3. **Apply quantum mechanical principles** to one-dimensional systems, tunnelling, harmonic oscillator, angular momentum, and the hydrogen atom.

Detailed Syllabus:

Unit-1 Origin of Quantum Theory:
Failures of classical physics, Blackbody radiation and Planck's quantum hypothesis, Photoelectric effect, Compton Effect, Pair production and pair annihilation, Wave nature of matter: de-Broglie hypothesis, Wavelength of de-Broglie waves, Properties of matter waves, Velocity of de-Broglie Waves, Wave-particle duality, Davisson-Germer experiment, Wave packets, Group and phase velocities and relation between them, Probability, Wave amplitude and wave functions, Heisenberg's uncertainty principle: Derivation from wave packets and its applications.

Unit-2: Schrödinger wave equation and basic concepts of quantum mechanics:
Schrödinger wave equation: time dependent and time independent, Physical interpretation of wave function, conditions for physical acceptability of wave functions, properties of wave function, normalization of wave functions, Probability, probability current density and continuity equation, Solution of time dependent Schrödinger wave equation, orthogonal properties of wave function, Eigen values and Eigen functions, operators and observables, Expectation values, Ehrenfest's Theorem, Hermitian operators and their properties, parity operator and its properties, Simultaneous Eigen functions: Commutators.

Unit-3: Applications of Schrödinger wave equation to 1-D problems:
Particle in a one-dimensional box, potential step- the single step barrier, the rectangular potential barrier:: reflection and transmission, quantum phenomenon of tunneling: tunnel effect, finite square well potential, one dimensional simple harmonic oscillator: energy levels and wave functions, Zero point energy.

Unit-4: Angular Momentum and hydrogen atom problem
Orbital angular-momentum operator and related commutation relations, Ladder operators, Orbital angular momentum in spherical polar coordinates, Eigen values of L^2 and Lz, Time independent Schrödinger wave equation for spherically symmetric potential and its application to the hydrogen atom problem.

Text Books:

1. L. I. Schiff, Quantum Mechanics, 3rd edition, (McGraw Hill Book Co., New York 1968).
2. E. Merzbacher, Quantum Mechanics, 3rd edition, (John Wiley & Sons, Inc1997)

Reference Books:

1. J. L. Powell & B. Crasemann, Quantum Mechanics, (Addison-Wesley Pubs.Co.,1965)
2. J. J. Sakurai, Modern Quantum Mechanics, (Addison-Wisley, 2^{nd} ed).
3. Kamlesh K Sharma, A Text Book of Engineering Physics-II, (Pragati Prakashan, 2014)
4. Ajoy Ghatak & S. Lokanathan, Quantum Mechanics: Theory and Applications, 5th Edition,

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** the fundamental concepts of quantum theory, matter waves, wave-particle duality, and uncertainty principle.
CO2.	**Explain** wave functions, Schrödinger equations, operators, eigenvalues, and expectation values.
CO3.	**Apply** Schrödinger's equation and quantum principles to basic quantum systems.
CO4.	**Analyse** one-dimensional quantum systems, tunnelling, finite potential wells, and harmonic oscillators.
CO5.	**Evaluate** quantum mechanical results related to energy, wave functions, uncertainty, and angular momentum.
CO6.	**Develop** mathematical models of quantum systems and apply them to the hydrogen atom and its quantum states.

BHP504: Mathematical Physics	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. **Develop a fundamental understanding of mathematical methods** including differential equations, matrices, eigenvalue problems, and special functions.
2. **Familiarize students with Fourier and Laplace transforms** and their important properties and applications.
3. **Develop problem-solving skills** by applying mathematical techniques to solve differential equations and physical problems.

Detailed Syllabus:

Unit-1: Differential Equations and Special Functions
Ordinary differential equations, linear differential equations of first and second order, series solutions of differential equations, ordinary and regular singular points, Introduction to special functions, Legendre and Bessel differential equations.

Unit-2: Matrices and Eigenvalue Problems
Matrices and their types, Matrix algebra, Determinants and their properties, Rank of a matrix, Inverse of a matrix by different methods, Solution of simultaneous linear equations using matrix methods, Eigenvalues and eigenvectors, Cayley-Hamilton theorem, Diagonalization of matrices, Quadratic forms, Applications of matrices in physical problems.

Unit-3: Fourier Series and Fourier Transforms
Fourier series, Fourier coefficients, Even and odd functions, Half-range sine and cosine series, Applications of Fourier series, Fourier Integral Theorem, Sine and Cosine Transforms, Properties of Fourier Transforms: Shifting, Scaling, Parseval's identity.

