Scheme of Instruction & Syllabi

Of

Bachelor of Science (Honours)

Physics

(Effective from Session 2026-2027)

Second 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

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

INVERTIS UNIVERSITY BAREILLY

Detailed Syllabus

for

Bachelor of Science (Honours) in Physics

Second year

(w.e.f. 2026-27)

BHP301: Electromagnetic Theory	
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 classical electromagnetic theory**, including electrostatics, magnetostatics, electromagnetic induction, and Maxwell's equations.
2. **Familiarize students with electromagnetic properties of matter**, including polarization, magnetization, electric displacement, auxiliary magnetic field, susceptibility, permittivity, and permeability.
3. **Develop the ability to apply electromagnetic principles** to analyse electromagnetic waves, energy transport, reflection and refraction, and related physical phenomena.

Detailed Syllabus:

Unit 1: Electrostatics Electric charge & charge densities, electric force between two charges. General expression for Electric field in terms of volume charge density (divergence & curl of Electric field), general expression for Electric potential in terms of volume charge density and Gauss law (applications included). Study of electric dipoles. Electric fields in matter, polarization, auxiliary field **D** (Electric displacement), electric susceptibility and permittivity.

Unit 2: Magnetostatics Electric current & current densities, magnetic force between two current elements. General expression for Magnetic field in terms of volume current density (divergence and curl of Magnetic field), General expression for Magnetic potential in terms of volume current density and Ampere's circuital law (applications included). Study of magnetic dipole (Gilbert & Ampere model). Magnetic fields in matter, magnetization, auxiliary field **H**, magnetic susceptibility and permeability.

Unit 3: Time Varying Electromagnetic Fields Faraday's laws of electromagnetic induction and Lenz's law. Displacement current, equation of continuity and Maxwell-Ampere's circuital law. Self and mutual induction (applications included). Derivation and physical significance of Maxwell's equations. Theory and working of moving coil ballistic galvanometer (applications included).

Unit-4: Electromagnetic Waves Electromagnetic energy density and Poynting vector. Plane electromagnetic waves in linear infinite dielectrics, homogeneous & inhomogeneous plane waves and dispersive & non-dispersive media. Reflection and refraction of homogeneous plane electromagnetic waves,

law of reflection, Snell's law, Fresnel's formulae (only for normal incidence & optical frequencies) and Stoke's law.

Textbooks:

1. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e. 2. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 2", Pearson Education Limited, 2012 3. D. J. Griffiths, "Introduction to Electrodynamics", Prentice-Hall of India Private Limited, 2002, 3e 4. E. M. Purcell, "Electricity and Magnetism (In SI Units): Berkeley Physics Course Vol 2", McGraw Hill, 2017, 2e 5. D.C. Tayal, "Electricity and Magnetism", Himalaya Publishing House Pvt. Ltd., 2019, 4e

Course Outcomes:

After completing the course, students will be able to:

CO1.	Explain and **apply** the principles of electrostatics, electric fields, potentials, Gauss's law, and electric dipoles to solve basic electromagnetic problems.
CO2.	**Analyse** magnetic fields, current distributions, Ampere's law, magnetic dipoles, and magnetic properties of matter using appropriate theoretical principles.
CO3.	**Explain and apply** Faraday's law, Lenz's law, displacement current, electromagnetic induction, and self and mutual induction to physical systems.
CO4.	**Derive and interpret** Maxwell's equations and explain their physical significance in the description of electromagnetic phenomena.
CO5.	**Analyse** electromagnetic wave propagation, electromagnetic energy density, Poynting vector, and wave behaviour in different media.
CO6.	**Apply and evaluate** the principles of reflection and refraction of electromagnetic waves using Snell's law, Fresnel's formulae, and related boundary conditions.

BHP302: Semiconductor 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 semiconductor physics**, including energy bands, intrinsic and extrinsic semiconductors, charge carriers, Fermi level, conductivity, mobility, drift, and diffusion.
2. **Familiarize students with the working principles and characteristics of p-n junctions and semiconductor diodes**, including biasing, diode equation, junction resistance, capacitance, and breakdown mechanisms.
3. **Develop the ability to apply semiconductor diode principles** to understand special-purpose diodes, diode circuits, rectifiers, filters, and regulated power supplies.

Detailed Syllabus:

Unit-1: Fundamentals of Semiconductors
Energy bands in solids; valence and conduction bands; conductors, insulators and semiconductors; intrinsic and extrinsic semiconductors; n-type and p-type semiconductors; electrons and holes; majority and minority charge carriers; Fermi level and its variation with temperature and doping; carrier concentration and conductivity of intrinsic and extrinsic semiconductors; mobility, drift and diffusion of charge carriers.

Unit-2: P-N Junction and Semiconductor Diode
Formation of p-n junction; depletion region and barrier potential; energy band diagram of a p-n junction; forward and reverse biasing; current flow mechanism; recombination, drift and saturation current; diode equation and I-V characteristics; junction resistance and capacitance; ideal and practical diode; breakdown mechanisms—Zener and avalanche breakdown; basic idea of diode fabrication.

Unit-3: Special Semiconductor Diodes
Zener diode: construction, working, I-V characteristics; photodiode: principle, construction and applications; light-emitting diode (LED): principle, working and applications; solar cell: photovoltaic effect, principle and working; basic comparison and applications of special-purpose semiconductor diodes.

Unit-4: Diode Circuits and Rectifiers
Diode circuits with DC and AC sources; diode clippers and clampers; positive, negative and biased clipping circuits; clamping circuits; half-wave and full-wave rectifiers; centre-tapped and bridge rectifiers; rectifier efficiency, ripple factor and peak inverse voltage (PIV); basic filter circuits; regulated and unregulated power supplies; Zener diode as a voltage regulator.

Textbooks:

1. Robert Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 8^Th^ Edition, Pearson Education, India, 2004. 2. B.L. Thareja and R.S. Sedha, Principles of Electronic Devices and Circuits, S. Chand & Company Ltd.

