GURU KASHI UNIVERSITY

Bachelor of Science in Non-Medical (BNM)

Session: 2025-26

Faculty of Sciences, Humanities and Languages

Graduate Attributes of the Programme: -

Type of learning outcomes	**The Learning Outcomes Descriptors**
Graduates should be able to demonstrate the acquisition of:	
Learning outcomes that are specific to disciplinary/interdisciplinary areas of learning	Develop a deep understanding of fundamental principles in classical and modern physics, mathematical methods, and chemical sciences.
	Apply mathematical and computational techniques to analyze real-world problems in physics, chemistry, and interdisciplinary areas.
	Gain hands-on experience with laboratory techniques, instrumentation, and scientific methods used in physics, chemistry, and applied mathematics.
	Apply scientific knowledge responsibly, considering sustainability, environmental impact, and ethical aspects of research and technology.
Generic learning outcomes	Interpret statistical and numerical data, use computational tools, and apply mathematical techniques to various domains.
	Develop innovative solutions, explore new ideas, and apply creative thinking to solve scientific and technological challenges.

Programme Learning outcomes: An Undergraduate Certificate is awarded to students who have demonstrated the achievement of the outcomes located at level 4.5:

Element of the Descriptor	**Programme learning outcomes relating to Undergraduate Certificate**
The graduates should be able to demonstrate the acquisition of:	
Knowledge and understanding	Recognize the role of science in societal development, environmental sustainability, and technological progress.
	Demonstrate comprehensive knowledge of fundamental concepts in Physics, Chemistry, and Mathematics, along with their applications in real-world scenarios.
	Understand the interdisciplinary nature of science and its role in advancing technology, industry, and research.
	Explain the principles of experimental and theoretical sciences, including classical and modern physics, advanced mathematical techniques, and chemical processes.
General, technical and professional skills required to perform and accomplish tasks	Gain proficiency in laboratory techniques, including instrumentation, spectroscopy, and experimental analysis in Physics and Chemistry.
	Apply statistical and mathematical methods in scientific research, industrial applications, and data-driven decision-making.
	Apply statistical and mathematical methods in scientific research, industrial applications, and data-driven decision-making.
Application of knowledge and skills	Apply theoretical concepts to design and conduct experiments, analyze data, and draw meaningful conclusions.
Generic learning outcomes	Cultivate self-directed learning and adaptability to keep pace with emerging trends in science and technology.
Constitutional, humanistic, ethical, and moral values	Uphold professional ethics, ensuring safety, accuracy, and responsibility in scientific and industrial activities.

Employability and job-ready skills, and entrepreneurship skills and capabilities/qualities and mindset	Develop technical proficiency for careers in research, industry, data science, and technology-driven fields.
Credit requirements	48 credits
Entry requirements	10+2 (or equivalent) with Physics, Chemistry, and Mathematics as core subjects.

Program Structure

SEMESTER: 1st									
Course Code	**Course Title**	**Type of Courses**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
BNM1100	Mechanics	Core Course	3	0	0	3	25	50	75
BNM1101	Inorganic Chemistry	Core Course	3	0	0	3	25	50	75
BNM1102	Matrix and Co-ordinate Geometry	Core Course	4	0	0	4	30	70	100
BNM1103	Fundamentals of Computers & Office Tools	Skill Enhancement Course	3	0	0	3	25	50	75
BNM1104	Punjab History Culture	Multidisciplinary Course	3	0	0	3	25	50	75
BNM1105	Communication Skills	Ability Enhancement Course	2	0	0	2	15	35	50
VAC0002	Human Values and Professional Ethics	Value Added Course	2	0	0	2	15	35	50
BNM1106	Mechanics Lab	Core Course	0	0	2	1	10	15	25
BNM1107	Inorganic Chemistry Lab	Core Course	0	0	2	1	10	15	25
Elective-I (Any one of the following)									
BNM1108	Condensed Matter Physics	Minor Course	2	0	0	2	15	35	50
BNM1109	Waves & Oscillation								
Total			**22**	**0**	**4**	**24**	**195**	**405**	**600**

SEMESTER: 2nd									
Course Code	**Course Title**	**Type of Courses**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
BNM2150	Electricity & Magnetism	Core Course	4	0	0	4	30	70	100
BNM2151	Physical Chemistry	Core Course	4	0	0	4	30	70	100
BNM2152	Real Analysis	Core Course	4	0	0	4	30	70	100
BNM2153	Data Analysis & Visualization in Science	Skill Enhancement Course	3	0	0	3	25	50	75
BNM2154	Human Resource & Organizational Management	Multidisciplinary Course	3	0	0	3	25	50	75
VAC0001	Environment Education	Value Added Course	2	0	0	2	15	35	50
BNM2155	Electricity & Magnetism Lab	Core Course	0	0	2	1	10	15	25
BNM2156	Physical Chemistry Lab	Core Course	0	0	2	1	10	15	25
Elective-II (Any one of the following)									
BNM2157	Differential Equations	Minor Course	2	0	0	2	15	35	50
BNM2158	Linear Algebra								
Total			**22**	**0**	**4**	**24**	**190**	**410**	**600**

Programme learning outcomes: An Undergraduate Diploma is awarded to students who have demonstrated the achievement of the outcomes located at level 5:

Element of the Descriptor	**Programme learning outcomes relating to Undergraduate Diploma**
The graduates should be able to demonstrate the acquisition of:	
Knowledge and understanding	Demonstrate advanced knowledge in core disciplines of Physics, Chemistry, and Mathematics, with a deeper understanding of their fundamental principles and real-world applications.
	Understand complex scientific theories, mathematical formulations, and chemical processes and their interdisciplinary applications in modern science and technology.
	Develop the ability to critically evaluate scientific literature, research papers, and industrial case studies to expand knowledge horizons.
	Recognize the impact of scientific discoveries on society, environment, and technological advancements, ensuring responsible and sustainable scientific practices.
Skills required to perform and accomplish tasks	Perform advanced laboratory experiments using sophisticated instruments and analyze experimental data with accuracy and precision.
	Demonstrate the ability to collaborate in interdisciplinary research and projects, integrating knowledge from multiple scientific domains.
	Develop scientific writing and communication skills, preparing research reports, technical papers, and project documentation.
Application of knowledge and skills	Implement scientific problem-solving techniques in industrial research, product development, and technological innovation.
Generic learning outcomes	Adapt to new technological advancements and continuous learning to stay updated with emerging trends in science and industry.

Constitutional, humanistic, ethical, and moral values	Recognize the role of science in addressing societal challenges such as climate change, renewable energy, and public health.
Employability and job-ready skills, and entrepreneurship skills and capabilities/qualities and mindset	Foster entrepreneurial thinking, identifying business opportunities in science-based industries and startups.
Credit requirements	92 credits
Entry requirements	Completion of Level 4.5 (Undergraduate Certificate).

SEMESTER: 3rd									
Course Code	**Course Title**	**Type of Courses**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
BNM3200	Thermodynamics & Statistical Physics	Core Course	3	0	0	3	25	50	75
BNM3201	Organic Chemistry	Core Course	3	0	0	3	25	50	75
BNM3202	Complex Analysis	Core Course	4	0	0	4	30	70	100
BNM3203	Experimental Techniques & Lab Safety	Skill Enhancement Course	3	0	0	3	25	50	75
BNM3204	Philosophy of Science & Ethics	Multidisciplinary Course	3	0	0	3	25	50	75
BNM3205	Renewable Energy & Sustainable Technologies	Vocational Course	4	0	0	4	30	70	100
BNM3206	Critical Reading and Analytical Writing	Ability Enhancement Course	2	0	0	2	15	35	50
BNM3207	Thermodynamics & Statistical Physics Lab	Core Course	0	0	2	1	10	15	25
BNM3208	Organic Chemistry Lab	Core Course	0	0	2	1	10	15	25
Total			**22**	**0**	**4**	**24**	**195**	**405**	**600**

SEMESTER: 4th									
Course Code	**Course Title**	**Type of Courses**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
BNM4250	Nuclear and Particle Physics	Core Course	3	0	0	3	25	50	75
BNM4251	Abstract Algebra	Core Course	3	0	0	3	25	50	75
BNM4252	Polymer Chemistry	Core Course	4	0	0	4	30	70	100
BNM4253	Geoinformatics & Remote Sensing	Vocational Course	4	0	0	4	30	70	100
BNM4254	Critical Writing and Communication in Punjabi	Ability Enhancement Course	2	0	0	2	15	35	50
IKS0012	The Outreach of Indian Knowledge System	Value Added Course	2	0	0	2	15	35	50
BNM4255	Nuclear and Particle Physics Lab	Core Course	0	0	2	1	10	15	25
BNM4256	Polymer Chemistry Lab	Core Course	0	0	2	1	10	15	25
Total			**18**	**0**	**4**	**20**	**160**	**340**	**500**

Programme learning outcomes: The Bachelor's degree is awarded to students who have demonstrated the achievement of the outcomes located at level 5.5:

Element of the Descriptor	**Programme learning outcomes relating to Bachelor Degree**
The graduates should be able to demonstrate the acquisition of:	
Knowledge and understanding	Acquire specialized knowledge in Physics, Chemistry, and Mathematics, with deeper insights into advanced theories, methods, and their interdisciplinary connections.
	Analyze complex scientific problems, integrating principles from different disciplines to develop innovative solutions.
	Demonstrate expertise in data-driven research methodologies, including computational modeling, experimental design, and statistical analysis.
	Recognize the role of scientific research in technological advancements, industrial applications, and sustainable development.
General, technical and professional skills required to perform and accomplish tasks	Gain proficiency in experimental research, utilizing advanced laboratory techniques and instrumentation.
	Enhance scientific communication skills, producing high-quality research papers, technical reports, and professional presentations.
	Work effectively in multidisciplinary teams, demonstrating leadership, collaboration, and project management skills.
Application of knowledge and skills	Apply advanced mathematical and scientific principles to develop innovative models for physical and chemical systems.
Generic learning outcomes	Exhibit high-order thinking skills, including critical analysis, logical reasoning, and innovation in scientific problem-solving.
Constitutional, humanistic, ethical, and moral values	Foster global scientific collaboration, respecting diversity and inclusivity in academic and industrial environments.
Employability and job-ready skills, and entrepreneurship skills and	Develop entrepreneurial acumen, identifying opportunities for innovation and startup ventures in science and technology.

capabilities/qualities and mindset	
Credit requirements	136 credits
Entry requirements	Completion of Level 5 (Undergraduate Diploma).

SEMESTER: 5th									
Course Code	**Course Title**	**Type of Courses**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
BNM5300	Spectroscopy	Core Course	3	0	0	3	25	50	75
BNM5301	Organic Synthesis	Core Course	3	0	0	3	25	50	75
BNM5302	Calculus	Core Course	4	0	0	4	30	70	100
BNM5303	Mathematical Optimization & Operations Research	Vocational Course	4	0	0	4	25	50	75
IKS0013	Mathematics in the Vedas and Sulva Sutras	Value Added Course	2	0	0	2	15	35	50
BNM5304	Spectroscopy Lab	Core Course	0	0	2	1	10	15	25
BNM5305	Organic Synthesis Lab	Core Course	0	0	2	1	10	15	25
BNM5306	Internship	Skill Based	0	0	0	4	30	70	100
Elective-III (Any one of the following)									
BNM5307	Chemical Energetics, Equilibria & Functional Group Organic Chemistry	Minor Course	2	0	0	2	15	35	50
BNM5308	Analytical Methods in Chemistry								
Total			**18**	**0**	**4**	**24**	**185**	**390**	**575**

SEMESTER: 6th									
Course Code	**Course Title**	**Type of Courses**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
BNM6350	Quantum Mechanics	Core Course	3	0	0	3	25	50	75
BNM6351	Quantum Chemistry & Spectroscopy	Core Course	3	0	0	3	25	50	75
BNM6352	Analytical Geometry and Vector Analysis	Core Course	4	0	0	4	30	70	100
BNM6353	Food Chemistry & Quality Control	Vocational Course	4	0	0	4	30	70	100
BNM6354	Digital Communication and Media Literacy	Ability Enhancement Course	2	0	0	2	15	35	50
BNM6355	Quantum Mechanics Lab	Core Course	0	0	2	1	10	15	25
BNM6356	Quantum Chemistry & Spectroscopy Lab	Core Course	0	0	2	1	10	15	25
Elective-IV (Any one of the following)									
BNM6357	Electronics	Minor Course	2	0	0	2	15	35	50
BNM6358	Radiation Physics								
Total			**19**	**0**	**4**	**21**	**160**	**340**	**500**

Grand Total	**121**	**0**	**24**	**137**	**1085**	**2290**	**3375**

SEMESTER – I

Course Title: Mechanics	L	T	P	Cr.
Course Code: MPY1101	3	0	0	3

Total Hours: 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Define the various coordinate systems, its applications, Michelson Morley experiment, Einstein's postulates of theory of relativity
2. Demonstrate the fundamental forces of nature, concept of center mass, central forces and the motion of particle under central force and to determine the turning points of orbit.
3. Determine the phenomena of collisions and idea about center of mass and laboratory frames and their correlation
4. Derive the frames of reference, Coriolis forces and its applications and effect of rotation of earth on gravity.