Unit-4: Laplace Transforms and Applications
Laplace Transforms: Existence theorem, Laplace transforms of elementary functions, Properties of Laplace Transforms: Shifting, Scaling, Derivatives and integrals of functions, Unit step function, Periodic functions, Applications of Laplace transforms in solving ordinary differential equations.

Text Books:

1. Mary L. Boas, *Mathematical Methods in the Physical Sciences*, John Wiley & Sons.
2. B.D. Gupta, *Mathematical Physics*, Vikas Publishing House.

Reference Books:

1. George B. Arfken, Hans J. Weber & Frank E. Harris, *Mathematical Methods for Physicists*, Academic Press.

2. H.K. Dass & Er. Rajnish Verma, *Higher Engineering Mathematics*, S. Chand Publishing.

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** fundamental concepts of differential equations, matrices, special functions, Fourier series, and integral transforms.
CO2.	**Explain** the properties and mathematical procedures associated with differential equations, matrices, Fourier and Laplace transforms.
CO3.	**Apply** mathematical methods to solve differential equations, matrix problems, Fourier series, and transform-based problems.
CO4.	**Analyse** eigenvalue problems, special functions, Fourier expansions, and transform properties for mathematical and physical systems.
CO5.	**Evaluate** solutions obtained using matrix methods, Fourier techniques, and Laplace transforms for accuracy and physical significance.
CO6.	**Develop** mathematical solutions to physical problems using appropriate differential equations, matrix methods, Fourier series, and Laplace transforms.

BHP505: Introduction to Data Science	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. **Develop fundamental programming skills** in C++, including algorithms, data types, operators, input/output, and structured programming.
2. **Familiarize students with programming constructs** such as conditional statements, loops, arrays, structures, functions, and modular programming.
3. **Develop problem-solving skills** through pointers, dynamic memory allocation, searching, sorting, string handling, and standard C++ functions.

Detailed Syllabus:

Unit 1: Introduction to Computers and C++
Introduction to Programming Environment, first C++ program. Introduction to the concept of an algorithm, from algorithms to programs. Structured Programming, trace an algorithm, number systems and conversion methods. Standard I/O in 'C++'. Fundamental Data Types and Storage Classes: character types, integer, short, long, unsigned, single and double-precision floating point, storage classes (automatic, register, static, external).

Unit 2: Operators and Expressions
Using numeric and relational operators, mixed operands and type conversion, logical operators, bit operations, operator precedence and associativity.

Unit 3: Conditional Program Execution
Applying if and switch statements, nesting if and else, restrictions on switch values, use of break and default with switch. Uses of while, do and for loops, multiple loop variables, assignment operators, break and continue. Passing arguments by value, scope rules and global variables, separate compilation and linkage, building your own modules.

Unit 4: Program Loops and Iteration
Array notation and representation, manipulating array elements, using multidimensional arrays, arrays of unknown or varying size. Purpose and usage of structures, declaring structures, assigning of structures.

Unit 5: Modular Programming
Pointer and address arithmetic, pointer operations and declarations, using pointers as function arguments, dynamic memory allocation, sequential search, bubble and selection sort, string operations. Defining and calling macros, utilizing conditional compilation, and passing values to the compiler. Input/Output: fopen, fread, etc. String handling functions. Math functions: log, sin, and alike. Other standard C++ functions.

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** fundamental concepts of algorithms, C++ programming, data types, operators, and basic input/output operations.
CO2.	**Explain** programming constructs, conditional statements, loops, arrays, structures, functions, and modular programming concepts.
CO3.	**Apply** C++ programming concepts to develop programs using operators, control statements, loops, arrays, functions, and standard libraries.
CO4.	**Analyse** programming problems and develop efficient solutions using arrays, structures, pointers, strings, and modular programming techniques.
CO5.	**Evaluate** program logic and performance using appropriate searching, sorting, debugging, and memory-management techniques.
CO6.	**Develop** structured C++ programs to solve computational problems using modular programming, dynamic memory allocation, file handling, and standard functions.

BHP551: Electromagnetics Lab	
Teaching Scheme	**Examination Scheme**
Practical: 4 hrs/Week Credits: 2	Attendance - 5 Marks Teachers Assessment - 10 Marks End Semester Exam - 35 Marks

Course Objectives:

1. **Develop practical skills** in electrical and magnetic measurements using standard laboratory instruments and bridge methods.
2. **Familiarize students with experimental techniques** for studying AC circuits, resonance, inductance, resistance, magnetic fields, and hysteresis.
3. **Develop skills in experimental data analysis**, including measurement, calculations, graphical analysis, error estimation, and interpretation of results.