Reference Books:

1. A. P. Malvino, Electronic Principles, Glencoe, 1993. 2. John Morris, Analog Electronics. 3. Allen Mottershead, Electronic Circuits and Devices, PHI, 1997. 4. V. K. Mehta, Principals of Electronics, (S Chand & Co, New Delhi) 2010 5. N. N. Bhargava, D. C. Kulshreshtha& SC Gupta, Basic Electronics & Linear Circuits, Tata McGrawHill, 2006

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Explain** the energy-band structure of solids and **distinguish** between conductors, insulators, and intrinsic and extrinsic semiconductors based on their electronic properties.
CO2.	**Analyse** charge-carrier concentration, Fermi level, conductivity, mobility, drift, and diffusion in intrinsic and extrinsic semiconductors.
CO3.	**Explain and analyse** the formation, biasing, current characteristics, resistance, capacitance, and breakdown mechanisms of p-n junction diodes.
CO4.	**Explain and apply** the operating principles and applications of special semiconductor diodes, including Zener diodes, photodiodes, LEDs, and solar cells.
CO5.	**Analyse and apply** diode circuits, including clippers, clampers, half-wave and full-wave rectifiers, and basic filter circuits.
CO6.	**Evaluate** the performance of rectifier and power-supply circuits using parameters such as rectification efficiency, ripple factor, peak inverse voltage, and voltage regulation.

BHC301: Organic Chemistry of Functional Groups	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12 Marks Teachers Assessment – 6 Marks Attendance – 12 Marks III Semester Exam – 70 marks

Course Objectives:

1. To give knowledge of halogenated hydrocarbons.
2. To describe alcohol and phenols.
3. To explain about ethers and epoxides.
4. To explain about carbonyl compounds.
5. To describe carboxylic acids and their derivatives.

Detailed Syllabus

Unit-1 Chemistry of Halogenated Hydrocarbons: **Alkyl halides:** Methods of preparation, nucleophilic substitution reactions - SN_1, SN_2 and SN mechanisms, Elimination reactions - E_1, E_2, and E_1cB mechanisms. **Aryl halides:** Preparation from arenes and diazonium salts. nucleophilic aromati substitution/addition elimination mechanism. The benzyne mechanism (elimination-additio framework).
Unit-2 Alcohols and Phenols **Alcohols:** Methods of formation, monohydric, dihydric (glycols) and trihydric (glycerol alcohols, hydrogen bonding, relative reactivity of 1^0, 2^0, 3^0 alcohols, glycols: Oxidativ cleavage by $Pb(OAc)_4$ and HIO_4. **Phenols:** Industrial preparation (from cumene, benzen sulfonic acid), Factors influencing the acidity of phenols (resonance, inductive effects o substituents). Electrophilic aromatic substitution reactions, mechanism of Reimer - Tieman and Claisen rearrangement.
Unit-3 Ethers and Epoxide **Ethers:** Preparation, Williamson's ether synthesis. Chemical reactions – cleavage an autoxidation. Mechanism of ether cleavage by HI (Zeisel's method). **Epoxides:** Synthesis of epoxides, orientation of epoxide ring opening. Chemical reactions o epoxides with alcohols and $LiAlH_4$.
Unit-4 Carbonyl Compounds Structure, relative reactivity and preparation of aldehydes and ketones. Nucleophilic additio of HCN, RMgX to carbonyls. Mechanisms of Aldol condensation, Cannizzaro reactions Baeyer-Villiger oxidation of ketones, Clemmensen reduction, and Perkin reaction.

Text and Reference Books

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Course Outcomes (COs)

After completing the course, students will be able to:

CO1	Describe the basic concepts of organic functional groups.
CO2	Classify the alcohol, preparation, properties and relative reactivity of 1^0, 2^0, 3^0 alcohols.
CO3	Draw the different reaction mechanisms like aldol, Cannizaro and haloform etc.
CO4	Compare the SN2 and SN1 reactions.
CO5	Evaluate the reactions of epoxides with alcohols.
CO6	Design the synthesis of carboxylic acid and its derivatives.

BHC302: Thermodynamics and Chemical Equilibria	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12 Marks Teachers Assessment – 6 Marks Attendance – 12 Marks III Semester Exam – 70 marks

Course Objectives:

1. To give an overview of chemical thermodynamics.
2. To describe the Laws of Thermodynamics.
3. To explain the Le Chatelier principle.
4. To explain the solutions and colligative properties.
5. To explain about nuclear binding energy.

Detailed Syllabus

Unit-1 Chemical Thermodynamics

Definition of thermodynamic terms: system and surroundings; open, closed and isolated systems; intensive and extensive properties; state and path functions**.** **Zeroth law** o thermodynamics. **First law:** Concept of heat (q), work (w), internal energy (U) and statemen of first law; enthalpy (H), heat capacity, C_p and C_v. **Second Law:** Concept of entropy thermodynamic scale of temperature, statement of the second law of thermodynamics Calculation of entropy change for reversible and irreversible processes.

Unit-2 Electrochemistry

Kohlrausch law, Arrhenius theory of electrolytic dissociation, Ostwald's dilution law sal hydrolysis, buffer solutions, mechanism of buffer action, definition of p^H and $p^K a$, determinatio of p^H using hydrogen, indicators and theory of acid-base indicators. Migration of ions: transpor number and its determination by Hittorf's method.

Unit-3 Chemical Equilibrium

Criteria of thermodynamic equilibrium, chemical equilibria in ideal gases, concept of fugacity Law of mass action, relationships between K_p, K_c, and K_x. Le Chatelier's principle: Effects o temperature, pressure, concentration, and inert gas addition on systems like NH_3. equilibriun between ideal gases and a pure condensed phase.

Unit-4 Solutions and Colligative Properties

Ideal and non-ideal solutions, methods of expressing concentration of solutions, activity and activity coefficients, dilute solution. Colligative properties, Raoult's and Henry's laws and thei applications, relative lowering of vapour pressure, elevation of boiling point, depression o freezing point, Osmosis and Osmotic pressure.

Unit-5 Phase & Ionic Equilibria

Statement and meaning of term-phase, component and degree of freedom, derivation of Gibbs phase rule: $F = C - P + 2$, phase equilibria of a one-component system: water, CO_2 and S system.

Recommended Textbook:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press (2006).
2. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
3. Engel, T. & Reid, P. Thermodynamics, Statistical Thermodynamics, & Kinetics Pearson Education, Inc: New Delhi (2007). McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).

Course Outcomes (COs)

After completing the course, students will be able to:

CO1	Define state and path functions.
CO2	Interpret Concept of entropy and thermodynamic scale of temperature.
CO3	Estimate transference number and its determination.
CO4	Analyze the outline of equilibrium between ideal gases and a pure condensed phase
CO5	Evaluate the Elevation of boiling point, Depression of freezing point
CO6	Classify the problems of Radioactive elements

BHM301: Probability Theory & Statistics	
Teaching Scheme	**Examination Scheme**
Lectures:3hrs/Week	Class Test-12Marks
Tutorials:1hr/Week	Teachers Assessment-6Marks Attendance– 12Marks
Credits:4	End Semester Exam–70marks

Course Objectives:

The primary objective of this course is to:

1. Make the student familiar with permutation and combination.
2. Understand the concept of probability and probability distribution
3. To study the basics of statistics, measure central tendency and dispersion.
4. Develop statistical methods for correlation, regression analysis.
5. Understand the principles of probability distribution.