Course Content

UNIT -I **10 Hours**

Dynamics of Rigid Body: Cartesian and spherical polar co–ordinate systems, area, volume, velocity and Acceleration in these systems. Equation of motion of a rigid body, moment of inertia, radius of gyration, theorems of parallel and perpendicular axes, Principle Axes and Euler's equations, moments of inertia of a ring, disc, rectangular beam, hollow and solid cylinder.

UNIT -II **12 Hours**

Inverse Square Law Forces: Central forces, Equation of motion under central force, Force between a Point Mass and Spherical shell. Force between a Point Mass and Solid Sphere; Orbits, equation of orbit, turning points, eccentricity. Two-body problem - reduced mass, Kepler Laws.

UNIT -III **13 Hours**

Relativity: Inertial frame of reference. Galilean transformation. Effect of rotation of earth on 'g'. Foucault's pendulum and its equation of motion. Fictitious Forces, Velocity and Acceleration in Rotating coordinate systems. Michelson-Morley Experiment, Basic postulates of special relativity, Lorentz transformations. Length contraction, Time dilation, Twin Paradox, Variation of mass with velocity.

UNIT -IV **10 Hours**

Elastic and Inelastic Scattering: Types of Scattering and conservation laws, Laboratory and centre of mass system equivalent one body problem. Elastic collision in Lab. and C.M. systems, velocities, angles, and energies, cross section of elastic scattering, Rutherford scattering.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem analysis.

SUGGESTED READINGS:-

- *Berkeley, Mechanics, Volume. I, C. Kittle.*
- *Daniel Kleppner& Robert J. Kolenkow, An Introduction to Machines Tata McGraw-Hill.*
- *R.G. Takwale & P.S. Puranik, Introduction of Classical Mechanics Tata McGraw-Hill.*
- *R.H. Good, Basic Concepts of Relativity, East-West Press, New Delhi.*
- *S.P. Puri, Special Theory of Relativity, Asia Publishing House, Bombay.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Course Title: Inorganic Chemistry	L	T	P	Cr.
Course Code: BNM1102	3	0	0	3

Total Hours: 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Predict geometries and shapes of various molecules.
2. Analyze electron gain enthalpy, trends of electron gain enthalpy
3. Differentiate between ionic and covalent bonds.
4. Evaluate the physical and electronic properties of solid-state materials.

Course Content

UNIT-I **12 Hours**

Atomic Structure: Idea of de Broglie matter waves, Heisenberg uncertainity principle, atomic orbitals, shapes of s, p, d orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements and ions.

Chemical Periodicity: Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. Ionization enthalpy, Successive ionization enthalpies, Electron gain enthalpy and its trend in periodic table.

UNIT-II **11 Hours**

Chemistry of Noble gases: Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.

Chemical Bonding – I: Covalent Bond-Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. BeF_2 , BF_3, CH_4, PF_5, SF_6, IF_7, $Sncl_2$, BF_4, PF_6-, $SnCl_6$.

UNIT-III **11 Hours**

Chemical Bonding – II: Covalent Bond: Valence shell electron pair repulsion (VSEPR) theory to NH_3, H3O+, SF_4, CIF_3, ICI^-_2,H_2O and ICI^+_2, MO theory, homonuclear (elements and ions of 1st and 2nd row), diatomic molecules, multicenter bonding in electron deficient molecule (Boranes) percentage ionic character from dipole moment and electronegativity difference.

UNIT-IV **11 Hours**

Ionic Solids:- Concept of close packing, Ionic structures, (NaCl type, Zinc blende, Wurzite, CaF2, and antifluorite), radius ratio rule and coordination number, Limitation of radius ratio rule, efficiency of packing lattice defects, semiconductors, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rule. Metallic bond-free electron, valence bond and bond theories.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

SUGGESTED READINGS:-

- *Lee, J.D. Concise (1991).Inorganic Chemistry, ELBS.*
- *Atkins, P.W. & Paula, J., (2016) Physical Chemistry, Oxford Press, 2006.*
- *Day, M.C. and Selbin, J., (2015) Theoretical Inorganic Chemistry, ACS Publications.*
- *J.E. Huheey, E.A. Keiter, R.L. Keiter, (1999) Inorganic Chemistry, Pearson Education, Singapore.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Course Title: Matrices and Coordinate Geometry	L	T	P	Cr.
Course Code: BNM1103	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Grasp the basics of Matrices and coordinate geometry including applied aspect for enhancing quantitative skills and pursuing higher mathematics and research as well.
2. Develop a wide-ranging application of the subject and enlarge the knowledge of matrices for solving linear homogeneous and non-homogeneous system of equations.
3. Equip themselves with necessary analytic and technical skills by applying the principles of geometry.
4. Acquire the standard concepts and tools at an intermediate to advance level of geometrical techniques.

Course Content

UNIT I **18 hours**

Matrix introduction, matrix operations with their properties, symmetric, skew-symmetric, Hermitian and skew- Hermitian matrices, idempotent, nilpotent, involuntary, orthogonal and unitary matrices, singular and non-singular matrices, elementary operations on matrices, adjoint and inverse of a matrix, singular and non-singular matrices, Trace of a matrix.

UNIT II **15 hours**

Rank of a matrix, elementary transformations of a matrix, elementary matrices, rank of the sum and product of two matrices, inverse of a non-singular matrix through elementary row transformations, equivalence of matrices.

Solutions of a system of linear equations, condition of consistency and nature of the general solution of a system of linear non homogeneous equations.

UNIT III **15 hours**

Circle: General equation of circle, circle through intersection of two lines, Tangents and Normals, Chord of contact, pole and polar, pair of tangents from a point, equation of chord in terms of midpoint, angle of intersection and orthogonality

Parabola: General equation of Parabola, Properties of Parabola, parametric representation of Parabola, tangents, normal

UNIT IV **12 hours**

Ellipse: Properties of ellipse, parametric representation of ellipse, tangents and normals. **Hyperbola:** Properties of hyperbola, parametric representation of hyperbola, asymptotes of hyperbola, Conjugate hyperbola, tangents and normals.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS:-

- *Hari Kishan, (2008), A Textbook of Matrices, Atlantic Publishers.*
- *Fuzhen Zhang, (1999), Matrix Theory- Basic Results and Techniques, Springer.*
- *Shanti Narayan, P.K. Mittal, (2010), A Textbook of Matrices, S Chand & Company.*
- *T.M. Apostal, (1974),Vol. I, John Wiley & Sons Inc.*
- *Ajit Kumar and S. Kumaresan, (2019), A Basic Course in Real Analysis, CRC Press.*
- *S. Balachandra Rao & C. K. Shantha, (1992), Differential Calculus, New Age Publication.*
- *H. Anton, I. Birens and S. Davis, (2007), Calculus, John Wiley and Sons, Inc.*
- *G.B. Thomas and R.L. Finney, (2010), Calculus, Pearson Education.*
- *P.K. Jain and Khalil Ahmad: A Text Book of Analytical Geometry of two Dimensions, Wiley Eastern Ltd. 1994.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Fundamentals of Computers and Office Tools	L	T	P	Cr.
Course Code: BNM1104	3	0	0	3

Total Hours: 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand the fundamental components and functions of computer hardware and software.
2. Develop and analyze data using spreadsheet tools.
3. Design and deliver effective presentations with multimedia support.
4. Practice file management, data security, and troubleshooting techniques.

Course Content

UNIT I **12 Hours**

Introduction to Computers: Hardware vs. software, Basic computer architecture (CPU, memory, storage, input/output devices). Operating systems: functions and common interfaces (Windows, macOS, Linux), Introduction to computer networks and internet basics

UNIT II **10 Hours**

Word Processing Tools: Introduction to Microsoft Word, Document creation: text formatting, styles, and templates, Inserting and formatting graphics and tables, reviewing, editing, and collaboration features

UNIT III **13 Hours**

Spreadsheets and Data Management: Basics of spreadsheet applications :Microsoft Excel, Data entry, formatting, and basic formulas. Use of functions, data sorting, and filtering. Introduction to charts and data visualization. Creating a budget sheet or data analysis worksheet with charts

UNIT IV **10 Hours**

Presentation and Communication Tools: Introduction to Microsoft PowerPoint, Slide design principles: layout, color schemes, and multimedia integration. Incorporating transitions, animations, and speaker notes. Basics of email communication and calendar management. Designing a complete presentation and exploring communication tools (email, calendar).

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS:

- *Becker, R. A., & McKnight, D. L. (2020). Fundamentals of computers (6th ed.). Pearson.*
- *Norton, P. (2017). Introduction to computers (8th ed.). McGraw-Hill Education.*
- *Nordell, R. (2021). Microsoft Office 365 – In practice (2021 edition). McGraw-Hill.*
- *Shelly, G. B., & Vermaat, M. E. (2018). Discovering computers: Fundamentals (10th ed.). Cengage Learning.*

Course Title: Punjab History and Culture	L	T	P	Cr.
Course Code: BNM1105	3	0	0	3

Total Hours: 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand the historical development of Punjab from ancient to modern times.
2. Analyze the impact of various dynasties and movements on Punjab's society and culture.
3. Appreciate the role of Punjab in shaping India's religious and socio-political landscape.
4. Explore the evolution of Punjabi language, literature, and traditions.

Course Content

UNIT-I **12 Hours**

Ancient Punjab : Geographical significance of Punjab, Indus Valley Civilization and Harappan culture in Punjab, Vedic Age and early tribal settlements, Religious developments: Buddhism and Jainism in Punjab.

UNIT-II **13 Hours**

Medieval Punjab: Guru Nanak Dev Ji and Sikh Gurus, Sikh religious, social, and cultural reforms, Punjab under the Mughals: Relationship with Sikh Gurus, Banda Singh Bahadur and Sikh resistance.

UNIT-III **10 Hours**

Modern Punjab – Colonial Rule and Independence Movement: Rise of Maharaja Ranjit Singh and the Sikh Empire, Anglo-Sikh Wars and British annexation of Punjab, Role of Punjab in India's freedom struggle, Partition of 1947 and its impact on Punjab.

UNIT-IV **10 Hours**

Contemporary Punjab: Development of Punjabi language and literature, Punjabi folk culture: Bhangra, Gidda, and folk tales, Religious diversity and major festivals of Punjab, Punjab in post-independence India: Economic, social, and political developments.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

Suggested Readings:

- *Grewal, J. S. (1998). The Sikhs of the Punjab (2nd ed.). Cambridge University Press.*
- *Singh, K. (2004). A history of the Sikhs (Vol. 1 & 2). Oxford University Press.*
- *Singh, Fauja. (1972). History of Punjab (Vol. 1, 2, & 3). Punjabi University, Patiala.*
- *McLeod, W. H. (2009). Sikhism and history. Oxford University Press.*
- *Oberoi, H. (1994). The construction of religious boundaries: Culture, identity, and diversity in the Sikh tradition. University of Chicago Press.*

Course Title: Communication Skills	L	T	P	Cr.
Course Code: BNM1106	2	0	0	2

Total Hours: 15

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Demonstrate effective communication skills in listening, speaking, reading, and writing (LSRW) through practical exercises and interactions.
2. Participate confidently in group discussions, public speaking, and everyday conversations using appropriate verbal and non-verbal cues.
3. Construct well-structured sentences and paragraphs, and summarize or précis texts effectively for academic and professional purposes.
4. Interpret and utilize body language, eye contact, gestures, and facial expressions in social and professional communication.

Course Content

UNIT I **6 Hours**

Fundamentals of Communication: Communication: Definition, Process, Importance, and Types (Verbal & Non-verbal) of communication. Barriers to Communication and strategies to overcome them. Effective Communication Skills: Listening, Speaking, Reading, Writing (LSRW).

UNIT II **6 Hours**

Speaking & Listening Skills**:** Pronunciation, Stress, and Intonation in English. Speaking Skills: Introducing oneself, everyday conversations, group discussions, and public speaking**.** Listening Skills: Active listening techniques, note-taking, and comprehension exercises.