List of Experiments:

Student has to perform any eight of the following experiments:

1. To study the response of a series LCR circuit and determine the resonant frequency, impedance at resonance, quality factor and bandwidth.
2. To study the response of a parallel LCR circuit and determine the anti-resonant frequency and quality factor.
3. To determine the specific resistance of the material of a wire using Carey Foster's bridge.
4. To determine a low resistance using a potentiometer.
5. To calibrate an ammeter and a voltmeter using a potentiometer.
6. To trace the hysteresis curve of a ferromagnetic sample and to determine its susceptibility and permeability.
7. To determine the ballistic constant of a ballistic galvanometer.
8. To study the variation of magnetic field along the axis of a current-carrying circular coil and to estimate the radius of the coil.
9. To determine the self-inductance of a coil using Anderson's bridge.
10. To determine a high resistance by the method of leakage.

Text Books:

1. Geeta Sanon, B.Sc. Practical Physics, 1st Edition (2007), R. Chand & Co.
2. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.

Reference Books:

1. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
2. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** the fundamental principles of electrical and magnetic measurements, AC circuits, resonance, bridges, and galvanometers.
CO2.	**Explain** the working principles of LCR circuits, potentiometers, bridges, ballistic galvanometers, and magnetic field measurement techniques.
CO3.	**Apply** standard experimental methods to determine resistance, inductance, resonant frequency, quality factor, and magnetic parameters.
CO4.	**Analyse** experimental data and circuit responses, including resonance characteristics, magnetic hysteresis, and field variation.
CO5.	**Evaluate** experimental results using appropriate calculations, graphs, and error estimation techniques.
CO6.	**Design and perform** suitable experimental procedures for electrical and magnetic measurements using appropriate laboratory techniques and instruments.

BHP552: Data Science Lab	
Teaching Scheme	**Examination Scheme**
Practical: 4 hrs/Week Credits: 2	Attendance - 5 Marks Teachers Assessment - 10 Marks End Semester Exam - 35 Marks

Course Objectives:

1. **Develop practical skills** in Python-based data analysis using NumPy, Pandas, Matplotlib, and scikit-learn.
2. **Familiarize students with data processing and machine-learning techniques**, including regression, classification, clustering, and dimensionality reduction.
3. **Develop scientific data-analysis and problem-solving skills** through real-world datasets, time-series analysis, and project-based learning.

List of Experiments:

Student has to perform any eight of the following experiments/assignments:

1. Installation and familiarisation with the Python data-science stack (NumPy, Pandas, Matplotlib, scikit-learn).
2. Import, clean and pre-process a real-world dataset using Pandas (handling missing values, duplicates and outliers).
3. Compute descriptive statistics (mean, median, mode, variance, standard deviation, correlation) of a given dataset.
4. Visualise data distributions using histograms, box plots, scatter plots and bar charts using Matplotlib/Seaborn.
5. Perform simple and multiple linear regression on a dataset and evaluate the model's performance.
6. Implement a logistic-regression or k-nearest-neighbour classifier on a labelled dataset.
7. Perform k-means clustering on an unlabelled dataset and visualise the clusters.
8. Perform Principal Component Analysis (PCA) for dimensionality reduction and visualisation.
9. Analyse a time-series physics dataset (e.g., sensor/experimental data) and plot the underlying trend.
10. Mini-project: analysis of an open scientific dataset chosen by the student, with presentation of the results.

Text Books:

1. Wes McKinney, Python for Data Analysis, O'Reilly Media.
2. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media.

Reference Books:

1. Aurelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow, O'Reilly Media.
2. Allen B. Downey, Think Stats, O'Reilly Media.

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** the fundamental concepts and functions of Python data-science libraries and basic statistical measures.
CO2.	**Explain** data preprocessing, visualisation, statistical analysis, and basic machine-learning methods.
CO3.	**Apply** Python tools to clean, analyse, visualise, and interpret scientific datasets.
CO4.	**Analyse** datasets using regression, classification, clustering, PCA, and time-series techniques.
CO5.	**Evaluate** the performance and suitability of data-analysis and machine-learning models using appropriate measures.
CO6.	**Develop** a data-driven mini-project by applying suitable computational and analytical techniques to an open scientific dataset and presenting the findings.

BHP553: Internship / Field Work	
Teaching Scheme	**Examination Scheme**
Credits: 4	Internal Assessment - 30 Marks End Semester Exam - 70 Marks

Course Objectives:

1. **Provide students with practical exposure** to professional, industrial, research, or field environments related to Physics and allied disciplines.
2. **Enable students to apply theoretical knowledge and practical skills** to real-world problems and professional situations.
3. **Develop professional competencies**, including teamwork, communication, time management, documentation, and technical report writing.
4. **Familiarize students with career opportunities** in industry, research, higher education, and other interdisciplinary fields.