Unit I	**Permutation and Combinations & Probability** Permutation, properties of permutation, combination, properties of combination relation between permutation and combination, Random experiment, outcomes sample space, events, types of event, probability, types of probability, Additive law of probability, Conditional probability, Multiplications law of probability, dependen and independent events, total probability, Baye's theorem
Unit II	**Random variables & Probability Distribution** Definition of random variables. Cumulative distribution function (c.d.f.) of a random variable. Discrete and Continuous random variables. Probability mass functior (p.m.f.) and Probability density function (p.d.f.) of a random variable.
Unit III	**Measures of Central Tendency**: Mean, Median, Mode, Geometric Mean and Harmonic Mean Properties with Merits and Demerits
Unit IV	Dispersion, measurement of dispersion, Absolute and Relative Measures Range Mean deviation, Quartile, Quartile devition, Quartile range, Standard deviation Deciles, Percentiles, moments, central moments, measures of Skewness and Kurtosis of a probability distribution
Unit V	**Bivariate data**: Moment generating function (m.g.f.), its properties and uniqueness, Markov and Chebyshev inequalities, and their applications; Bivariate data: Scatter diagram, covariance, Spearman's rank correlation.

Textbooks:

1. Devore, Jay L., Probability and Statistics for Engineering and Science, Cengage Learning India Private Limited, Delhi
2. Mood, A. M., Graybill, F. A. Boes, D.C., Introduction to the Theory of Statistics, Tata McGraw-Hill Pub. Co. Ltd.

Reference Books:

1. B. S. Grewal: “Higher Engineering Mathematics”, Khanna publishers,44th Ed.2018.
2. Guptha, S.C & Kapoor, V.K., Fundamentals of Mathematical Statistics, *Sultan Chand & Sons, New Delhi*
3. Guptha ,C.B and Vijay Guptha, Introduction to Statistical Methods, Vikas Publishing house
4. S.C. Gupta and V.K. Kapoor - Fundamentals of Mathematical Statistics- 12th ed.- Sultan Chand & Sons- New Delhi- 2020.
5. P. Mukhopadhyay.- Mathematical Statistics-3rd ed.- Books and Allied (P) Ltd-Kolkata2018.
6. B.L. Agarwal - Basic Statistics- 6th ed.- New Age International Publication-2015.
7. V.K. Rohatgi and E. Saleh - An Introduction to Probability and Statistics- 3rd ed.-John Wiley & Sons Inc.- New Jersey- 2015.

Course Outcomes:

At the end of the course, the student will be able to:

1. Elucidate the basic principles of statistics
2. Apply the correlation and regression analysis to engineering problem
3. Apply the principles of probability to thermodynamic problems
4. Calculate measures of Skewness and Kurtosis
5. Explain Markov and Chebyshev inequalities, and their applications

BHM302- Differential Equations	
Teaching Scheme	**Examination Scheme**
Lectures:3hrs/Week	ClassTest-12Marks
Tutorials:1hr/Week	TeachersAssessment-6 Marks Attendance– 12Marks
Credits:4	EndSemesterExam–70marks

Course Objectives:

1. Develop a thorough understanding of ordinary differential equations and their applications.
2. Introduce techniques for solving first-order and higher-order differential equations.
3. Familiarize students with linear differential equations and various analytical solution methods.
4. Introduce the fundamentals of partial differential equations and methods of solution.
5. Classify second-order partial differential equations and understand their significance.

Detailed Syllabus

UNIT 1	**Introduction to Ordinary Differential Equations:** Basic theory of linear differentia equations, solutions of differential equations, linear dependence and independenc of solutions, Wronskian and its properties, existence and uniqueness of solution (introductory concepts).
UNIT 2	**First-Order Differential Equations**: First-order differential equations including exac differential equations, integrating factors, methods for determining integrating factors first-order higher-degree differential equations solvable for x, y and p and Clairaut' differential equation.
UNIT 3	**Higher-Order Differential Equations:** Methods for solving higher-order ordinar differential equations, reduction of order, linear homogeneous differential equation with constant coefficients, linear non-homogeneous differential equations wit constant coefficients, complementary function, particular integral, and the method o variation of parameters.
UNIT 4	**First-Order Partial Differential Equations**: Introduction to partial differentia equations, order and degree of partial differential equations, linear and nonlinea partial differential equations, formation of first-order partial differential equations, an solution of first-order linear partial differential equations using Lagrange's method.
UNIT 5	**Second-Order Partial Differential Equations:** Classification of second-order partia differential equations into elliptic, parabolic, and hyperbolic types, together wit illustrative examples and introductory applications of these equations in physical an engineering problems.

Textbooks:

1. Shepley L. Ross, *Differential Equations*, 3rd Edition, Wiley India Pvt. Ltd., New Delhi, 2007.
2. William E. Boyce and Richard C. DiPrima, *Elementary Differential Equations and Boundary Value Problems*, 10th Edition, John Wiley & Sons, 2012.

3. George F. Simmons, *Differential Equations with Applications and Historical Notes*, 2nd Edition, McGraw-Hill Education, 1991.
4. Earl A. Coddington, *An Introduction to Ordinary Differential Equations*, Dover Publications, New York, 1989.

Reference Books:

1. Dennis G. Zill, A First Course in Differential Equations with Modeling Applications, 11th Edition, Cengage Learning, Boston, 2018.
2. Martin Braun, Differential Equations and Their Applications, 4th Edition, Springer-Verlag, New York, 1993.
3. Morris Tenenbaum and Harry Pollard, Ordinary Differential Equations, Dover Publications, New York, 1985.
4. E. A. Coddington and Norman Levinson, Theory of Ordinary Differential Equations, McGraw-Hill Book Company, New York, 1955.
5. Ian Sneddon, Elements of Partial Differential Equations, Dover Publications, New York, 2006.
6. Fritz John, Partial Differential Equations, 4th Edition, Springer-Verlag, New York, 1982.
7. Stanley J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, New York, 1993.
8. Peter J. Olver, Introduction to Partial Differential Equations, Springer International Publishing, Cham, 2014.