UNIT III **6 Hours**

Writing & Reading Skills: Sentence structure, paragraph writing, précis writing, and summarization. Formal & Informal Writing: Emails, reports, applications, and letter writing. Reading Skills: Skimming, scanning, and understanding the gist of passages.

UNIT IV **6 Hours**

Professional & Social Communication**:** Body language, gestures, eye contact, and facial expressions. Soft Skills for Career Development: Teamwork,

Leadership, and Conflict Resolution. Presentation Skills: Preparing and delivering effective presentations.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS:

- *Lesikar, R. V., & Flatley, M. E. (2008). Basic business communication: Skills for empowering the internet generation (11th ed.). Tata McGraw-Hill.*
- *Mohan, K., & Raman, M. (2010). Effective communication (2nd ed.). Tata McGraw-Hill.*
- *Murphy, R. (2019). English grammar in use (5th ed.). Cambridge University Press.*
- *Wren, P. C., & Martin, H. (2023). High school English grammar & composition. S. Chand Publishing.*

Course Title: Human Values and Professional Ethics	L	T	P	Cr.
Course Code: VAC0002	2	0	0	2

Total Hours: 30

Course Learning Outcomes: After completion of this course, the learner will be able to:

1. Understand the essence of Indian ethos, cultural values and ethical principles derived from scriptures, integrating self-exploration with scientific inquiry.
2. Analyze human values, self-awareness and ethical decision-making by distinguishing between perspectives, ideologies and universal moral principles.
3. Evaluate constitutional values, global responsibilities and the role of ethics in citizenship while promoting inclusivity and social welfare.
4. Develop essential life skills, stress management techniques and holistic well-being through mindfulness, self-discipline and personality development.

Course Content

Unit-I **7 Hours**

Introduction to Indian Ethos: Meaning of ethos and cultural essence of India, Scriptures as the base of the Indian Knowledge System (IKS), Integrating the two methodologies: interiorization process for self-exploration and exterior scientifc pursuit for the prosperity of world, The Law of Karma and Nishkama Karma (The Law of action and selfless action), Practical: Five hours of Yoga practice per week, Ethics through Music and Indian Poetry, Community Engagement

Unit-II **8 Hours**

Human Values and Ethics: Knowing the Self and the universal values that we stand for. This is self-enquiry & self-discovery, Background conversations and deep listening, recognizing the assumptions that we make, the biases we have and the implications for ethical action. Self-identity: distinguishing and embracing oneself (and others) four profiles (inner potential, social, professional, personality), Distinguish ideology, perspectives beliefs from embodying values. Practical: Self discovery, self enquiry and Mindfulness, Yama & Niyama of Ashthang Yoga

Unit-III **7 Hours**

Constitutional Values, Global Responsibility & Skills for Youth: Values embedded in the Preamble of the Indian Constitution, Integration of Human

Rights and duties. Principles and responsibilities: as citizens of India, towards global environment, Loksangraha and Vasudhaiva Kutumbakam, Conscious Full Spectrum Response model. Distinguishing judgement from discernment, Practical: Development of concentration among students through music, fine arts, mathematics, sports, yoga and mindfulness

Unit-IV **8 Hours**

Integrated Personality and Well-being : The three gunas (qualities of sattva—purity and harmony, rajas —activity and passion, tamas —darkness and chaos), the four antah-karanas (inner instruments) and panch kosha (five sheaths), Stress management, Oneness, non-duality and equanimity, Physical, mental, social and spiritual well-being. Practical: Talks on importance of the Ayurvedic concept of well-being and nutrition, sports activities.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS:

- *Mahadevan, B., Bhat, V.R. and Nagendra, P.R.N. 2022. Introduction to Indian Knowledge System. Delhi: PHI.*
- *Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.*
- *Kashyap, Subhash C. 2019. Constitution of India. A handbook for students. New Delhi: National Book Trust.*
- *https://www.holy-bhagavad-gita.org/*
- *https://iksindia.org/*
- *NPTEL Course: Exploring Human Values: Visions of Happiness and Perfect Society*
- *https://ebooks.inflibnet.ac.in/hrmp01/*

Course Title: Mechanics Lab	L	T	P	Cr.
Course Code: BNM1107	0	0	2	1

Total Hours: 15

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Demonstrate conceptual understanding of fundamental physics principles.
2. Communicate physics reasoning in oral and in written form.
3. Solve physics problems use qualitative and quantitative reasoning including sophisticated mathematical techniques.
4. Use experimental, conceptual and theoretical methods

Course Content

List of Practical's:

1. Measurements of length (or diameter) using Vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the motion of the spring and calculate (a) Spring constant and, (b) g.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine g and velocity for a freely falling body using Digital Timing Technique.
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille s method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater s Pendulum.

Note: Each student is required to perform at least ten experiments.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, E-team teaching, Group discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS:-

- *G. L. Squires, Practical Physics ,Cambridge University Press.*
- *Napier Shaw and Richard Glazebrook, Practical Physics, Nabu Press.*
- *C.L. Arora ,(2010), Practical Physics, S. Chand &Co.*
- *R.S. Sirohi,(2012), Practical Physics, WileyEastern.*

Course Title: Inorganic Chemistry Lab	L	T	P	Cr.
Course Code: BNM1108	0	0	2	1

Total Hours: 15

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Perform experimental practice of quantitative volumetric analysis.
2. Develop laboratory skills in analyzing samples of different solutions.
3. Determine of the concentration or the mass of the minimum formula from the titrated chemical material composing a pure liquid or a solution.
4. Learn the main objective of volumetric analysis to determine the concentration of a substance in a given sample.

Course Content

List of Practical's:

(A) Titrimetric Analysis

(i) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants.

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents.

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe(II) with K2Cr2O7 using internal (diphenylamine, anthranilic acid) and external indicator.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz,Open talk, Case analysis.

SUGGESTED READINGS:-

- *Vogel, A.I. (2018) A Textbook of Quantitative Inorganic Analysis, ELBS.*

- *Marr. G and Rocket, B. W. (1999) B. W. Practical Inorganic Chemistry, University Science Books. Lee, J.D. Concise (1991).Inorganic Chemistry, ELBS.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Condensed Matter Physics	L	T	P	Cr.
Course Code: BNM1109	2	0	0	2

Total Hours: 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. List the crystal structures in one, two and three dimensional and structures of bravais lattices.
2. Define the different techniques and methods for crystal structure analysis and to find out the packing fractions of different structures.
3. Describe the interior of the substances using X-ray diffraction in crystals and reciprocals of SC, BCC and FCC.
4. Test theoretical basis of experimental material science and technology, structures of diamond and NaCl.
5. Solve problems of Crystal planes, Miller indices, Laue equations and Brillouin zones.

Course Content

UNIT I **8 Hours**

Crystal structure: General definitions of Lattice, basis and primitive cell, Symmetry operations for a two dimensional crystal. Bravais lattices in two and three dimensions, Index system for crystal planes, Structure of common lattice types (scc, fcc, bcc, hcp, diamond, NaCl, CsCl&Zns structures). Reciprocal Lattice, Brillouin zones, atomic form factor, structure factor of simple structures.

UNIT II **7 Hours**

Lattice Vibrations : Dynamics of monatomic and diatomic linear chains, optical and acoustic modes, concept of phonons, inelastic scattering of photons and neutrons by phonons, density of states (one & Three dimensions) Einstein and Debye models of heat capacity, thermal expansion.

UNIT III **7 Hours**

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

UNIT IV **8 Hours**

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability Langevin-Debye equation. Complex Dielectric Constant.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis

SUGGESTED READINGS:-

- *C. Kittel(2003), Introduction to Solid State Physics (Wiley Eastern).*
- *M.L. Cohen and S. Louie, Fundamentals of Condensed Matter Physics,*
- *B. D. Cullity, Magnetism and Magnetic Materials, Wiley-IEEE Press.*
- *Chaikin and Lubensky ,Principles of Condensed Matter Physics, Cambridge University Press.*
- *S.H. Patil (1985), Elements of Modern Physics TMGH.*
- *Puri and Babbar(1998), Solid State Physics, MGH Co.*
- *Suggested digital platform: NPTEL/ SWAYAM/ MOOCs*

Course Title: Waves & Oscillations	L	T	P	Cr.
Course Code: BNM1110	2	0	0	2

Total Hours 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Demonstrate the different types of the waves and their nature, electromagnetic waves & its spectrum.
2. Differentiate periodic motions & simple harmonic motions with examples like Torsion pendulum, Compound Pendulum, Damped Simple harmonic motion, Electrical Oscillations.
3. Solve for the solutions and describe the behavior of a damped and driven harmonic oscillator in both time and frequency domains.
4. Deliver the general equation of wave motion in general and TM waves in stretched strings and longitudinal waves in gases.

Course Content

UNIT I **8 Hours**

Simple Harmonic Oscillations: Simple harmonic motion, Equation of SHM, Differential equation and solution of SHM. Applications of SHO: Compound pendulum, Electrical Oscillations, Torsion Pendulum, Transverse Vibrations of a mass on a string, composition of two perpendicular SHMs of same period.

UNIT II **7 Hours**

Damped Harmonic Oscillations: Decay of free Vibrations due to damping, types of damping, Determination of damping coefficients – Logarithmic decrement, relaxation time and Q-factor. Electromagnetic damping.

UNIT III **7 Hours**

Forced Harmonic Oscillations: A forced oscillator, Transient and Steady State Oscillations, velocity versus driving force frequency, Resonance, power supplied to forced oscillator by the driving force. Q-factor of a forced oscillator.

UNIT IV **8 Hours**

Waves in Physical Media: Types of waves, Transverse and longitudinal waves, wave length, period, angular frequency, Wave motion in one dimension, Transverse waves on a string, longitudinal waves on a rod.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis

SUGGESTED READINGS:-

- *S.P. Puri,, (2005), Text Book of Vibrations and Waves, Macmillan India Ltd.*
- *H.J. Pain, ELBS & John Wiley,(2012), Physics of Vibrations and Waves, London.*
- *Edward C. Jordan and K.G. Balmain,(2013), EM Waves and Radiating Systems, Prentice Hall.*
- *A.P. French,(2008), Vibrations and Waves, Arnold Heinemann India, New Delhi.*
- *P.K. Ghosh,(2018), The Mathematics of Waves and Vibrations, McMillan India.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Semester-II

Course Title: Electricity and Magnetism	L	T	P	Cr.
Course Code: BNM2151	3	0	0	3

Total Hours 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.
2. Apply the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions and magnetic energy density.
3. Analyze different problems in electromagnetism using mathematical methods involving vectors and simple differential and integral calculus, both analytically and numerically
4. Have a rudimentary grasp on how experimental equipment related to electricity and magnetism can be used.

Course Content

UNIT I **15 Hours**

Vector calculus : Basic ideas of Vector Calculus, Scalar & vector fields, Gradient of a vector field, Line, Surface and Volume integrals of a vector and their physical significance, Flux of a vector field, combination of grad, div & curl, Gradient, Divergence, curl and their physical significance, Stroke's theorem, Gauss's divergence theorem.

UNIT II **15 Hours**

Electrostatics : Coulomb's Law for point charges and continuous distribution of charges, electric field due to dipole, line charge, ring and sheet of charge. Electric field lines, Gauss's Law and its differential form.

UNIT III **15 Hours**

Electric Potential: Potential as line integral of field, potential difference, Gradient of a scalar function, Derivation of the field from the potential, potential of a charge distribution, uniformly charged disc. Force on a surface charge, energy associated with an electric field, Gauss's theorem and differential form of Gauss's law, Laplacian and Laplace's equation, Poisson's equation.

UNIT IV **15 Hours**

Magnetostatics: Brief overview of Magnetic fields and forces, magnetic force on a current carrying wire. Torque on a current loop, Biot-Savart law .Field due to infinite wire carrying steady current, field of rings and coils. Magnetic field due to a solenoid, Force on parallel current carrying wires. Ampere's circuital law and its applications to infinite hollow cylinder, solenoid and toroid. Magnetic vector potential and its expression.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis

SUGGESTED READINGS:-

- *Arthur F. Kipp, Fundamentals of Electricity and Magnetism, Tata McGraw Hill.*
- *E.M. Purcell, Electricity and Magnetism, Berkeley Physics Course, Vol. II*
- *David Griffith, Introduction to Classical Electrodynamics, Prentice Hall.*
- *A.S. Mahajan& A.A. Rangwala, Electricity & Magnetism, Tata McGraw Hill.*
- *W.J. Duffin, Electricity & Magnetism, 4th Edition, Tata McGraw Hill.*
- *Edward C. Jordan and K. G. Balmain, EM Waves and Radiating Systems, Prentice Hall.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Course Title: Physical Chemistry	L	T	P	Cr.
Course Code: BNM2152	3	0	0	3

Total Hours: 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Recognize the different states of matter.
2. Differentiate the real and ideal gases on the basis of states of matter.
3. Demonstrate the kinetic properties of gases and its practical usage in day to day life.
4. Evaluate the states of matter necessary for industrial purposes.