Scope / Guidelines:

1. Students shall undertake an internship of **a minimum duration of 2–4 weeks or equivalent field work** in a research laboratory, industry, academic institution, or reputed organisation related to Physics, Instrumentation, Electronics, Data Science, Materials Science, or an allied area. Alternatively, students may undertake supervised field work, community-based activities, or a survey-based study under the guidance of a faculty mentor.
2. The internship or field work shall be **approved in advance by the Department** in consultation with the faculty mentor and, where applicable, the host organisation.
3. Students shall maintain a **work diary/logbook** documenting their activities, learning experiences, tasks performed, and skills acquired during the internship or field work.
4. Students shall follow the **professional, safety, ethical, and academic guidelines** of the host organisation or field activity.
5. At the completion of the internship/field work, students shall submit a **certificate from the host organisation**, wherever applicable, along with a comprehensive report in the format prescribed by the Department.
6. Students shall present their experience and learning outcomes through a **seminar/presentation** and appear for a viva-voce as part of the final evaluation.

Evaluation Scheme:

1. Internal Assessment (30 Marks): work-diary/log book, mentor's assessment and a mid-term presentation.

2. End Semester Examination (70 Marks): submission of the internship/field-work report and a viva-voce examination before a departmental committee.

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** relevant concepts and principles of Physics applicable to the assigned

	internship or field-work activities.
CO2.	**Explain** the tasks, procedures, tools, and professional practices encountered during the internship or field work.
CO3.	**Apply** theoretical knowledge and practical skills to address real-world problems and perform assigned professional or field-based tasks.
CO4.	**Analyse** observations, work experiences, technical information, or field data using appropriate scientific and analytical methods.
CO5.	**Evaluate** the outcomes of the internship or field work and critically reflect on the skills acquired, challenges encountered, and possible improvements.
CO6.	**Develop** professional competencies and effectively communicate the internship/field-work experience through a structured report, presentation, and viva-voce.

BHP601: Solid State Physics	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. **Develop a fundamental understanding of solid-state physics**, including crystal structures, lattice dynamics, energy bands, and the physical properties of solids.
2. **Familiarize students with electrical, magnetic, dielectric, and superconducting properties** of materials and their theoretical models.
3. **Develop the ability to apply concepts of solid-state physics** to understand material behaviour and technological applications.

Detailed Syllabus:

Unit 1: Crystal Structure and Lattice Dynamics
Solids: amorphous and crystalline materials; lattice translation vectors; lattice with a basis, the unit cell; types of lattices and coordination number; Miller indices; atomic packing fraction; separation between lattice planes; simple crystal structures --- SC, BCC, FCC, and HCP; the reciprocal lattice and Brillouin zones; diffraction of X-rays by crystals, Bragg's law. Elementary lattice dynamics: interatomic forces and the concept of normal modes; dispersion relation for a monatomic linear chain; heat capacity of solids --- the Dulong-Petit law and its failure at low temperature, the Einstein and Debye theories of specific heat.

Unit 2: Electrical and Magnetic Properties of Solids
Energy bands & energy-band diagrams, the classification of solids into conductors, insulators and semiconductors. Elementary band theory of solids: the Bloch theorem, the Kronig-Penney model and the origin of energy bands and bandgaps from a periodic potential; the effective mass of an electron; the concept of holes. Magnetic properties: dia-, para-, ferri-, ferro- and antiferromagnetic materials; classical Langevin theory of diamagnetism and Para-magnetism; Curie's law; Weiss's theory of ferromagnetism and the concept of ferromagnetic domains; the B-H curve, hysteresis and energy loss.

Unit 3: Dielectric Properties of solids
Dielectric properties: polarisation and the local electric field at an atom (Lorentz field); the depolarisation field; dielectric constant and electric susceptibility; polarizability and the classical theory of electric polarizability; the Clausius-Mosotti equation and its use in relating microscopic polarizability to the macroscopic dielectric constant.

Unit 4: Superconductivity
Temperature dependence of resistivity in superconducting materials; the Meissner effect; Type-I and Type-II superconductors; temperature dependence of the critical field; London's

equation and the penetration depth; a qualitative idea of BCS theory; phonons as quanta of lattice vibration; high-temperature superconductors and applications of superconductivity.

Text Books:

1. Charles Kittel, Introduction to Solid State Physics, 7th/8th edition, John Wiley and Sons, Inc.
2. A. J. Dekker, Solid State Physics, Macmillan India Limited, 2000.
3. S. O. Pillai, Solid State Physics, 7th edition, New Age International Publishers.