Course Outcomes:

At the end of the course, the student should be able to:

1. Explain the basic concepts, existence, uniqueness, and properties of linear differential equations.
2. Solve first-order differential equations using exact equations, integrating factors, and higher-degree methods.
3. Solve higher-order linear differential equations with constant coefficients using complementary function, particular integral, and variation of parameters.
4. Formulate and solve first-order partial differential equations using Lagrange's method.
5. Classify second-order partial differential equations into elliptic, parabolic, and hyperbolic types and interpret their mathematical significance.

BHP351: Thermal Physics 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 conducting experiments related to thermal radiation, thermal conductivity, resistance, and heat measurement.
2. **Familiarize students with experimental techniques** for determining important thermal and physical constants.
3. **Develop skills in data analysis**, including measurement, calculations, error estimation, and interpretation of experimental results.

List of Experiments:

Student has to perform any five of the following experiments:

1. To verify Stefan's law of radiation and to determine the value of Stefan's constant.
2. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
3. To determine the coefficient of thermal conductivity of copper by Searle's apparatus.
4. To determine the temperature coefficient of resistance of the given material using a platinum resistance thermometer (PRT).
5. To determine the mechanical equivalent of heat (J) using Joule's calorimeter.
6. To determine the mechanical equivalent of heat (J) by Callender and Barnes' method.

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.	Apply experimental methods to verify Stefan's law and determine Stefan's constant.
CO2.	Determine the thermal conductivity of good and bad conductors using standard methods.

CO3.	Determine the temperature coefficient of resistance using a platinum resistance thermometer.
CO4.	Determine the mechanical equivalent of heat using calorimetric methods.
CO5.	Analyse experimental data using appropriate calculations and error estimation techniques.
CO6.	Interpret experimental results in terms of fundamental principles of thermal physics.

BHC351: Synthesis in Chemistry Lab	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hrs/Week	External marks- 35
Credits: 2	Internal marks- 15

Course Objectives:

1. To Master Synthetic Techniques.
2. To Understand Reaction Mechanics.
3. To Develop Instrument Proficiency.
4. To Foster Analytical Skills.
5. To Prioritize Chemical Safety

Detailed Syllabus

LIST OF EXPERIMENTS

Part A: Organic Synthesis & Derivatives

1. Acetylation of an Amine

- Experiment: Synthesis of Acetanilide from Aniline.
- Techniques Covered: Nucleophilic acyl substitution, refluxing, cold crystallization and vacuum filtration.

2. Aromatic Electrophilic Substitution (Nitration)

- Experiment: Synthesis of *p*-Nitro acetanilide from Acetanilide.
- Techniques Covered: Nitrating mixture preparation, temperature maintenance (exothermic reaction management), and recrystallization using ethanol.

3. Oxidation Reactions

- Experiment: Synthesis of Benzoic Acid from Benzyl Alcohol or Benzaldehyde.
- Techniques Covered: Use of alkaline $KMnO_4$, acidification, and precipitation protocols.

4. Halogenation of Aromatic Rings (Bromination)

- Experiment: Synthesis of 2,4,6-Tribromophenol from Phenol.
- Techniques Covered: In-situ halogenation, filtration, and drying of crystalline solids

5. Condensation Reactions (Aldol Condensation)

- Experiment: Synthesis of Dibenzalacetone from Benzaldehyde and Acetone.
- Techniques Covered: Base-catalyzed carbon-carbon bond formation, washing with water/alcohol, and calculating percentage yield.

6. Diazotization and Dye Synthesis

- Experiment: Synthesis of Methyl Orange or Fluorescein.
- Techniques Covered: Low-temperature salt formulation (0°C to 5°C maintenance) coupling reactions, and salting-out techniques

Part B: Inorganic & Coordination Complex Synthesis

7. Synthesis of Coordination Compounds (Iron Complex)

- Experiment: Preparation of Potassium Trioxalatoferrate(III), $K_3[Fe(C_2O_4)_3]3H_2O$.
- Techniques Covered: Coordination of bidentate ligands, crystal growth, and protection of light-sensitive complexes.

8. Synthesis of Double Salts

- Experiment: Preparation of Mohr's Salt (Ferrous Ammonium Sulfate) or Potash Alum.
- Techniques Covered: Stoichiometric dissolution in minimal warm acid, slow cooling for macro-crystal formulation.

9. Synthesis of Copper Complexes

- Experiment: Preparation of Tetraamminecopper(II) Sulfate, $[Cu(NH_3)4]SO_4.H_2O$.
- Techniques Covered: Ligand displacement, precipitation via solvent polarity variation (adding ethanol to an aqueous solution).

10. Synthesis of Green Nickel Complexes

- Experiment: Preparation of Hexaamminenickel(II) Chloride, $[Ni(NH_3)_6]Cl_2$.
- Techniques Covered: Gas/liquid phase reactions using concentrated ammonia and product recovery via suction filtration.

Part C: Industrial Polymers & Advanced Characterization

11. Thermosetting Resins Synthesis

- Experiment: Synthesis of Phenol-Formaldehyde Resin (Bakelite Stage A / Novolac)
- Techniques Covered: Acid or base-catalyzed polymerization, step-growth mechanism tracking, and handling viscous polymers.

12. Characterization and Thin Layer Chromatography (TLC)

- Experiment: Chromatographic Separation and RF evaluation of synthesized organic products (e.g., separating aniline from acetanilide).
- Techniques Covered: Stationary/Mobile phase selection, spotting capillary technique, and UV/Iodine chamber visualization.

Course Outcomes (COs)

After completing the course, students will be able to:

CO1	Execute Advanced Synthesis
CO2	Apply Purification Protocols.
CO3	Conduct Purity Assessments.
CO4	Perform Quantitative Analysis.

Paper	Code	Subject	L	T	P	MSM	ESM	Total	Credits
Lab-9	BHM351	Aptitude and Reasoning	0	0	4	15	35	50	2

[Course objectives, detailed syllabus, text/reference books and course outcomes to be provided by the concerned Board of Studies.]

BHP401: Digital Electronics	
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 digital number systems, binary codes, Boolean algebra, and logic gates.
2. **Familiarize students with the design and operation** of combinational and sequential digital circuits.
3. **Develop problem-solving skills** using Boolean simplification and Karnaugh maps for designing and analysing digital logic circuits.