Course Content

UNIT-I **12 Hours**

Gaseous state: Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, Maxwell distribution and its use in evaluating molecular velocities and average kinetic energy.

UNIT II **11 Hours**

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Reasons of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, Isotherms of real gases and their comparison with van der Waals isotherms, and van der Waals constants, law of corresponding states.

UNIT III **11 Hours**

Liquid state: Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity, Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases, Qualitative discussion of structure of water.

UNIT IV **11 Hours**

Solid state: Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

SUGGESTED READINGS:-

- *Peter Atkins, P., & De Paula, J. (2014). Atkins' physical chemistry. OUP Oxford.*
- *Martin, W. R., Davidson, A. S., & Ball, D. W. (2016). Journal of Chemical Education.*
- *Ball, D. W. (2007). Physical Chemistry Thomson Press, India.*
- *Castellan, G. W. (2004 Physical Chemistry 4th Ed. Narosa).*
- *Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Course Title: Real Analysis	L	T	P	Cr.
Course Code: BNM2153	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
2. Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence, comparison test, Cauchy's root Test, ratio Test, Rabbe's of an infinite series of real numbers.
3. Equipped with the knowledge of improper integrals, and their convergences, convergence and uniform convergence of sequences and series of functions for further applications in the relevant fields.
4. Utilize the analytic and technical skills necessarily at practical field and analyse the real analysis for further higher studies.

Course Content

UNIT I **15 hours**

Continuity and Differentiability of functions: Continuity of functions, Uniform continuity, Differentiability, Taylor's theorem with various forms of remainders. Integration: Riemann integral-definition and properties, inerrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus.

UNIT II **15 hours**

Sequence and Series: Sequences, theorems on limit of sequences, Cauchy's convergence criterion, infinite series, series of non-negative terms, Absolute convergence, tests for convergence, comparison test, Cauchy's root Test, ratio Test, Rabbe's Logarithmic test, De Morgan's Test, Alternating series, Leibnitz's theorem.

UNIT III **15 hours**

Improper Integrals: Improper integrals and their convergence, Comparison test, Dritchlet's test, Absolute and uniform convergence, Weierstrass M-Test, Infinite integral depending on a parameter.

UNIT IV **15 hours**

Uniform Convergence: Point wise convergence, Uniform convergence, Test of uniform convergence, Weierstrass M-Test, Abel's and Dritchlet's test, Convergence and uniform convergence of sequences and series of functions.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Quiz.

Suggested Readings:-

- *Walter Rudin, (1976), Principle of Mathematical Analysis (3rd edition) McGraw-Hill Kogakusha, International Student Edition.*
- *Bartle, Robert G., & Sherbert, Donald R. (2015). Introduction to Real Analysis (4th ed.). Wiley India Edition. New Delhi.*
- *T. M. Apostol, (1985), Mathematical Analysis, Narosa Publishing House, New Delhi.*
- *S. C. Malik and Savita Arora, (2012), Mathematical Analysis , New Age International Pvt. (Ltd).*
- *Bilodeau, Gerald G., Thie, Paul R., & Keough, G. E. (2010). An Introduction to Analysis (2nd ed.). Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.*

Course Title: Data Analysis and Visualization in Science	L	T	P	Cr.
Course Code: BNM2154	3	0	0	3

Total Hours: 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Effectively acquire, clean, and preprocess scientific datasets from various sources to ensure data quality and reliability.
2. Apply descriptive and inferential statistical methods to explore and summarize scientific data.
3. Leverage programming skills to implement data analysis workflows and automate processes, facilitating reproducible research and effective data management.
4. Synthesize theoretical and practical knowledge to tackle complex scientific challenges, culminating in project work that applies data analysis and visualization techniques to real-world datasets.

Course Content

UNIT I **12 Hours**

Introduction to Data Analysis in Science: Importance of data analysis in scientific research. Types of scientific data: structured, unstructured, experimental, and observational. Overview of data sources in science: Databases, sensors, simulations, surveys. Introduction to Python for data analysis (NumPy, Pandas, Matplotlib).

UNIT II **10 Hours**

Data Preprocessing and Cleaning: Handling missing data, Data transformation and normalization, Removing outliers, Data integration and aggregation, working with different data formats (CSV, JSON, HDF5). Exploratory Data Analysis: Descriptive statistics (mean, median, standard deviation, correlation).

UNIT III **13 Hours**

Data Visualization Techniques: Fundamentals of visualization (color theory, readability), Data visualization techniques (histograms, scatter plots, box plots),

Visualization libraries in Python (Matplotlib, Seaborn, Plotly), Advanced plots: heatmaps, contour plots, 3D visualizations. Interactive dashboards and real-time visualization

UNIT IV **10 Hours**

Applications & Case Studies in Science: Data analysis in **Physics, Chemistry, and Biology,** Machine learning basics for scientific data, Climate & environmental data analysis, Project-based learning: Working with real-world datasets.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Quiz.

Suggested Readings:-

- *McKinney, W. (2022). Python for data analysis: Data wrangling with pandas, NumPy, and Jupyter (3rd ed.). O'Reilly Media.*
- *VanderPlas, J. (2016). Python data science handbook: Essential tools for working with data. O'Reilly Media.*
- *Beuermann, K., & Wen, J. (2021). Data analysis for the life sciences with R and Python. CRC Press.*
- *Westra, E. (2018). Python interactive data visualization with Bokeh. Packt Publishing.*
- *Grus, J. (2019). Data science from scratch: First principles with Python (2nd ed.). O'Reilly Media.*

Course Title: Human Resource and Organizational Management	L	T	P	Cr.
Course Code: BNM2155	3	0	0	3

Total Hours: 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Analyze the role of HRM in achieving organizational goals.
2. Evaluate organizational behavior theories and apply them to real-world management challenges.
3. Develop effective recruitment, training, and performance management systems.
4. Design compensation, benefits, and employee relations strategies.

Course Content

UNIT I **12 Hours**

Foundations of HRM and Organizational Behavior: Evolution and strategic importance of HRM, HRM versus Personnel Management. **Organizational Behavior Theories:** Motivation, leadership, and team dynamics. Communication patterns and decision-making processes.

UNIT II **10 Hours**

Talent Acquisition, Development, and Performance Management: Workforce planning and job analysis. Recruitment strategies and selection techniques, Designing effective training programs, Career development and succession planning. Appraisal methods and feedback mechanisms

UNIT III **10 Hours**

Employee Relations, Compensation, and Benefits: Conflict resolution and negotiation strategies, Building employee engagement and trust. Salary structures, incentive plans, and benefits administration. Legal frameworks and ethical considerations in pay practices

UNIT IV **13 Hours**

Leadership, Organizational Change, and Culture: Contemporary leadership theories and styles. Developing leadership skills and competencies. Defining and shaping organizational culture, Assessing and modifying cultural elements for strategic fit. Theories and models of organizational change, managing resistance and ensuring successful transformation.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Quiz.

SUGGESTED READINGS:

- *Dessler, G. (2020). Human resource management (16th ed.). Pearson.*
- *Robbins, S. P., & Judge, T. A. (2019). Organizational behavior (18th ed.). Pearson.*
- *Mello, J. A. (2015). Strategic human resource management (5th ed.). Cengage Learning.*
- *Kotter, J. P. (2012). Leading change. Harvard Business Review Press.*
- *Becker, B. E., Huselid, M. A., & Ulrich, D. (2001). The HR scorecard: Linking people, strategy, and performance. Harvard Business Press.*

Course Title: Environment Education	L	T	P	Cr.
Course Code: VAC0001	2	0	0	2

Total Hours: 30

Course Learning Outcomes: After completing all the units, students will learn:

1. Grasp the concept of Environmental Science, its components, types of natural resources, their distribution, and usage, with a focus on India.
2. Discuss the factors impacting biodiversity loss and ecosystem degradation in India and the world.
3. An overview of Contemporary Environmental Issues i.e National and Global efforts to address climate change adaptation and mitigation.
4. To understand environmental laws for monitoring pollution.
5. Principles guiding human responsibility toward the environment.
6. Toxic chemicals and analytical methods for monitoring environmental pollutants.

Course Content

Unit-I. Human – Environment Interaction, Natural Resources, and Sustainable Development **6 Hours**

The man-environment interaction: Humans as hunter-gatherers; Mastery of fire; Origin of agriculture; Emergence of city-states; Great ancient civilizations and the environment, Indic Knowledge and Culture of sustainability; Middle Ages and Renaissance; Industrial revolution and its impact on the environment; Population growth and natural resource exploitation; Global environmental change. Environmental Ethics and emergence of environmentalism: Anthropocentric and eco-centric perspectives (Major thinkers); The Club of Rome- Limits to Growth; UN Conference on Human Environment 1972; World Commission on Environment and Development and Rio Summit. Natural resources: Definition and Classification. Microbes as a resource; Status and challenges. Environmental impact of over-exploitation, issues and challenges; Water scarcity and Conflicts over water. Mineral resources and their exploitation; Environmental problems due to extraction of minerals and use; Soil as a resource and its degradation. Energy resources: Sources and their classification. Implications of energy use on the environment. Introduction to sustainable development: Sustainable Development Goals (SDGs)- targets and indicators, challenges and strategies for SDGs.

Unit-II: Biodiversity Conservation and Environmental Issues **6 Hours**

Biodiversity as a natural resource; Levels and types. Biodiversity in India and the world; Biodiversity hotspots; Species and ecosystem threat categories. Major

ecosystem types in India, their services, classification, significance and characteristics of forests, wetlands, grasslands, agriculture, coastal and marine; Threats to biodiversity and ecosystems: Land use and land cover change; Commercial exploitation of species; Invasive species; Fire, disasters and climate change. Major conservation policies: in-situ and ex-situ approaches; National and International Instruments for biodiversity conservation; the role of traditional knowledge, community-based conservation; Gender and conservation. Environmental issues and scales: micro-, meso-, synoptic and planetary scales; Temporal and spatial extents of local, regional, and global phenomena. Pollution: Types of Pollution- air, noise, water, soil, thermal, radioactive ;municipal solid waste, hazardous waste; transboundary air pollution; acid rain; smog. Land use and Land cover change: land degradation, deforestation, desertification, urbanization. Biodiversity loss: past and current trends, impact. Global change: Ozone layer depletion; Natural Disasters – Natural and Man-made (Anthropogenic).

Unit-III: Environmental Pollution, Health, Climate Change: Impacts, Adaptation and Mitigation **8 Hours**

Definition of pollution; Point and non-point sources. Air pollution: sources, Impacts, Primary and Secondary pollutants; Criteria pollutants- carbon monoxide, lead, nitrogen oxides, ground-level ozone, particulate matter and sulphur dioxide; Other important air pollutants- Volatile Organic compounds (VOCs), Peroxyacetyl Nitrate (PAN), Polycyclic aromatic hydrocarbons (PAHs) and Persistent organic pollutants (POPs); Indoor air pollution; National Ambient Air Quality Standards. Water pollution: Sources; River, lake and marine pollution, groundwater pollution, impacts ; Water quality parameters and standards. Soil pollution: sources and pollutants. Solid and hazardous waste, its impacts. Noise pollution: Definition, Unit of measurement, sources, noise standards; adverse impacts. Thermal and Radioactive pollution: Sources and impacts. Climate change: natural variations in climate due to greenhouse gas emission- past, present & future. Structure of atmosphere. Projections of global climate change with special reference to temperature, rainfall, climate variability and extreme events; Importance of 1.5 °C and 2.0 °C limits to global warming; Climate change projections for the Indian sub-continent. Impacts, vulnerability and adaptation to climate change: Observed impacts of climate change on ocean and land systems; Sea level rise, changes in marine and coastal ecosystems; Impacts on forests, natural ecosystems, animal species, agriculture, health, urban infrastructure; the concept of vulnerability and its assessment; Adaptation vs. resilience; Climate-resilient development; Indigenous knowledge for adaptation to climate change. Mitigation of climate change: Synergies between adaptation and mitigation measures; Green House Gas (GHG) reduction vs. sink enhancement; Concept of carbon intensity, energy intensity and carbon neutrality; National and international policy instruments for

mitigation, decarbonizing pathways and net zero targets for the future; Energy efficiency measures; Carbon capture and storage, National climate action plan and Intended Nationally Determined Contributions (INDCs); Climate justice.