Reference Books:

1. N. W. Ashcroft and N. D. Mermin, Solid State Physics, Harcourt Asia, Singapore, 2003.
2. J. S. Blakemore, Solid State Physics, Cambridge University Press, Cambridge.
3. M. Ali Omar, Elementary Solid State Physics: Principles and Applications, Pearson Education, 1999.
4. Puri and Babbar, Solid State Physics, S. Chand.
5. Charles P. Poole Jr. and Frank J. Owens, Introduction to Nanotechnology, Wiley India, 2006.

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** the fundamental concepts of crystal structures, lattice properties, energy bands, dielectric behaviour, magnetism, and superconductivity.
CO2.	**Explain** crystal structures, lattice vibrations, band theory, magnetic properties, dielectric polarization, and superconducting phenomena.
CO3.	**Apply** concepts of solid-state physics to analyse crystal structures, X-ray diffraction, heat capacity, electrical conduction, and material properties.
CO4.	**Analyse** lattice dynamics, energy-band formation, magnetic ordering, dielectric response, and superconducting characteristics using suitable theoretical models.
CO5.	**Evaluate** different theoretical approaches such as Einstein-Debye theory, Bloch theorem, Langevin theory, Weiss theory, and BCS theory for explaining solid-state phenomena.
CO6.	**Develop** conceptual understanding of material-based applications by relating solid-state properties to semiconductor devices, magnetic materials, dielectric systems, and superconducting technologies.

BHP602: Nuclear and particle Physics	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. **Develop a fundamental understanding** of nuclear structure, nuclear forces, radioactivity, and nuclear models.
2. **Familiarize students** with nuclear reactions, fission, fusion, nuclear reactors, and applications of nuclear physics.
3. **Introduce the basic concepts of elementary particles**, fundamental interactions, particle classification, and the Standard Model.

Detailed Syllabus:

Unit 1: Nuclear Structure and Nuclear Forces
Nuclear structure and its Basic properties such as nucleus: mass, charge, size and its determination, spin and magnetic moment, mass defect and binding energy, binding energy per nucleon and its variation with mass number. Nuclear forces: saturation phenomena and exchange forces, the deuteron and its ground-state properties, qualitative introduction to the nature and range of the nuclear force.

Unit 2: Radioactivity and Nuclear Models
Natural radioactivity: fundamental laws of radioactive decay, the law of radioactive disintegration and half-life; mean (average) life, basic ideas of alpha, beta and gamma decay. Nuclear models: the liquid-drop model; the single-particle shell model, the Bethe-Weizsacker semi-empirical mass formula, the magic numbers.

Unit 3: Nuclear Reactions and Applications
Nuclear reactions and their conservation laws; the cross-section of a nuclear reaction; theory of nuclear fission; nuclear reactors and their basic principle of operation; nuclear fusion and its role in stellar energy generation; Applications of nuclear physics in power generation, medicine and industry.

Unit 4: Elementary Particles, Accelerators and Detectors
Elementary particles: classification based on rest mass, spin and lifetime; fundamental particle interactions --- gravitational, electromagnetic, weak and strong; basic conservation laws (baryon number, lepton number, strangeness) and an elementary introduction to the quark model and the Standard Model of particle physics, Unification of models.

Reference Books:

1. D. C. Tayal, Nuclear Physics, Himalaya Publication.

2. Irving Kaplan, Nuclear Physics, Oxford Publication, New Delhi.

3. S. N. Ghoshal, Nuclear Physics, S. Chand & Co.

4. B. R. Martin, Nuclear and Particle Physics: An Introduction, John Wiley & Sons, 2009.

5. V. K. Mittal, R. C. Verma and S. C. Gupta, Introduction to Nuclear and Particle Physics, PHI Learning.

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** the fundamental concepts of nuclear structure, nuclear properties, nuclear forces, radioactivity, nuclear reactions, and elementary particles.
CO2.	**Explain** nuclear models, radioactive decay, nuclear forces, nuclear fission and fusion, fundamental interactions, and the basic quark model.
CO3.	**Apply** nuclear principles and conservation laws to analyse radioactive decay, nuclear reactions, binding energy, and nuclear processes.
CO4.	**Analyse** nuclear structure, nuclear models, fission and fusion processes, particle properties, and fundamental interactions using appropriate physical concepts.
CO5.	**Evaluate** the principles and applications of nuclear energy, nuclear reactors, radiation, and nuclear technologies in medicine and industry.
CO6.	**Develop** a conceptual framework for understanding elementary particles and their interactions within the quark model and the Standard Model of particle physics.