Detailed Syllabus:

Unit-1: Number System
Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and inter conversion.
Binary Codes: ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation. Binary Addition and Binary Subtraction using 1's & 2's compliment, Multiplication and Division.

Unit-2: Logic Gates and Circuits
Truth Table, Symbolic Representation and Properties of OR, AND, NOT, NOR, NAND, EX-OR & EX-NOR Gates. Implementation of OR, AND & NOT gates (realization using diodes & transistors). De Morgan's theorems. NOR & NAND gates as Universal Gates. Application of EX-OR & EX-NOR gates as parity checker. Boolean Algebra. Karnaugh Map.

Unit-3: Combinational Circuits
Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor. Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders.

Unit-4: Sequential Circuits:
SR, JK & D Flip-Flops, Shift Register (transfer operation of Flip-Flops), and Asynchronous & Synchronous counters.

Text Books:

1. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e

2. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e

3. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e
4. M. Morris Mano and Michal D. Ciletti, Digital Design (4^th^ Edition), Pearson
5. Donald P Leach & A.P. Malvino, Digital Principles and Applications, Glencoe (1995)
6. A. Anand Kumar, Fundamentals of Digital Circuits, Prentice Hall India (2004)
7. HertbertTaub and Donald L Schilling, Digital Integrated Electronics, McGraw Hil

Course Outcomes:

After completing the course, students will be able to:

CO1.	Convert and perform arithmetic operations in different number systems and explain common binary coding schemes.
CO2.	Explain and analyse the operation of basic logic gates, Boolean algebra, De Morgan's theorems, and universal gates.
CO3.	Simplify Boolean expressions using Karnaugh maps and design basic logic circuits.
CO4.	Analyse and design combinational circuits such as adders, subtractors, multiplexers, demultiplexers, encoders, and decoders.
CO5.	Explain and analyse the operation of SR, JK, and D flip-flops and their applications in digital systems.
CO6.	Analyse the working principles of shift registers and synchronous and asynchronous counters.

BHP402: Modern 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 special relativity and quantum mechanics**, including relativistic effects, wave-particle duality, and the origins of quantum theory.
2. **Familiarize students with atomic physics and X-ray phenomena**, including atomic spectra, Bohr's model, X-ray production, and Bragg's law.
3. **Introduce the principles and applications of modern optical technologies**, including lasers, optical fibers, and holography.

Detailed Syllabus:

Unit-1:- Theory of Relativity
Frame of reference, Inertial and non-inertial frames, Galilean transformation, Michelson-Morley experiment, Postulates of special theory of relativity, Lorentz transformations, Length contraction, Time dilation, Relativistic momentum and energy, Mass-energy equivalence.

Unit-2:-Origin of Quantum Mechanics
Blackbody radiation, Planck's quantum hypothesis, Photoelectric effect, Compton effect, De Broglie hypothesis, Wave-particle duality, Heisenberg uncertainty principle, Schrödinger wave equation (time-independent), Physical interpretation o f wave function.

Unit-3:- Atomic Physics and X-Rays
Bohr's theory of hydrogen atom, atomic spectra, Franck-Hertz Experiment, Correspondence Principle, X- ray production, Continuous and Characteristic X-rays, Bragg's law and applications.

Unit-4:- **Lasers, Fiber Optics and Holography**
In troduction to Lasers, Population inversion, Pumping, Optical resonato r, Einstein's A and B coefficients, Principles and applications of lasers, Optical fiber: Numerical aperture, Acceptance angle, Types of optical fibers, Signal attenuation and dispersion, Principle of holography, Construction, reconstruction, and applications of holography.

Textbooks:

1. Arthur Beiser, **Concepts of Modern Physics,** McGraw-Hill Education.
2. S.H. Patil, **Elements of Modern Physics**, McGraw-Hill Education.

Reference Books:

1. Kenneth S. Krane, **Modern Physics**, John Wiley & Sons.
2. R. Murugeshan & Kiruthiga Sivaprasath, **Modern Physics**, S. Chand Publishing

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

CO1.	**Recall** the fundamental concepts and principles of special relativity, quantum theory, atomic physics, X-rays, lasers, optical fibers, and holography.
CO2.	**Explain** the basic principles of Lorentz transformations, quantum phenomena, atomic models, X-ray production, laser action, optical fiber communication, and holography.
CO3.	**Apply** the principles of relativity, quantum mechanics, atomic physics, and optical technologies to solve basic numerical and conceptual problems.
CO4.	**Analyse** relativistic effects, quantum phenomena, atomic spectra, X-ray diffraction, laser operation, and optical fiber characteristics using appropriate physical principles.
CO5.	**Evaluate** physical phenomena and technological systems based on the principles of modern physics, lasers, optical fibers, and holography.
CO6.	**Design and develop** conceptual models or solutions based on the principles of modern physics and their applications in emerging scientific and technological areas.

BHC401: Advanced Inorganic Chemistry	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
	Attendance – 12 Marks
Credits: 4	IV Semester Exam – 70 marks

Course Objectives:

1. To give knowledge of s and p block elements.
2. To describe the noble gases.
3. To explain about VBT and MOT.
4. To explain about inorganic polymers.
5. To describe silicones.

Unit-1 Chemistry of S and P Block Elements:

Periodic trends: Electronic configuration, atomic and ionic radii, ionization enthalpy, hydratio enthalpy, and oxidation states electronegativity, and electron gain enthalpy. Inert pair effect Relative stability of different oxidation states, diagonal relationship and anomalous behaviou of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification- ionic, covalent and interstitial. Basi beryllium acetate and nitrate. Study of the following compounds with emphasis on structure bonding, preparation, properties and uses: Boric acid and borates, boron nitrides borohydrides (diborane), carboranes and graphitic compounds, silanes, oxides and oxoacid of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds polyhalide ions, pseudohalogens and basic properties of halogens.

Unit-2 Noble Gases :

Occurrence & uses, rationalization of inertness of noble gases, Clathrates. Preparation properties, hybridization, shapes, and geometry (VSEPR theory) of : **Fluorides:** (XeF) (Linear), $(XeF)_4$ (Square Planar), $(XeF)_6$ (Distorted Octahedral) ; **Oxides & Oxyfluorides** $(XeO)_3$ (Pyramidal), $(XeOF)_4$ (Square Pyramidal). Valence bond treatment and MO treatmen for XeF_2.

Unit-3 Inorganic Polymers:

Types of inorganic polymers, comparison with organic polymers. Synthesis, structura bonding and applications of silicones and siloxanes, borazines, silicates, phosphazenes, an polysulphates.