Unit-IV: Environment Management, Treaties and Legislation **10 Hours**

Introduction to environmental laws and regulation: Article 48A, Article 51A (g) and other environmental rights; Introduction to environmental legislations on the forest, wildlife and pollution control. Environmental management system: ISO 14001 Concept of Circular Economy, Life cycle analysis; Cost-benefit analysis Environmental audit and impact assessment; Environmental risk assessment Pollution control and management; Waste Management- Concept of 3R (Reduce, Recycle and Reuse) and sustainability; Ecolabeling /Ecomark scheme. Bilateral and multilateral agreements on international co-operation of instruments; conventions and protocols; binding and nonbinding measures; Conference of the Parties (COP) Major International Environmental Agreements:- Convention on Biological Diversity (CBD); Cartagena Protocol on Biosafety; Nagoya Protocol on Access and Benefit-sharing; Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES); Ramsar Convention on Wetlands of International Importance; United Nations Convention to Combat Desertification (UNCCD); Vienna Convention for the Protection of the Ozone Layer; Montreal Protocol on Substances that Deplete the Ozone Layer and the Kigali Amendment; Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; Stockholm Convention, Minamata Convention, United Nations Framework Convention on Climate Change (UNFCCC); Kyoto Protocol; Paris Agreement; India's status as a party to major conventions Major Indian Environmental Legislations: The Wild Life (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air (Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; The Biological Diversity Act, 2002; The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006; Noise Pollution (Regulation and Control) Rules, 2000; Industry-specific environmental standards; Waste management rules; Ramsar sites; Biosphere reserves; Protected Areas; Ecologically Sensitive Areas; Coastal Regulation Zone; Production and consumption of Ozone Depleting substances, Green Tribunal; Some landmark Supreme Court judgements Major International organisations and initiatives: United Nations Environment Programme (UNEP), International Union for Conservation of Nature (IUCN),World Commission on Environment and Development (WCED), United Nations Educational, Scientific and Cultural Organization (UNESCO), Intergovernmental Panel on Climate Change (IPCC), and Man and the Biosphere (MAB) programme.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Quiz.

SUGGESTED READINGS:

- *Chahal, M. K. (2024). Environmental Science and Hazards Management (Ecology and Risk Management), ISBN:978-93-6440-586-7.*
- *Baskar, S. and Baskar, R. (2009). Natural Disasters (Earth's Processes & Geological Hazards), ISBN: 978-81-7806-168-9.*
- *Tiefenbacher, J (ed.) (2022), Environmental Management - Pollution, Habitat, Ecology, and Sustainability, Intech Open, London. 10.5772/*
- *Kanchi Kohli and Manju Menon (2021) Development of Environment Laws in India, Cambridge University Press.*
- *Bhagwat, Shonil (Editor) (2018) Conservation and Development in India: Reimagining Wilderness, Earthscan Conservation and Development, Routledge.*
- *Manahan, S.E. (2022). Environmental Chemistry (11th ed.). CRC Press. https://doi.org/10.1201/9781003096238.*
- *William P.Cunningham and Mary A. (2015) Cunningham Environmental Science: A Global Concern, Publisher (Mc-Graw Hill, USA)*
- *Central Pollution Control Board Web page for various pollution standards. https://cpcb.nic.in/ standards/*
- *Theodore, M. K. and Theodore, Louis (2021) Introduction to Environmental Management, 2nd Edition. CRC Press.*
- *Ministry of Environment, Forest and Climate Change (2019) A Handbook on International Environment Conventions & Programmes. https://moef.gov.in/wp- content/uploads/2020/02/ convention-V-16-CURVE-web.pdf*

Course Title: Electricity and Magnetism Lab	L	T	P	Cr.
Course Code: BNM2157	0	0	2	1

Total Hours: 15

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Demonstrate conceptual understanding of fundamental physics principles.
2. Communicate physics reasoning in oral and in written form.
3. Solve physics problems use qualitative and quantitative reasoning including sophisticated mathematical techniques.
4. Use experimental, conceptual and theoretical methods

Course Content

1. To study the characteristics of a RC Circuit.
2. To compare capacitances using De Sauty's bridge.
3. Measurement of field strength and its variation in a solenoid.
4. To verify the Thevenin and Norton theorems.
5. To verify the Superposition, and Maximum power transfer theorems.
6. To determine self-inductance of a coil by Anderson's bridge.
7. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q And (d) Band width
8. To study the response curve of a parallel LCR circuit and determine its a Anti resonant frequency and (b) Quality factor Q
9. To determine e/m ratio of electron by long and short solenoid methods.
10. To study C.R.O as display and measuring device by reading sine and square waves.
11. To determine the capacity of a capacitor by discharging through voltmeter.
12. To find the capacity of a capacitor using flashing and quenching of a neon lamp.
13. To determine the intensity of earth's magnetic field using tangent galvanometer.

Note: Each student is required to perform at least ten experiments.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, E-team teaching, Group discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS:

- *G. L. Squires, Practical Physics, Cambridge University Press.*
- *Napier Shaw and Richard Glazebrook, Practical Physics, Nabu Press.*

- *C.L. Arora, Practical Physics, S. Chand &Co.*
- *R.S. Sirohi, Practical Physics, Wiley Eastern.*

Course Title: Physical Chemistry Lab	L	T	P	Cr.
Course Code: BNM2158	0	0	2	1

Total Hours: 15

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Determine Surface tension of different liquids.
2. Prepare Buffer Solution of different pH value.
3. Study the effect of pH on addition of acid and base.
4. Analyze the viscosity of different solutions at different concentration.

Course Content

List of Practical's:

1. Surface tension measurements.

a. Determine the surface tension by (i) drop number (ii) drop weight method.
b. Study the variation of surface tension of detergent solutions with concentration.

1. Viscosity measurement using Ostwald's viscometer.

a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
b. Study the variation of viscosity of sucrose solution with the concentration of solute.

1. Indexing of a given powder diffraction pattern of a cubic crystalline system.

4. pH metry

a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
b. Preparation of buffer solutions of different pH
   i. Sodium acetate-acetic acid
   ii. Ammonium chloride-ammonium hydroxide.
c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
d. Determination of dissociation constant of a weak acid.

Note: Each student is required to perform at least ten experiments.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz,Open talk, Case analysis.

SUGGESTED READINGS:-

- *Khosla, B. D.; Garg, V. C. & Gulati, (2011) A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi.*
- *Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. (2003) Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York.*
- *Halpern, A. M. & McBane, G. C. (2003) Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York.*
- *Suggested digital platform: NPTEL/ SWAYAM/ MOOCs.*

Course Title: Differential Equations	L	T	P	Credit
Course Code: BNM2159	2	0	0	2

Total Hours: 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Familiarize with various methods of solving differential equations of first and second order and to have qualitative applications
2. Solve various working rule for finding solution of linear differential equations with constant coefficients.
3. Evaluate solution using homogeneous linear equations or Cauchy-Euler equations, linear differential equations of second order with variable coefficients, initial and boundary value problems.
4. Discuss the applications of real world problems using ordinary differential equations.

Course Content

UNIT I **8 Hours**

Introduction of Differential equations, Order and Degree of Differential Equations, Complete primitive (general solution, particular solution and singular solutions), Existence and uniqueness of the solution dy/dx= f(x,y).

UNIT II **7 Hours**

Differential equations of first order and first degree, Separation of variables, Homogeneous linear Equations, Exact Equations, Integrating Factor, Linear Equation, Equation of First order but not of first degree

UNIT III **8 Hours**

Linear differential equations with constant coefficients, Complementary function, Particular integral, Working rule for finding solution of linear differential equations with constant coefficients, Homogeneous linear equations or Cauchy-Euler equations

UNIT IV **7 Hours**

Simultaneous differential equations, Differential equations of the form dx/P= dy/Q= dz/R where P, Q, R are functions of x, y, z. Exact differential equations,

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS:-

- *G.F. Simmons, (2002), Differential Equations with Application and Historical Notes, Tata –McGraw Hill.*
- *B. Rai, D.P. Choudhary & H. J. Freedman, (2002), A Course of Ordinary Differential Equations, Narosa.*
- *Ian N. Snedden, (2013), Elements of Partial Differential Equations, Dover Publication.*
- *L.E. Elsgolts, (1970), Differential Equation and Calculus of variations, University Press of the Pacific.*
- *M. D. Raisinghania, (2018), Ordinary and Partial Differential Equations, S Chand. Rudin, W., Principles of Mathematical Analysis, McGraw-Hill (2013).*
- *Malik, S.C. and Arora, S., Mathematical Analysis, Wiley Eastern (2010).*

Course Title: Linear Algebra	L	T	P	Credit
Course Code: BNM2160	2	0	0	2

Total Hours: 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Compute with the characteristic polynomial, eigen values, eigenvectors, and eigen spaces, as well as the geometric and the algebraic multiplicities of an eigen value and apply the basic diagonalization result.
2. Build the concrete structure of modern algebra with the basic concepts of Group, abelian group, subgroup etc. and with their properties.
3. Explore the concepts for understanding and analyzing more advanced topics like Conjugate subgroups, Invariant sub groups, Quotient group, Homomorphism and Isomorphism on groups etc. for strong grip on modern algebra.
4. Create an understanding of rings, various types of rings, characteristic of a ring, field, skew field etc. on the previous concepts of groups.

Course Content

UNIT-I **7 hours**

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

UNIT-II **8 hours**

Ring homomorphisms, properties of ring homomorphisms. Isomorphism theorems I, II and III, field of quotients.

UNIT-III **7 hours**

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

UNIT-IV **8 hours**

Introduction to linear transformations, Subspaces, dimension of subspaces, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphism's. Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Quiz.

SUGGESTED READINGS:-

- *Friedberg, Stephen H., Insel, Arnold J., & Spence, Lawrence E. (2003). Linear Algebra (4th ed.). Prentice-Hall of India Pvt. Ltd. New Delhi.*
- *Hadley, G, (2002), Linear Algebra, Narosa Publishing House, New Delhi.*
- *Hoffman and Kunze, (1972),Linear Algebra, Prentice Hall of India, New Delhi.*
- *H. Helson, (1994),Linear Algebra, Hindustan Book Agency, New Delhi.*
- *Dutta, K. B. (2004), Matrix and Linear Algebra, Prentice Hall of India.*

Semester- III

Course Title: Thermodynamics and Statistical Mechanics	L	T	P	Cr.
Course Code: BNM3200	3	0	0	3

Total Hours: 45

Learning Outcomes: At the end of the course, the students are able to:

1. Explain the concept of the entropy and randomness, distribution of four distinguishable particles in two compartment of equal size.
2. Differentiate Carnot cycle and their efficiency of conversion of heat into work and vice versa.
3. Demonstrate the Concept of macro states microstates, thermodynamic probability and Effects of constraints on the system.
4. Examine in depth about statistical distribution and have basic Ideas about Maxwell Boltzmann, Bose-Einstein and Fermi Dirac Statistics and their applications.

Course Content

UNIT I **12 Hours**

Thermodynamics: Laws of Thermodynamics, Carnot cycle, Carnot's theorem. Entropy as a thermodynamic variable, Principle of increase of entropy. Thermodynamic scale of temperature; its identity with perfect gas scale, impossibility of attaining absolute zero. Change of entropy along a reversible path in a P.V. diagram, Entropy of a perfect gas, Equation of state of an ideal gas from simple statistical consideration, Heat death of the universe.

UNIT II **13 Hours**

Maxwell's thermodynamical relations: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Derivation of Maxwell's thermodynamical relations, Cooling produced by adiabatic stretching, Adiabatic compression, Change of internal energy with volume, specific heat at constant pressure and constant volume, Expression for Cp -Cv , Kinetic Theory of Gases : Change of state and Clayperon equation, Thermodynamical treatment of Joule-Thomson effect, Use of Joule-Thomson effect.

UNIT III **10 Hours**

Kinetic Theory of Gases Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. Molecular Collisions. Mean Free Path. Collision Probability. Estimates of Mean Free Path.

Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

UNIT IV **10 Hours**

Statistical Physics: Concept of macro states and microstates, thermodynamic probability, Effects of constraints on the system, distribution of n particles in two compartments, Distribution of distinguishable n particles in k compartments of unequal sizes. Phase space and its division into elementary cells, Three kinds of statistics.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-tetam teaching, Self-learning.