BHP603: Statistical Mechanics	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. **Develop a fundamental understanding of statistical mechanics**, including probability, thermodynamic probability, phase space, and statistical interpretation of thermodynamics.
2. **Familiarize students with statistical distribution laws**, including Boltzmann and Maxwell-Boltzmann distributions and their applications.
3. **Introduce quantum statistics** and develop an understanding of Bose-Einstein and Fermi-Dirac distributions and their applications to photons and electrons.

Detailed Syllabus:

Unit 1: The Statistical Basis of Thermodynamics
Probability and thermodynamic probability, principle of equal a priori probabilities, probability distribution and its narrowing with increase in number of particles, expressions for average properties. Constraints; accessible and inaccessible states, distribution of particles with a given total energy into a discrete set of energy states.

Unit 2: Some Universal Laws
Phase space representation, division of phase space into energy sheets and phase cells of arbitrary size, applications to one-dimensional harmonic oscillators and free particles. Equilibrium between two systems in thermal contact, bridge with macroscopic physics, probability and entropy, Boltzmann entropy relation. Statistical interpretation of the second law of thermodynamics, Boltzmann canonical distribution law and its applications; rigorous form of equipartition of energy.

Unit 3: Maxwellian Distribution of Speeds in an Ideal Gas
Distribution of speeds and velocities, experimental verification, distinction between mean, r.m.s. and most probable speed values.

Unit 4: Transition to Quantum Statistics
Planck constant 'h' as a natural constant and its implications, cases of particle in a one-dimensional box and one-dimensional harmonic oscillator. Indistinguishability of particles and its consequences, Bose-Einstein and Fermi-Dirac distributions, photons in black body chamber, free electrons in metal, Fermi level and Fermi energy.

Text Books:

1. F. Reif, *Statistical Physics: Berkeley Physics Course Volume 5* (Tata McGraw-Hill, 2008)

2. S. Lokanathan and R. S. Gambhir, *Statistical and Thermal Physics: An Introduction* (P.H.I., 1991)

Reference Books:

1. R. K. Patharia, *Statistical Mechanics* (Oxford: Butterworth, 1996)
2. K. Huang, *Statistical Mechanics* (Wiley, 1987)
3. B. B. Laud, *Introduction to Statistical Mechanics* (Macmillan, 1981)

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** the fundamental concepts of probability, thermodynamic probability, phase space, entropy, and statistical distributions.
CO2.	**Explain** the statistical interpretation of entropy, the second law of thermodynamics, Boltzmann distribution, and equipartition of energy.
CO3.	**Apply** statistical methods and distribution laws to analyse ideal gases, harmonic oscillators, and free particles.
CO4.	**Analyse** Maxwell-Boltzmann speed distributions and distinguish between mean, most probable, and root-mean-square speeds.
CO5.	**Evaluate** the significance of quantum statistics and compare the applicability of Bose-Einstein and Fermi-Dirac distributions.
CO6.	**Develop** statistical models for quantum systems and apply them to photons in blackbody radiation and electrons in metals.

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BHP604: Nanomaterials and Applications	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. **Develop a fundamental understanding of nanoscience and nanotechnology**, including size-dependent properties, quantum confinement, and electronic structure of nanomaterials.
2. **Familiarize students with the synthesis and characterization techniques** used for the preparation and analysis of nanomaterials.
3. **Introduce the properties and applications of nanostructures**, including quantum wells, wires, dots, and carbon nanotubes.

Detailed Syllabus:

Unit I : Introduction to Nanostructure Materials:
Nanoscience & nanotechnology, Size dependence of properties, Moor's law, Surface energy and Melting point depression of nanoparticles, Free electron theory (qualitative idea) and its features, Idea of band structure, insulators, semiconductors and conductors, Energy band gaps of semiconductors, Effective masses and Fermi surfaces, Localized particles, Donors, Acceptors and Deep traps, Mobility, Excitons, Density of states, variation of density of states with energy and size of crystal.

Unit II: Quantum Size Effect
Quantum confinement, Nanomaterials structures, Quantum well, Quantum wire and Quantum dot, Fabrication techniques.

Unit III: Characterization techniques of Nanomaterials
Determination of particle size, XRD (Scherrer's formula), Increase in width of XRD peaks of nanoparticles, Shift in absorption spectra peak of nanoparticles, shift in photoluminescence peaks, Electron microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Probe microscopy (SPM), Scanning Tunneling Electron Microscopy (STEM) and Atomic Force Microscopy (AFM).

Unit IV: Synthesis of Nanomaterials: Key issues in the synthesis of Nanomaterials, Different approaches of synthesis, Top down and Bottom up approaches, Cluster beam evaporation, Ball Milling, Chemical vapor deposition, capping agents, Carbon nanotubes (CNT)- Synthesis, Properties and Applications.