Text and Reference Books

1. Greenwood, N.N. and Earnshaw, Chemistry of the Elements, Butterworth-Heinemann. 1997.
2. Lee, J.D. Concise Inorganic Chemistry, ELBS (1991).
3. Canham, G.R. and Overton, T., Descriptive Inorganic Chemistry, Freeman &Co.2006
4. Cotton, F.A. and Wilkinson, G, Advanced Inorganic Chemistry, Wiley, VCH, 1999.

Course Outcomes (COs)

After completing the course, students will be able to:

CO1	Explain the relative stability of different oxidation states.
CO2	State that hydrides and their classification ionic, covalent and interstitial.
CO3	Describe the oxides and oxoacids of nitrogen, Phosphorus and chlorine.
CO4	Preparation and properties of XeF_2 and XeF_4, XeF_6.
CO5	Briefly describe the types of inorganic polymers, comparison with organic polymers

BHC402: Heterocyclic and Polycyclic Chemistry	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12 Marks Teachers Assessment -6 Marks Attendance – 12 Marks IV Semester Exam – 70 marks

Course Objectives:

1. To give knowledge of nitrogen Containing Functional Groups
2. To describe the effect of substituents and solvents on basicity.
3. To explain polynuclear hydrocarbons.
4. To explain classification and nomenclature of heterocyclic compounds.
5. To explain about alkaloids.

Detailed Syllabus

Unit-1 Nitrogen Containing Functional Groups Systematic nomenclature, preparation and important reactions of nitro compounds ($-NO_2$) nitriles (-CN) and isonitriles (-NC). **Amines ($-RNH_2$):** Effect of substituents and solvents on basicity; preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction Distinction between 1^0, 2^0 and 3^0 amines with Hinsberg reagent and nitrous acid ($-HNO_2$) Diazonium Salts $Ar-N_2^+X^-$: Preparation and their applications.
Unit-2 Polynuclear Hydrocarbons Classification, structural types, nomenclature and aromaticity of polynuclear hydrocarbons Synthesis and chemical reactions of naphthalene, anthracene, phenanthrene, and biphenyl
Unit-3 Heterocyclic Compounds Classification, nomenclature and aromatic characteristics of 5-numbered and 6 membered rings containing one heteroatom. Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine. Structure elucidation of indole (Fischer indole synthesis and Madelung synthesis). Structure elucidation of quinoline and isoquinoline (Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis Doebner-Miller synthesis. Derivatives of furan: Furfural and furoic acid.

Unit4- Alkaloid Classification, Isolation, & General Properties. Natural occurrences and their physiological action Hoffmann's exhaustive methylation, Emde degradation. Structural elucidation and synthesis of Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

Text and Reference Books

1. Organic Chemistry (8th edition) written by Paula Yurkanis Bruice.
2. Kalsi, P. S. Textbook of Organic Chemistry (1st Ed.), New Age International (P) Ltd.
3. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt.Ltd. (Pearson Education).
4. Organic Chemistry Natural Products O.P. Agarwal (Vol-1&2)

Course Outcomes (COs)

After completing the course, students will be able to:

CO1	Define or describe all concepts of substituents and solvents on basicity.
CO2	Understand the reactions and mechanism of Furan, Pyrrole.
CO3	To Learn the of naphthalene and anthracene.
CO4	Focus on natural occurrence, Isolation and physiological action of alkaloid.
CO5	Judge the significance of Hoffmann’s exhaustive methylation

BHM401- Integral Transforms	
Teaching Scheme Lectures:3hrs/Week Tutorials:1hr/Week Credits:4	**Examination Scheme** ClassTest-12Marks TeachersAssessment-6 Marks Attendance– 12Marks EndSemesterExam–70marks

Course Objectives:

1. Introduce the theory and properties of Laplace transforms.
2. Develop skills in solving differential equations using Laplace transforms.
3. Understand Fourier series and their convergence properties.
4. Learn finite and infinite Fourier transforms and their applications.
5. Apply integral transform techniques in solving mathematical and engineering problems.

Detailed Syllabus

UNIT 1	**Introduction to Laplace Transforms:** Definition and existence theorem of the Laplace transform, linearity property, basic properties of Laplace transforms, and Laplace transforms of elementary functions.
UNIT 2	**Properties of Laplace Transforms**: Laplace transforms of derivatives and integrals of functions, convolution theorem, inverse Laplace transforms, and properties of inverse transforms.
UNIT 3	**Applications of Laplace Transforms:** Applications of Laplace transforms to the solution of ordinary differential equations, including initial value problems and practical applications in mathematics, science, and engineering.
UNIT 4	**Fourier Series**: Fourier series, Fourier expansion of periodic and piecewise monotonic functions, convergence of Fourier series, half-range expansions, and full-range expansions.
UNIT 5	**Fourier Transforms:** Finite and infinite Fourier transforms, Fourier integral representation, properties of Fourier transforms, and applications of Fourier transform techniques in solving mathematical, physical, and engineering problems.

Text Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, Hoboken, 2011.
2. Joel L. Schiff, The Laplace Transform: Theory and Applications, Springer, New York, 1999.
3. R. V. Churchill and James Ward Brown, Fourier Series and Boundary Value Problems, 8th Edition, McGraw-Hill Education, New York, 2011.
4. Murray R. Spiegel, Laplace Transforms, Schaum's Outline Series, McGraw-Hill Education, New York, 1965.

Reference Books:

1. Lokenath Debnath and Dambaru Bhatta, Integral Transforms and Their Applications, 3rd Edition, CRC Press, Boca Raton, 2015.
2. David V. Widder, The Laplace Transform, Princeton University Press, Princeton, 1946.

3. Elias M. Stein and Rami Shakarchi, Fourier Analysis: An Introduction, Princeton University Press, Princeton, 2003.
4. Ronald N. Bracewell, The Fourier Transform and Its Applications, 3rd Edition, McGraw-Hill Education, New York, 2000.
5. Brian Davies, Integral Transforms and Their Applications, 3rd Edition, Springer, New York, 2002.
6. A. D. Poularikas (Ed.), The Transforms and Applications Handbook, 3rd Edition, CRC Press, Boca Raton, 2010.
7. Murray R. Spiegel, Fourier Analysis, Schaum's Outline Series, McGraw-Hill Education, New York, 1974.
8. Ian N. Sneddon, The Use of Integral Transforms, McGraw-Hill Book Company, New York, 1972.