SUGGESTED READINGS:

- *M.W. Zemansky, Richard Dittman,Heat and Thermodynamics, McGraw-Hill.*
- *Carl S. Helrich, Modern Thermodynamics with Statistical Mechanics, Springer.*
- *Sears & Salinger, Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Narosa Publications.*
- *S.J. Blundell and K.M. Blundell,Concepts in Thermal Physics, Oxford University Press*
- *Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill Publishers.*
- *R.K. Pathria ,Statistical Mechanics, Oxford University Press.*
- *F. Reif ,Statistical Physics, Berkeley Physics Course, Tata McGraw-Hill.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Course Title: Organic Chemistry	L	T	P	Cr.
Course Code: BNM3201	3	0	0	3

Total Hours: 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Describe the need of studying hybridization and its relevance to the organic molecules.
2. Predict about the various shapes of organic molecules.
3. Demonstrate the physical properties of organic molecules
4. Analyze and reproduce accepted mechanisms of organic reactions including all intermediates and resonance structures.

Course Content

UNIT I **12 Hours**

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions. 2 . Mechanism of Organic Reactions

UNIT II **11 Hours**

Stereochemistry: Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations. Optical Isomerism: Optical Activity, Enantiomers, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations, Conformational analysis.

UNIT III **10 Hours**

Chemistry of Aliphatic Hydrocarbons

A. Carbon-Carbon sigma bonds Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions,

B. Carbon-Carbon pi bonds: Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2- and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction;

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

UNIT IV **11 Hours**

Aromatic Hydrocarbons Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

SUGGESTED READINGS:-

- *Morrison, R. N. & Boyd, R. N.(2010)Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
- *Finar, I. L.(2005)Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
- *Finar, I. L. Organic Chemistry(2009) (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
- *Eliel, E. L. &Wilen, S. H. (2008)Stereochemistry of Organic Compounds; Wiley: London, 1994.*
- *Kalsi, P. S. (2016)Stereochemistry Conformation and Mechanism; New Age International, 2005.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Course Title: Complex Analysis	L	T	P	Cr.
Course Code: BNM3202	4	0	0	4

Total Hours: 60

Learning Outcomes: On successful completion of this course, the successful students will be able to:

1. Acquire the basic ideas of analysis for complex functions in complex variables with visualization through relevant practical situations.
2. Understand the significance of differentiability of complex functions leading to the understanding of Cauchy-Riemann equations.
3. Evaluate the contour integrals and understand the role of Cauchy-Goursat theorem and the Cauchy integral formula.
4. Expand some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.

Course Content

UNIT I **15 Hours**

Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples.

UNIT II **15 Hours**

Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals.

UNIT III **15 Hours**

Antiderivatives, Proof of antiderivative theorem, Cauchy-Goursat theorem, Cauchy integral formula; An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra.

UNIT IV **15 Hours**

Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples, Absolute and uniform convergence of power series, Uniqueness of series representations of power series, Isolated singular points,

Residues, Cauchy's residue theorem, residue at infinity; Types of isolated singular points, Residues at poles and its examples.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Quiz, Problem Analysis.

Suggested Readings:-

- *Brown, James Ward, & Churchill, Ruel V. (2014). Complex Variables and Applications (9th ed.). McGraw-Hill Education. New York.*
- *Bak, Joseph & Newman, Donald J. (2010). Complex analysis (3rd ed.). Undergraduate Texts in Mathematics, Springer. New York.*
- *Zills, Dennis G., & Shanahan, Patrick D. (2003). A First Course in Complex Analysis with Applications. Jones & Bartlett Publishers, Inc.*
- *Mathews, John H., & Howell, Rusell W. (2012). Complex Analysis for Mathematics and Engineering (6th ed.). Jones & Bartlett Learning. Narosa, Delhi. Indian Edition.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Experimental Techniques and Lab Safety	L	T	P	Cr.
Course Code: BNM3204	3	0	0	3

Total Hours: 45

Learning Outcomes: On successful completion of this course, the successful students will be able to:

1. Demonstrate proficiency in using fundamental measuring instruments.
2. Perform precise and accurate measurements while minimizing experimental errors.
3. Understand the working principles and applications of vacuum systems, cryogenics, spectroscopic instruments, and electrical measuring devices.
4. Safely handle laboratory materials, including low-temperature substances and radioactive materials.

Course Content

UNIT I **13 Hours**

Basic Laboratory Techniques & Measurements: Introduction to laboratory practices, Importance of accuracy and precision, Vernier calipers, micrometer screw gauge, spherometer, spectrometer, Error analysis: Types of errors, propagation of errors, significant figures, Calibration of instruments, SI units and standardization of measurements.

UNIT II **12 Hours**

Handling of Laboratory Equipment & Materials: Basics of vacuum systems: Rotary pump, diffusion pump, cryogenic techniques, Cryogenics and handling of low-temperature materials (liquid nitrogen, dry ice), Electrical instruments: Digital multimeter, oscilloscope, signal generator, Handling of radioactive materials: Safety protocols, radiation shielding.

UNIT III **10 Hours**

Laboratory Safety & Hazard Management : Introduction to laboratory hazards: Chemical, electrical, biological, and fire hazards, Material Safety Data Sheets (MSDS) and hazard symbols, Safe handling and disposal of chemicals, First aid procedures in case of laboratory accidents, Fire safety: Use of fire extinguishers, emergency response.

UNIT IV **10 Hours**

Basic Laboratory Techniques & Chemical Safety: Laboratory glassware: Types, handling, and calibration of volumetric apparatus, weighing techniques: Analytical balance and digital weighing methods, Preparation of standard solutions and dilution techniques, Chemical hazards and safety: Safe handling and storage of chemicals, Material Safety Data Sheets (MSDS) and hazard classification, Proper disposal of chemical waste

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Quiz, Problem Analysis.

SUGGESTED READINGS:-

- *G.L. Squires, Practical Physics, Cambridge University Press*
- *Vogel's Textbook of Quantitative Chemical Analysis, Pearson*
- *J. M. Khurana, Experimental Techniques in Physics, Narosa Publishing*
- *R. A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press*
- *K. S. Birdi, Handbook of Laboratory Experiments in Physics, CRC Press*
- *F. James, Statistical Methods in Experimental Physics, World Scientific.*

Course Title: Philosophy of Science and Ethics	L	T	P	Cr.
Course Code: BNM3204	3	0	0	3

Total Hours: 45

Learning Outcomes: On successful completion of this course, the successful students will be able to:

1. Explain the scientific method, including observation, hypothesis formulation, experimentation, and theory development.
2. Analyze the philosophical perspectives of Karl Popper, Thomas Kuhn, and other thinkers regarding scientific progress.
3. Recognize ethical challenges in scientific practices, including plagiarism, data falsification, and research misconduct.
4. Reflect on the social responsibilities of scientists and the impact of scientific advancements on humanity.

Course Content

UNIT I **10 Hours**

Introduction to Philosophy of Science: Definition and scope of the philosophy of science, Scientific method: Observation, hypothesis, experimentation, theory formulation, Inductive and deductive reasoning in science. The role of falsifiability (Karl Popper) and paradigm shifts (Thomas Kuhn), Science vs. pseudoscience.

UNIT II **10 Hours**

History and Development of Scientific Thought: Ancient to modern science: Contributions of Greek, Islamic, and Indian scholars, The Scientific Revolution and its impact. Key figures: Galileo, Newton, Darwin, Einstein, and their philosophical implications. The role of mathematics in science, Science and technology in society.

UNIT III **12 Hours**

Ethics in Science and Research: Introduction to scientific ethics: Honesty, objectivity, and integrity in research, Ethical issues in experimentation: Animal testing, human trials, and environmental impact. Plagiarism, data falsification, and research misconduct. Intellectual property rights and patents. Case studies on ethical dilemmas in science.

UNIT IV **13 Hours**

Science, Society, and Responsibility: Role of scientists in policy-making and public awareness, Science and religion: Conflicts and coexistence. Ethical concerns in emerging technologies (AI, genetic engineering, climate change). Sustainable development and the responsibility of scientists. The future of science: Ethical challenges and global collaboration

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Quiz, Problem Analysis.

Suggested Readings:-

- *Karl Popper, The Logic of Scientific Discovery, Routledge*
- *Thomas S. Kuhn, The Structure of Scientific Revolutions, University of Chicago Press*
- *Mario Bunge, Philosophy of Science: From Problem to Theory, Routledge*
- *Peter Bowler & Iwan Rhys Morus, Making Modern Science: A Historical Survey, University of Chicago Press*
- *David Resnik, The Ethics of Science: An Introduction, Routledge*
- *Bernard E. Rollin, Science and Ethics, Cambridge University Press*

Course Title: Renewable Energy & Sustainable Technologies	L	T	P	Cr.
Course Code: BNM3205	4	0	0	4

Total Hours: 60

Learning Outcomes: On successful completion of this course, the successful students will be able to:

1. Explore modern energy conservation techniques and smart grid technologies.
2. Explain the principles and applications of hydrogen fuel cells and battery storage.
3. Examine the relationship between energy production, climate change, and sustainability.
4. Predict future trends and technological advancements in the renewable energy sector.

Course Content

UNIT I **13 Hours**

Introduction to Renewable Energy Sources: Overview of global and national energy scenarios. Conventional vs. non-conventional energy sources. Solar energy: Principles, solar radiation, photovoltaic (PV) cells, solar thermal systems. Wind energy: Wind power generation, wind turbines, advantages and limitations. Small-scale hydroelectric power.

UNIT II **12 Hours**

Bioenergy and Geothermal Energy: Types, production, and applications of biomass and biofuels: Biogas technology: Anaerobic digestion, biogas plant design, and working. Algae-based biofuels and their potential. Geothermal energy: Sources, working principles, and applications. Environmental impact and sustainability of bioenergy and geothermal energy.

UNIT III **10 Hours**

Sustainable Technologies and Energy Storage: Energy conservation and management strategies. Smart grids and decentralized energy systems. Hydrogen fuel cells: Working principle, applications, and challenges. Battery technologies: Lithium-ion, sodium-ion, and flow batteries. Emerging energy storage technologies.

UNIT IV **10 Hours**

Climate Change, Policy, and Future Trends: Impact of energy production on climate change. Sustainable development and carbon footprint reduction. Policies and initiatives for renewable energy (India & global perspectives). Circular economy and green technologies. Future trends in renewable energy and sustainability.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Quiz, Problem Analysis.

Suggested Readings:-

- *John Twidell & Tony Weir, Renewable Energy Resources, Routledge*
- *S. P. Sukhatme & J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill*
- *G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers*
- *S. A. Abbasi & N. Abbasi, Renewable Energy Sources and Their Environmental Impact, PHI Learning*
- *Martin Kaltschmitt, Renewable Energy: Technology, Economics, and Environment, Springer*

Course Title : Critical Reading and Analytical Writing	L	T	P	Cr.
Course Code: BNM3206	2	0	0	2

Total Hours: 30

Learning Outcomes: At the end of the course, the students are able to:

1. Differentiate between passive and active reading and apply various reading techniques such as skimming, scanning, and detailed reading for improved comprehension.
2. Interpret context, tone, and perspective in texts to enhance understanding and engage in critical reading.
3. Evaluate the strength of arguments and evidence in written texts by identifying logical fallacies, biases, and rhetorical strategies.
4. Integrate information from multiple sources to construct well-supported analytical arguments in advanced writing tasks.

COURSE CONTENT

UNIT I **6 Hours**

Introduction to Critical Reading: Distinguishing between passive and active reading. Types of Reading: **Skimming**, scanning, and detailed reading. Reading for Comprehension and Interpretation: Understanding context, tone, and perspective in texts. Evaluating Arguments and Evidence: Identifying biases, logical fallacies, and the strength of arguments.

UNIT II **6 Hours**

Analyzing Literary and Non-Literary Texts: Identifying themes, motifs, character analysis, and narrative techniques. Analyzing articles, reports, essays, and advertisements for structure and argumentation. Analyzing Structure and Style: Understanding the purpose and form of different genres and their writing techniques. Comparative Analysis: Comparing texts to understand different perspectives and approaches.

UNIT III **6 Hours**

Writing Skills for Analysis: Developing a thesis statement, structuring an argument, and using evidence. Writing coherent and cohesive essays, including introductions, body paragraphs, and conclusions. Analyzing and interpreting complex ideas and presenting them clearly. Understanding the importance of revising drafts for clarity, grammar, and structure.