Text Books:

1. Nanostructures & Nanomaterials, Synthesis, Properties & Applications by Guozhong Cao, Imperial College Press.

2. Introduction to Nanotechnology, by Charles P. Poole, Jr. Frank J. Owens, John Wiley & Sons Inc. Publication.
3. Quantum Wells, Wires and Dots by Paul Harrison, John Wiley & Sons Ltd.
4. Quantum Dot Hetrostructures, by D. Bimberg, M. Grundman, N.N. Ledenstov.
5. Introduction to Nanoscience and Nanotechnology by Hornyak G.L., Tibbals H.F., Dutta J., Moore J.J., CRC Press.
6. Carbon Nanotechnology by Liming Dai Carbon Nanotubes: Properties and Applications by Michael J. O'. Connell.

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** the fundamental concepts of nanoscience, nanotechnology, quantum confinement, and size-dependent properties of nanomaterials.
CO2.	**Explain** the electronic structure, density of states, quantum size effects, and properties of quantum wells, wires, and dots.
CO3.	**Apply** appropriate principles and techniques to understand the synthesis and characterization of nanomaterials.
CO4.	**Analyse** the structural, optical, and morphological properties of nanomaterials using XRD, SEM, TEM, AFM, and related techniques.
CO5.	**Evaluate** different top-down and bottom-up synthesis approaches based on the properties and intended applications of nanomaterials.
CO6.	**Develop** conceptual understanding of nanomaterial-based technologies by relating the synthesis, properties, and applications of nanostructures such as carbon nanotubes.

BHP605: Environment and Climate Change	
Teaching Scheme	**Examination Scheme**
Credits:	

Course Objectives:

1. **Develop awareness of environmental systems and sustainable development**, including ecosystems, natural resources, and human–environment interactions.
2. **Familiarize students with environmental pollution, resource conservation, energy sources, and major environmental challenges** such as climate change and global warming.
3. **Promote environmental responsibility and awareness** of environmental protection, legislation, public health, environmental education, and sustainable practices.

Detailed Syllabus:

Unit-1

Definition, Scope & Importance, Need For Public Awareness- Environment definition, Eco system -- Balanced ecosystem, Human activities -- Food, Shelter, Economic and social Security. Effects of human activities on environment-Agriculture, Housing, Industry, Mining and Transportation
activities, Basics of Environmental Impact Assessment. Sustainable Development

Unit-2

Natural Resources- Water Resources- Availability and Quality aspects, Water borne diseases, Water induced diseases, Fluoride problem in drinking water, Mineral Resources, Forest Wealth, Material cycles-Carbon, Nitrogen and Sulphur Cycles, Energy -- Different types of energy, Electro-magnetic
radiation, Conventional and Non-Conventional sources -- Hydro Electric, Fossil Fuel based, Nuclear, Solar, Biomass and Bio-gas, Hydrogen as an alternative future source of Energy

Unit-3

Environmental pollution and their effects, Water pollution, Land pollution, Noise pollution, Public health aspects, Air pollution, Solid waste management,
Current environmental issues of importance, Population Growth, Climate Change and Global warming- Effects, Urbanization, Automobile pollution, Acid Rain, Ozone Layer depletion, Animal Husbandry, Environmental Protection-Role of Government, Legal aspects, Initiatives by Non-
governmental Organizations (NGO), Environmental Education, Women Education.

Text Books:

1. Benny Joseph -- "Environmental Studies" --Tata McgrawHill-2005
2. Dr. D.L. Manjunath, "Environmental Studies" --Pearson
3. R. Rajagopalan --"Environmental studies" --Oxford Publication --

4. 4. M. Anji Reddy -- "Text book of Environmental Science & Technology" --BS Publication.

Reference Books:

1. P. VenugoplanRao, "Principles of Environmental Science and Engineering"--Prentice Hall of India. 2. Meenakshi, "Environmental Science and Engineering" --Prentice Hall India

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** fundamental concepts of ecosystems, natural resources, environmental pollution, and sustainable development.
CO2.	**Explain** the effects of human activities on ecosystems, natural resources, public health, and environmental quality.
CO3.	**Apply** environmental principles to identify issues related to pollution, resource management, energy use, and sustainable development.
CO4.	**Analyse** major environmental challenges such as climate change, global warming, air and water pollution, acid rain, and ozone depletion.
CO5.	**Evaluate** the effectiveness of environmental protection measures, renewable energy sources, waste management, and sustainable practices.
CO6.	**Develop** awareness-based approaches and sustainable solutions for environmental conservation and public health through education and community participation.