Course Outcomes:

At the end of the course, the student should be able to:

1. Compute Laplace transforms and inverse Laplace transforms of elementary functions.
2. Apply Laplace transform techniques to solve ordinary differential equations.
3. Construct Fourier series for periodic functions and determine half-range and full-range expansions.
4. Evaluate finite and infinite Fourier transforms and apply Fourier integral representations.
5. Apply integral transform methods to solve practical problems arising in mathematics, physics, and engineering.

BHM402: Numerical Analysis	
Teaching Scheme	**Examination Scheme**
Lectures:3hrs/Week Tutorials:1hr/Week Credits:4	ClassTest-12Marks Teachers Assessment-6 Marks Attendance-12Marks End SemesterExam–70marks

Note: Scientific calculator non-programmable will be allowed during the examination.

Course Objectives:

The course is designed to teach:

1. To understand about fundamental concepts of finite differences and interpolation techniques.
2. To develop skills in applying central and divided difference formulas for unevenly spaced data.
3. To equip students with numerical tools for differentiation, integration, and solving ordinary differential equations.

4. To learn about numerical tools for differentiation, integration, and solving ordinary differential equations.
5. To learn about effective methods for solving transcendental, polynomial, and linear algebraic equations.

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Detailed Syllabus

UNIT 1	**Roots of Equations**: Solution of transcendental and polynomial equations using Iteration, Bisection, Regula-Falsi, and Newton-Raphson methods.
UNIT 2	**Finite Differences & Interpolation**: Shift operator, forward and backward difference operators, and their relationships. Interpolation techniques, Newton-Gregory's forward and backward interpolation formulae.
UNIT 3	**Divided Differences & Numerical linear algebra:** Divided differences and Newton's divided difference formula. Lagrange's interpolation formula. Central differences and formulae based on central differences: Gauss' and Stirling's formulae. Triangular Matrices, LU Decomposition, Simultaneous linear equations: Jacobi iteration method, Gauss-Seidel method and Crout's triangularization method.
UNIT 4	**Numerical Differentiation & Integration**: Numerical differentiation methods. Numerical integration , General quadrature formula, Trapezoidal rule, Simpson's 1/3 and Simpson's 3/8 rules, Weddle's rule, and Newton-Cotes formula

UNIT 5	**Numerical solution of ODEs:** Numerical solution of first-order differential equations: Taylor’s series method, Picard's method, Euler's method, Runge-Kutta (RK) method, and Milne's predictor-corrector method.

Textbooks & Reference Books:

1. Sastry, S. S., Introductory Methods of Numerical Analysis, PHI Learning.
2. Jain, M. K., Iyengar, S. R. K., & Jain, R. K., Numerical Methods for Scientific and Engineering Computation, New Age International.
3. Burden, R. L., & Faires, J. D., Numerical Analysis, Cengage Learning.
4. Scarborough, J. B., Numerical Mathematical Analysis, Oxford and IBH Publishing.
5. Conte, S. D., & de Boor, C., Elementary Numerical Analysis: An Algorithmic Approach, McGraw-Hill.

Course Outcomes:

At the end of the course, the student should be able to:

1. Understand and establish relationships between different difference operators to solve polynomial interpolation problems with equally spaced intervals.
2. Apply Newton's divided difference, Lagrange’s, Gauss', and Stirling's formulae to interpolate functions at unevenly spaced data points.
3. Perform numerical differentiation and integration using classic quadrature rules like Trapezoidal, Simpson's, and Weddle's formulas.
4. Find approximate solutions for first-order ordinary differential equations and simultaneous difference equations using iterative numerical schemes.
5. Locate real roots of transcendental/polynomial equations and solve dense systems of linear equations using direct and iterative algebraic methods.

BHP451: Semiconductor 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 studying the characteristics and applications of semiconductor devices, transistors, diodes, and timer circuits.
2. **Familiarize students with digital logic circuits** through the design and verification of logic gates, adders, subtractors, flip-flops, counters, and registers.
3. **Develop experimental and analytical skills** in circuit construction, measurement, data analysis, and interpretation of electronic circuit behaviour.

List of Experiments:

Student has to perform any eight of the following experiments:

1. To study the characteristics of a Field Effect Transistor (FET).
2. To study the characteristics of a MOSFET.
3. To study the characteristics of a photodiode.
4. To determine the Boltzmann constant using the forward characteristics of a p-n junction diode.
5. To study the truth tables of logic gates (AND, OR, NOT, NAND, NOR, EX-OR).
6. To verify NAND and NOR gates as universal gates.
7. To design and verify a half adder and a full adder using logic gates.
8. To design and verify a half subtractor and a full subtractor using logic gates.
9. To design and study an SR flip-flop.
10. To design and study a JK flip-flop.
11. To design a counter using flip-flops.
12. To design a register using flip-flops.
13. To study an astable multivibrator using a 555 timer IC.
14. To study the charging and discharging of a capacitor through a resistor.

Text Books:

1. Geeta Sanon, B.Sc. Practical Physics, 1st Edition (2007), R. Chand & Co.
2. D. Leach, A. Malvino and Goutam Saha, Digital Principles and Applications, McGraw Hill.

Reference Books:

1. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
2. S. K. Ghosh, Digital Electronics Practice using Integrated Circuits, Tata McGraw-Hill.

Course Outcomes:

After completing the course, students will be able to:

1. Set up circuits and plot the characteristics of FETs, MOSFETs and photodiodes.
2. Determine physical constants such as the Boltzmann constant from diode characteristics.
3. Design, wire and test basic combinational logic circuits such as adders and subtractors.
4. Design and test sequential circuits such as flip-flops, counters and registers.
5. Diagnose and correct faults in semiconductor and digital circuit set-ups.
6. Analyse experimental data and estimate the associated errors.

CO1.	**Recall** the basic principles and characteristics of semiconductor devices, logic gates, flip-flops, counters, registers, and timer circuits.
CO2.	**Explain** the working principles of FETs, MOSFETs, photodiodes, logic gates, flip-flops, multivibrators, and RC circuits based on experimental observations.
CO3.	**Apply** experimental techniques to determine device parameters and construct basic digital and electronic circuits.
CO4.	**Analyze** the characteristics and performance of semiconductor devices and the operation of combinational and sequential digital circuits.
CO5.	**Evaluate** experimental results and circuit performance using appropriate measurements, calculations, and error analysis.
CO6.	**Design and develop** functional electronic and digital circuits, including adders, subtractors, counters, registers, flip-flops, and multivibrators, using suitable components.