UNIT IV **6 Hours**

Advanced Writing Techniques: Integrating information from multiple sources into a coherent argument. Writing reviews and reflective essays on literature and non-fiction texts. **Developing a Writing Style:** Focus on tone, voice, and audience awareness in writing. Avoiding ambiguity and ensuring logical flow in writing.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Quiz, Problem Analysis.

SUGGESTED READINGS:-

- *Barnet, S., Cain, W. E., & Burto, W. (2016). Literature for composition: Essays, fiction, poetry, and drama (11th ed.). Pearson.*
- *Booth, W. C., Colomb, G. G., & Williams, J. M. (2016). The craft of research (4th ed.). University of Chicago Press.*
- *Browne, M. N., & Keeley, S. M. (2017). Asking the right questions: A guide to critical thinking (12th ed.). Pearson.*
- *Goshgarian, G. (2020). Exploring language (14th ed.). Pearson.*
- *Lunsford, A. A., Brody, M. J., Ede, L., Moss, B., & Walters, K. (2021). Everyone's an author (3rd ed.). W. W. Norton & Company.*

Course Title: Thermodynamics and Statistical Mechanics Lab	L	T	P	Cr.
Course Code: BNM3207	0	0	2	1

Total Hours: 15

Learning Outcomes: At the end of the course, the students are able to:

1. Understand the depth knowledge of Thermodynamics and Statistical Mechanics.
2. Demonstrate skills and competencies to conduct wide range of scientific experiments.
3. How to apply the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases,
4. Heat engines and Make connections between applications of general statistical theory in various branches of physics.

Course Content

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using Null Method.
8. Computational analysis of the behavior (any three) of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
    a. Study of local number density in the equilibrium state (i) average; (ii) fluctuations.
    b. Study of transient behavior of the system (approach to equilibrium)
    c. Relationship of large N and the arrow of time.

d. Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution

9. Single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose- Einstein statistics:
    a. Volume Cv, depend upon the temperature, total number of particles N and the spectrum of single particle states.
    b. Ratios of occupation numbers of various states for the systems considered above.
    c. Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.
10. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.
11. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, E-team teaching, Group discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS:

- *G. L. Squires, Practical Physics, Cambridge University Press.*
- *Napier Shaw and Richard Glazebrook, Practical Physics, Nabu Press.*
- *C.L. Arora ,(2010), Practical Physics, S. Chand &Co.*
- *R.S. Sirohi,(2012), Practical Physics, Wiley Eastern.*

Course Title: Organic Chemistry Lab	L	T	P	Cr.
Course Code: BNM3208	0	0	2	1

Total Hours: 15

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Apply the fundamentals of acid/base equilibria, including pH calculations, buffer behavior for performing acid/base titrations.
2. Use General periodicity patterns of (organic/inorganic) molecules, and the ability to design.
3. Estimation of ferrous and ferric by dichromate method.
4. Identifications and separation of constituents of a mixture or organic compounds by thin layer chromatography.

Course Contents

List of Practical's:

A. Laboratory Techniques

1. Determination of acetic acid in commercial vinegar using NaOH,
2. Alkalinity of water sample.
3. Determination of alkali content of antacid.
4. Estimation of calcium content in chalk as calcium oxalate by permanganometry.
5. Estimation of hardness of water by EDTA.
6. Estimation of ferrous and ferric by dichromatemethod.
7. Estimation of copper using sodium thiosulphate.

B. Thin Layer Chromatography

1. Determination of R, values and identification of organic compounds.

2. Separation of green leaf pigments (spinach leaves may be used).

3. Prepration and Separation of 2,4-dinitrophylhydrazones of acetone, benzophenone cyclohexanone using toluene and light petroleum (40:60).

4. Separation of a mixture of dyes

Transaction Mode- Video Based Teaching, Collaborative teaching, Group

Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

SUGGESTED READINGS:-

- *AI, V. Furniss BS. Hannaford AJ. Smith PWG. Tatchell AR. (2007) Vogel's Textbook of Practical Organic Chemistry, 920.*
- *Ahluwalia, V. K., & Aggarwal, R. (2001). Comprehensive practical organic chemistry: preparation and quantitative analysis. Universities Press.*
- *Ahluwalia, V. K., &Dhingra, S. (2004). Comprehensive Practical Organic Chemistry: Qualitative Analysis. Universities Press.*

Semester –IV

Course Title: Nuclear and Particle Physics	L	T	P	Cr.
Course Code: BNM4251	3	0	0	3

Total Hours: 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Analyze the ideas of basics of nucleus, Constituents of nucleus and their intrinsic properties, Qualitative facts about size, mass, density, and energy.
2. Explain about the general properties of nuclei, nuclear forces and detectors, radioactive decay and nuclear reactions.
3. Examine the liquid drop model. Semi-empirical mass formula, Conditions of nuclear stability, Fermi gas model. Nuclear shell modelto explain the nucleus structure
4. Categorize the different types of the radioactive decay and kinetics of nuclear reactions.

Course Content

UNIT I **13 Hours**

Nuclear Properties: Constituents of nucleus and their intrinsic properties, Qualitative facts about size, mass, density, energy, charge. Binding energy, angular momentum, magnetic moment and electric quadruple moments of the nucleus, Average binding energy and its variation with mass numbers. Properties of nuclear forces and saturation, Assumptions of liquid drop model. Semi-empirical mass formula, Conditions of nuclear stability, Fermi gas model. Nuclear shell model. Experimental evidence of magic numbers and its explanation.

UNIT II **12 Hours**

Radioactivity decays: Modes of decay and successive radioactivity. Alpha emission. Electron emission, Positron emission. Electron capture, Gamma-ray emission, Internal conversion, Qualitative discussion of alpha, beta and gamma spectra, Geiger-Nuttal rule, Neutrino hypothesis of beta decay, Evidence of existence of neutrinos. Nuclear reactions: Reaction cross section, Conservation laws. Kinematics of nuclear reaction, Q value and its physical significance, Compound nucleus.

UNIT III **10 Hours**

Radiation interaction with matter: Energy loss due to ionization (Bethe Block formula), Bremsstrahlung, Pair production, Radiation loss by fast electrons. Electron – positron annihilation. Particle Accelerators: Cyclotron. Betatron, Qualitative discussion of Synchrotron, Collider machines and linear accelerator. Radiation Detectors: Ionization chamber, Proportional counter, GM counter, Scintillation counter, Solid state detectors.

UNIT IV **10 Hours**

Elementary particles: masses of elementary particles, Decay modes, Classification of these particles, types of interactions. Conservation laws and quantum numbers, Concepts of isospin. Strangeness, Parity, Charge conjugation. Antiparticles, Gell Man method, Decay and strange Particles. Particle symmetry, Introduction to quarks and qualitative discussion of the quark model.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

SUGGESTED READINGS:-

- *Kaplan(2003), Nuclear Physics, Addision-Wiley Pub. Co. Inc.*
- *Bucham(1965), Nuclear Physics, Indian Ed.*
- *M.R. Bhiday and V.A. Joshi(2002) , An Introduction to Nuclear Physics, Orient Longman.*
- *D.C. Tayal (2001), Introductory Nuclear Physics, Himalaya Pub.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Abstract Algebra	L	T	P	Cr.
Course Code: BNM4252	4	0	0	4

Total Hours: 60

Learning Outcomes: On successful completion of this course, the successful students will be able to:

1. Define the concepts of group, ring, field, and will be able to readily give examples of each of these kinds of algebraic structures.
2. Define the concepts of coset and normal subgroup and to prove elementary propositions involving these concepts.
3. Define the concept of subgroup and will be able to determine (prove or disprove), in specific examples, whether a given subset of a group is a subgroup of the group.
4. Define and work with the concepts of homomorphism and isomorphism. Content

Course Content

UNIT I **15 Hours**

Normal and subnormal series of group, composition series of group, Jordan-holder theorem.

UNIT II **15 Hours**

Solvable and Nilpotent groups, Field & subfield definition & Examples, Extension fields, Algebraic extensions, Separable and Inseparable extensions Normal extension, Perfect fields

UNIT III **15 Hours**

Class equation of finite group, Cauchy's theorem for finite groups, Sylow Theorem, Wilson's Theorem, Lagrange's Theorem.

UNIT IV **15 Hours**

Polynomial Ring R[x] over a Ring R in an indeterminate X, Primitive polynomial. The ring of Gaussian integers as an Euclidean domain, Fermat's Theorem, Unique Factorization domain.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

Suggested Readings:-

- *Friedberg, Stephen H., Insel, Arnold J., & Spence, Lawrence E. (2003). Linear Algebra (4th ed.). Prentice-Hall of India Pvt. Ltd. New Delhi.*
- *J. B. Fraleigh, (2003), A first course in Abstract Algebra, Addison-Wiley.*
- *I.N. Herstein, (2006), Topics in Algebra, John Wiley & Sons.*
- *Thomas W Hungerford, (1990), Abstract Algebra–An Introduction, Sauders College Publishing.*
- *Joseph A Gallian, (2016), Contemporary Abstract Algebra, Brooks/Cole Cengage Learning.*
- *V. K. Khanna and S. K. Bhambri, (2014), A course in Abstract Algebra, Vikas Publishing House Pvt (Ltd).*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Course Title: Polymer Chemistry	L	T	P	Cr.
Course Code: BNM4253	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Distinguish between addition and condensation polymers.
2. Calculate average degree of polymerization.
3. Determine of molecular weight of polymers.
4. Analyze Physical, thermal, Flow & Mechanical Properties of different polymers.

Course Content

UNIT-I **15 Hours**

Introduction and history of polymeric materials: Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Functionality and its importance: Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization.

Kinetics of Polymerization: Mechanism and kinetics of step growth, radical chain growth, Mechanism and kinetics of copolymerization, polymerization techniques.

UNIT-II **15 Hours**

Crystallization and crystallinity: Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Nature and structure of polymers- Structure Property relationships

Determination of molecular weight of polymers(Mn, Mw, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

UNIT-III **15 Hours**

Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

Polymer Solution – Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

UNIT-IV **15 Hours**

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties)

Brief introduction to preparation, structure, properties and application of the following polymers: poly(vinyl chloride), poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins, polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylenesulphidepolypyrrole, polythiophene)].

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

SUGGESTED READINGS:-

- *G. Odian(2014)Principles of Polymerization, John Wiley.*
- *F.W. Billmeyer,(2017) Text Book of Polymer Science, John Wiley.*
- *P. Ghosh,(2019)Polymer Science & Technology, Tata Mcgraw-Hill.*
- *R.W. Lenz,(2019)Organic Chemistry of SyntheticHigh Polymers.*
- *Digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Geoinformatics and Remote Sensing	L	T	P	Cr.
Course Code: BNM4254	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Explain the concepts and components of geoinformatics, including remote sensing, GIS, and GPS.
2. Interpret remote sensing data for environmental and disaster monitoring.
3. Integrate GPS data with GIS for navigation, surveying, and mapping applications.
4. Apply GIS tools for various real-world applications such as urban planning and natural resource management.

Course Content

UNIT-I **15 Hours**

Introduction to Geoinformatics: Definition, scope, and applications of Geoinformatics. Components of geoinformatics: Remote sensing, GIS, and GPS. Geospatial data: Types (spatial and non-spatial), sources, and data formats. Coordinate systems and map projections. Basics of cartography and thematic mapping

UNIT-II **15 Hours**

Fundamentals of Remote Sensing: Principles of remote sensing and electromagnetic spectrum. Types of remote sensing: Passive and active. Platforms and sensors: Aerial photography, satellites, and drones. Image acquisition and resolution (spatial, spectral, temporal, and radiometric). Applications of remote sensing in environmental monitoring, agriculture, and disaster management

UNIT-III **15 Hours**

Geographic Information System (GIS): Concept and components of GIS, Spatial data models: Raster and vector data. Data input, editing, and management in GIS. GIS analysis techniques: Overlay, buffering, spatial interpolation. Applications of GIS in urban planning, forestry, and hydrology

UNIT-IV **15 Hours**

Global Positioning System and Applications: Working principles of GPS and satellite constellations. Types of GPS: NAVSTAR, GLONASS, Galileo, and IRNSS. GPS data collection and processing. Integration of GPS with GIS and remote sensing, Applications of GPS in navigation, surveying, and transportation.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

SUGGESTED READINGS:-

- *B. Bhatta, Remote Sensing and GIS, Oxford University Press*
- *Lillesand, T.M. & Kiefer, R.W., Remote Sensing and Image Interpretation, John Wiley & Sons*
- *C.P. Lo & Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Pearson*
- *George Joseph, Fundamentals of Remote Sensing, Universities Press*
- *Paul Longley, Michael Goodchild, David Maguire & David Rhind, Geographic Information Systems and Science, Wiley*

Course Title: The Outreach of Indian Knowledge System	L	T	P	Cr.
Course Code: IKS0012	2	0	0	2

Total Hours: 30

Learning Outcomes : On the completion of the course, the students will be able to

1. Understand to Gain knowledge about the historical development, philosophical roots, and interdisciplinary nature of the Indian Knowledge System (IKS), including its contributions to science, mathematics, medicine, and arts.
2. Analyze the traditional wisdom in fields like Ayurveda, Yoga, Astronomy, Metallurgy, and Linguistics, and how they have influenced both ancient and modern scientific advancements.
3. Examine the impact of Indian knowledge on global civilizations, including its contributions to trade, education, and cultural exchange, and how it shaped modern intellectual traditions.
4. Development the relevance of IKS in the modern world, including its role in sustainable development, environmental conservation, and its integration into contemporary education, research, and innovation.