BHP651: Material Science Lab	
Teaching Scheme	**Examination Scheme**
Practical: 2 hrs/Week Credits: 2	Attendance - 5 Marks Teachers Assessment - 10 Marks End Semester Exam - 35 Marks

Course Objectives:

1. **Develop practical skills** in conducting experiments related to semiconductor, dielectric, magnetic, nuclear, and electromagnetic properties.
2. **Familiarize students with standard experimental techniques** for determining physical constants and material properties.
3. **Develop skills in experimental data analysis**, including measurements, calculations, error estimation, and interpretation of results.

List of Experiments:

Student has to perform any five of the following experiments:

1. To study the Hall effect in a semiconductor sample and determine the type of majority charge carriers, the Hall coefficient and carrier mobility.
2. To determine the dielectric constant of a given material.
3. To determine the magnetic susceptibility of solids and liquids by Quincke's method.
4. To determine the half-life period of a radioactive source using a GM counter.
5. To determine the specific charge (e/m) of an electron by the helical (long solenoid) method.
6. To determine the self-inductance of a coil using Maxwell's inductance bridge.

Text Books:

1. Geeta Sanon, B.Sc. Practical Physics, 1st Edition (2007), R. Chand & Co.
2. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.

Reference Books:

1. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
2. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** the basic principles of Hall effect, dielectric properties, magnetic susceptibility, radioactivity, electron charge-to-mass ratio, and inductance bridges.
CO2.	**Explain** the working principles of the experimental methods and instruments

	used for measuring physical and material properties.
CO3.	**Apply** appropriate experimental techniques to determine Hall coefficient, carrier mobility, dielectric constant, magnetic susceptibility, half-life, specific charge, and self-inductance.
CO4.	**Analyse** experimental observations and relationships between measured quantities using suitable physical principles and calculations.
CO5.	**Evaluate** experimental results using appropriate data analysis, error estimation, and comparison with standard values.
CO6.	**Develop** proficiency in designing and performing systematic experiments to investigate the physical properties of materials and fundamental physical constants.

BHP652: Project Work	
Teaching Scheme	**Examination Scheme**
Credits: 6	Internal Assessment - 50 Marks End Semester Exam - 100 Marks

Course Objectives:

1. **Provide students with an opportunity to undertake an independent or guided project** in theoretical, experimental, computational, or interdisciplinary areas of Physics.
2. **Develop research skills** including literature review, problem formulation, methodology selection, data collection, analysis, and interpretation of results.
3. **Develop scientific communication skills** through systematic project documentation, report writing, oral presentation, and defence of the project work.
4. **Familiarize students with research ethics and academic practices** and prepare them for higher studies, research, and professional careers.

Scope / Guidelines:

1. Each student, or a small group as decided by the Department, shall undertake a project under the supervision of a faculty member in an area of Physics or an interdisciplinary field.
2. The project may be **experimental, theoretical, computational, or interdisciplinary**, and shall involve appropriate components such as literature survey, problem formulation, methodology, data collection or theoretical derivation, analysis, results, discussion, and conclusions.
3. Students shall submit a **project proposal/synopsis** at the beginning of the semester and present their progress periodically before the supervisor or departmental committee.
4. Students shall maintain appropriate records of their project work and follow accepted standards of **academic integrity, research ethics, and scientific documentation**.
5. A **final project report** in the prescribed format shall be submitted at the end of the semester, followed by a seminar/presentation and viva-voce examination.

Evaluation Scheme:

1. Internal Assessment (50 Marks): progress reviews, regularity, project synopsis and the supervisor's assessment of the work carried out.

2. End Semester Examination (100 Marks): submission of the project report, an open seminar/presentation, and a viva-voce examination before a departmental committee.

Course Outcomes:

After completing the course, students will be able to:

1. Formulate a research problem in Physics and carry out a systematic literature survey.

2. Plan and execute an experimental, theoretical or computational investigation using an appropriate methodology.

3. Analyse and interpret data/results and draw valid scientific conclusions.

4. Prepare a well-structured project report and defend the work through an oral presentation and viva-voce.

CO1.	**Recall** relevant concepts, principles, and scientific literature related to a selected project topic in Physics.
CO2.	**Explain** the background, objectives, methodology, and scientific significance of the selected project problem.
CO3.	**Apply** appropriate theoretical, experimental, computational, or analytical methods to investigate a defined problem.
CO4.	**Analyse** experimental data, computational results, or theoretical findings using suitable scientific and mathematical techniques.
CO5.	**Evaluate** the results critically, draw valid scientific conclusions, and identify limitations and possible future scope of the work.
CO6.	**Develop** a structured project report and effectively communicate and defend the project findings through scientific presentation and viva-voce.