BHC451: Instrumentation in Chemistry Lab	
Teaching Scheme Practicals: 2 hrs/Week Credits: 2	**Examination Scheme** External marks- 35 Internal marks- 15

Course Objectives:

1. To Introduce Analytical Instrumentation.
2. To Develop Operational Skills.
3. To Master Quantitative Data Analysis.
4. To Teach Modern Separation Techniques.

Detailed Syllabus

Part A: Optical & Spectroscopic Methods

1. Determination of λ_{max} and Verification of Beer-Lambert Law

- Experiment: Find the wavelength of maximum absorption λ_{max} for a Potassiun Permanganate ($KMnO_4$ or Copper Sulfate ($CuSO_4$) solution and verify the Beer Lambert law.
- Instrumentation Skills: Calibration of a UV-Visible Spectrophotometer, baseline correction, and plotting concentration vs. absorbance.

2. Spectrophotometric Quantitative Estimation

- Experiment: Quantitative estimation of Iron(III) in a given sample using 1,10 phenanthroline as a complexing agent.
- Instrumentation Skills: Chromogenic reaction handling, preparing a standard calibration curve, and determination of unknown concentration.

3. Multi-Component Simultaneous Estimation

- Experiment: Simultaneous determination of Caffeine and Benzoic acid in a soft drink or the simultaneous estimation of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.
- Instrumentation Skills: Resolution of overlapping spectra and applying matrix equations for multi-component analysis.

4. Flame Photometry

- Experiment: Determination of Sodium (Na^+) and Potassium (K^+) ions in a water/soil sample using a Flame Photometer.
- Instrumentation Skills: Handling fuel-oxidant regulators, standard addition method, and maintaining atomizer aspiration rates.

Part B: Electroanalytical Methods

5. pH-Metric Titrations

- Experiment: Determination of the strength of a given strong acid (HCl) and weak acid (CH_3COOH) in a mixture by titrating against a standard sodium hydroxide (NaOH) solution using a digital pH meter.
- Instrumentation Skills: Two-point calibration of glass electrodes and detecting inflection points via first/second derivative plots.

6. Potentiometric Redox Titration

- Experiment: Titration of a Ferrous Ammonium Sulfate (Mohr's salt) solution with standard Potassium Dichromate ($K_2Cr_2O_7$) using a Potentiometer.
- Instrumentation Skills**:** Handling Platinum indicator electrodes and Calomel reference electrodes, and monitoring potential changes (mV).

7. Conductometric Precipitation Titration

- Experiment: Estimation of Baryta (Ba^{2+} ions) by titrating a solution of Barium Chloride ($BaCl_2$) against Sodium Sulfate (Na_2SO_4) using a digital Conductometer.
- Instrumentation Skills: Operating a conductivity cell, measuring cell constant, and mapping precise equivalence nodes via intersecting conductance slopes.

8. Conductometric Acid-Base Mixtures

- Experiment: Quantitative estimation of a mixture of a strong acid (HCl) and a weak acid (CH_3COOH) using standard NaOH conductometrically.
- Instrumentation Skills: Recognizing distinctive shifts in structural mobility between H^+ ions, weak electrolytes, and excess hydroxyl ions.

Part C: Separation & Chromatographic Techniques

9. Thin Layer Chromatography (TLC) Purity Analysis

- Experiment: Separation and calculation of R_f values of active pharmaceutical components (e.g., Aspirin, Ibuprofen, or Paracetamol) in an analgesic tablet.
- Instrumentation Skills: TLC plate preparation/activation, capillary spotting technique, mobile phase choice, and visualization under a UV chamber.

10. Quantitative Column Chromatography

- Experiment: Separation and structural isolation of plant pigments (Chlorophylls and Carotenoids) from spinach leaves using column chromatography.
- Instrumentation Skills**:** Packing a stationary phase column (Silica/Alumina), monitoring elution rates, and fraction collecting.

11. High-Performance Liquid Chromatography (HPLC) Demonstration

- Experiment: Separation and quantitative determination of components in an analgesic mixture or soft drink using a standard HPLC setup.
- Instrumentation Skills: Sample micro-filtration, degasification routines, mobile phase delivery regulation, and reading peak retention indices (t_R).

12. Nephelo-Turbidimetry

- Experiment: Determination of Sulphate (SO_4^{2-}) or Chloride (Cl^-) ions in a municipal water sample using a Turbidimeter.
- Instrumentation Skills: Formation of uniform colloidal suspensions ($BaSO_4$ precipitates) and measuring scattered light intensity at a 90° angle.

Course Outcomes (COs)

After completing the course, students will be able to:

CO1	Operate Electroanalytical Instruments.
CO2	Execute Chromatographic Separations.
CO3	Apply Optical Spectroscopy.
CO4	Analyze and Validate Experimental Data.

BHM451: Numerical Analysis Lab	
Teaching Scheme	**Examination Scheme**
Lectures: 2 hrs/Week	External marks- 35
	Internal marks- 15
Credits:2	

Course Objectives:

The course is designed to teach:

1. To use computer-aided software (like MATLAB, Mathematica, or Maxima) for mathematical programming.
2. To find equation roots by coding iterative methods (such as Bisection or Newton-Raphson)
3. To design simple algorithms to solve problems
4. To understand the MATLAB environment.
5. To get basic knowledge about simple numerical computations and analyses using MATLAB.

Detailed Syllabus

UNIT 1	Use of computer aided software (CAS), for example Matlab/ Mathematica/ Maple/ Maxima etc., for developing the following Numerical programs (i) Any two of the following (a) Bisection Method (b) Regula- Falsi Method (c) Secant Method (d) Newton- Raphson Method
UNIT 2	(ii) Lagrange Interpolation or Newton Interpolation (iii) LU decomposition Method (iv) Gauss-Jacobi Method (v) Gauss-Siedel Method
UNIT 3	(vi) Trapezoidel Rule (vii) Simpson' 1/3 rule. (viii) Simpson' 3/8 rule.

Course Outcomes:

At the end of the course, the student should be able to:
1. Comfortably write, debug, and execute numerical analysis programs on standard CAS software.
2. Solve complex non-linear equations efficiently using their own coded root-finding algorithms.
3. Successfully solve large systems of linear equations using programmed matrix methods.
4. Construct approximation polynomials programmatically to fit and predict data points.
5. Compute definite integrals computationally using Trapezoidal, Simpson’s 1/3, and Simpson’s 3/8 programs.