Course Content

Unit-I **7 Hours**

Introduction, the outreach of Indian Knowledge System beyond Indian boundaries forms the ancient times.

Unit – II: **8 Hours**

Outreach to East, Southeast, Central and Southeast Asia of Indian phonetic script, decimal value place system-based arithmetic, algebra, astronomy and calendar, medical pharmacopeia, architecture, methods of making iron and steel, cotton textiles, etc.

Unit – III: **8 Hours**

The transmission of Indian linguistics, knowledge of plants, iron and steel metallurgy, textiles and dyeing, shipbuilding etc., to Europe in 17/18/19th centuries.

Unit – IV: **7 Hours**

Current global outreach of Ayurveda, History, merits and demerits, characteristics, future impacts of Yoga and Indian Fine Arts.

Transactional Mode

Seminars, Group discussion, Team teaching, Focused group discussion, Assignments, Project-based learning, Simulations, reflection and Self-assessment

SUGGESTED READINGS

- *Dharampal (1995). The Beautiful Tree: Indigenous Indian Education in the Eighteenth Century. Biblia Impex.*
- *Michel Danino (2010). The Lost River: On the Trail of the Sarasvati. Penguin India.*
- *Pingree, D. (1978). The Astronomical Works of Brahmagupta. Journal of the American Oriental Society.*
- *Sastry, T. A. (2008). Indian Traditional Knowledge: Opportunities for Sustainable Development. Indian Journal of Traditional Knowledge.*
- *P.P. Divakaran (2018). The Mathematics of India: Concepts, Methods, Connections. Hindustan Book Agency.*
- *Kapil Kapoor & Avadhesh Kumar Singh (2005). Indian Knowledge Systems. D.K. Printworld.*

Course Title: Nuclear and Particle Physics Lab	L	T	P	Cr.
Course Code: BNM4255	0	0	2	1

Total Hours: 15

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Gain hands-on experience in handling nuclear detectors.
2.Collect and analyze data and verify some results that they learn in theory.
3.Build the foundation to carry out research in the field of nuclear physics, nuclear reactions and applied nuclear physics.
4. Design the experiments themselves under the supervision.

Course Content

1. To determine the Dead Time of a G.M. Counter.
2. Absorptions of Beta Particles in Matter.
3. To Study Beta Particle Range and Maximum Energy.
4. Source Strength of a Beta Source.
5. Window Thickness of a G.M. Tube.
6. To Investigate the Statistics of Radioactive Measurements.
7. Study of Poisson Distribution.
8. Study of Gaussian Distribution.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS:

- *G. L. Squires, Practical Physics ,Cambridge University Press.*
- *Napier Shaw and Richard Glazebrook, Practical Physics, Nabu Press.*
- *C.L. Arora ,(2010), Practical Physics, S. Chand &Co.*
- *R.S. Sirohi,(2012), Practical Physics, Wiley Eastern.*

Course Title: Polymer Chemistry Lab	L	T	P	Cr.
Course Code: BNM4256	0	0	2	1

Total Hours: 15

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Demonstrate understanding of basic concepts and experimental methods in polymer chemistry.
2. Perform key polymer synthesis and characterization techniques.
3. Analyze and interpret experimental data in the context of polymer science.
4. Apply safety practices in handling chemicals and laboratory equipment used in polymer synthesis.

Course Content

1. To prepare urea-formaldehyde resin and determine its yield.
2. To synthesize phenol-formaldehyde resin and analyze its thermal behavior.
3. To determine the molecular weight of a polymer using viscometric method.
4. To perform free radical polymerization of styrene and calculate % yield.
5. To determine the glass transition temperature (Tg) of a polymer using differential thermal analysis.
6. To study the swelling behavior of a cross-linked polymer in different solvents.
7. To determine the rate of polymer degradation under UV light.
8. To determine the acid value and saponification value of a polyester sample.
9. To study the effect of pH on polymerization of acrylamide.
10. To prepare nylon 6,6 by interfacial polymerization.
11. To study thermal stability of PVC using thermogravimetric analysis (TGA).
12. To determine intrinsic viscosity and correlate with molecular weight of polymer.
13. To identify polymers using FTIR spectroscopy.

Note: Each student is required to perform at least ten experiments.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

SUGGESTED READINGS:

- *Rabek, J. F. (1995). Experimental Polymer Science. Springer.*

- *Vogel, A. I., Hannaford, A. J., Furnis, B. S., & Tatchell, A. R. (2009). Vogel's Textbook of Practical Organic Chemistry (5th ed.). Pearson Education.*
- *El Abedin, Y. Z., & Ponce de León, I. (2018). Practical Polymer Science: Global Solutions in Materials and Emerging Technologies. Wiley.*
- *Perrin, D. D., & Fink, W. L. (1997). Safety in Academic Chemistry Laboratories (4th ed.). American Chemical Society.*

SEMESTER-V

Course Title: Spectroscopy	L	T	P	Cr.
Course Code: BNM5300	3	0	0	3

Total Hours: 45

Learning Outcomes: At the end of the course, the students are able to:

1. Explain the concept of Excitation of atom with radiation, Transition probability and Spin orbit coupling (electron magnetic moment, total angular momentum).
2. Comprehend the spectrum of hydrogen with full details and to analyze the spectrum of hydrogen with all parameters.
3. Differentiate Selection rules, Regularities in atomic spectra, Interaction energy, X-ray spectra, Mosley law, and Absorption spectra.
4. Analyze the mechanics and Parameters of different experiments and spectra's like Frank Hertz experiment, Raman Spectra and X-ray Spectra.

Course Content

UNIT I **11 Hours**

One Electron Atomic Spectra: Excitation of atom with radiation. Transition probability, Spontaneous transition.Selection rules and life time.Spectrum of hydrogen atom. Frank Hertz Experiment, Line structure.

UNIT II **11 Hours**

Zeeman and PaschenEffect : Normal Zeeman effect, Electron spin, Stern Gerlach experiment, Spin orbit coupling (electron magnetic moment, total angular momentum),Hyperfine structure, Examples of one electron systems, Anomalous, Zeeman effect, Lande-g factor (sodium D-lines).

UNIT III **12 Hours**

Many Electron System Spectra: Exchange symmetry of wave functions, exclusion principle, Shells, Sub shells in atoms, atomic spectra (Helium), L.S. coupling, Selection rules, Regularities in atomic spectra, Interaction energy.

UNIT IV **11 Hours**

X-ray spectra: Production of X-rays, X-ray diffraction, Bragg's law, Bragg's spectrometer, Reflection and refraction of X-rays, Continuous X-ray spectrum, characteristics absorption and emission Spectra, Moseley's law, Applications of Moseley's law.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

SUGGESTED READINGS:

- *Arthur Beiser, Concepts of Modern Physics, McGraw Hill Publishers.*
- *C.N. Banwell, Fundamental of Molecular Spectroscopy, Tata McGraw Hill Pub. Co., Delhi.*
- *H.G. Kuhn, Atomic Spectra, Longmans Publishers.*
- *S.H. Patil, Elements of Modern Physics, McGraw Hill.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Organic Synthesis	L	T	P	Cr.
Course Code: BNM5301	3	0	0	3

Total Hours: 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Acquire deep insights of synthesis of organometallic compounds through various methods.
2. Study the synthesis, reactivity, aromatic character and importance of heterocyclic compounds.
3. Outline the synthesis of carboxylic acid and epoxide.
4. Suggest reactants or sequences of reactions/reactants for compounds of study that could transform the starting material into a target product.

Course Content

UNITI **13 Hours**

Organometallic Compounds: The Grignard reagents, its synthesis, structure and chemical reactions. Organolithium Compounds: preparation and chemical reactions. Organozinc and Organo copper Compounds: Nomenclature, structural features, its synthesis and chemical reactions.

UNIT II **12 Hours**

Organic Compounds of Nitrogen: Synthesis of nitroalkanes and nitroarenes, chemical reactions of nitroalkanes; Methods of preparation of amines by reductive amination of aldehydic and ketonic compounds, Gabriel-phthalimide reaction and Hofmann bromamide reaction; Stereochemistry of amines, separation of a mixture of primary, secondary and tertiary amines.

UNIT III **10 Hours**

Heterocyclic Compounds: Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reactions; synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution and nucleophilic substitution reactions in pyridine derivatives, comparison of basicity of pyridine, piperidine and pyrrole.

UNIT IV **10 Hours**

Carboxylic Acids : Structure and bonding, acidity of carboxylic acids, effects of substituents on acid strength, Synthesis of acid chlorides, esters and amides, Reduction of carboxylic acids, Mechanism of decarboxylation. Carboxylic Acids Derivatives, structure and nomenclature of acid chlorides, esters, amides and acid anhydrides, Relative stability & reactivity of acyl derivatives, synthesis of carboxylic acid derivatives, chemical reactions, mechanisms of esterification and hydrolysis.

Ethers and Epoxides: Nomenclature of ethers and methods of their formation, chemical reaction cleavage and autoxidation, Ziesel's method. Synthesis of epoxides. Acid and base catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organo-lithium reagents with epoxides.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

SUGGESTED READINGS:-

- *Acheson, R. M., & Jones, B. J. (1970). Addition reactions of heterocyclic compounds. PartXLII the mechanism of the thermal rearrangement of tetraethyl 7, 9-dimethyl-9a H-quinolizine-1, 2, 3,4-tetracarboxylatetothe4H-isomer.JournaloftheChemicalSocietyC:Organic.*
- *Cotton,F.A.,Wilkinson,G.,Murillo,C.A.,Bochmann,M.,&Grimes,R.(2018). Advanced inorganic chemistry(Vol. 6,p. 1455).New York:Wiley.*
- *Katritzky, A. R., & Rees, C. W. (1984). Comprehensive heterocyclic chemistry. Pergamum* Press.
- *Sainsbury, M. (Ed.). (1992). Aliphatic Compounds: Monocarboxylic Derivatives of Aliphatic Hydrocarbons,Their Analogues and Derivatives, Elsevier.*

Course Title: Calculus	L	T	P	Cr.
Course Code: BNM5302	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Recall the idea of derivative, rules of differentiation, test for concavity and convexity and understand the concept of p-r equation.
2. Demonstrate the concepts of curvature, radius of curvature, center of curvature and apply the concepts to solve problems.
3. Analyze the rules of identifying asymptotes, employ the same to find quadrature, length of an arc, Improper integrals and their convergence such as Comparison tests, Absolute and conditional convergence, Abel's and Dirichlet's tests.
4. Explain the hyperbolic functions and compare it with circular functions, trigonometric functions, inverse trigonometric functions and their applications.

Course Content

UNIT I **15 hours**

Successive differentiation, Asymptotes, Multiple points, Tests for concavity and convexity, points of inflexion, Tracing of curves in Cartesian, Curvature, radius of curvature, center of curvature.

UNIT II **15 hours**

Integration of hyperbolic and inverse hyperbolic functions, Reduction Formulae, application of definite integral to find quadrature, length of an arc.

UNIT III **15 hours**

Improper integrals and their convergence, Comparison tests, Absolute and conditional convergence, Abel's and Dirichlet's tests,

UNIT IV **15 hours**

Limits of sequence of numbers. Theorems for calculating limits of sequences, Infinite Series, Bounded and Monotonic sequences, Cauchys convergence criterion. Series of non-negative terms. Comparison tests. Cauchys' Integral test. Ratio tests. Alternating series. Absolute and conditional convergence. Lebnitz Theorem, Convergence of Taylor Series, Error Estimates. Applications of Power Series.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS:-

- *George B. Thomas, Maurice D. Weir and Joel R. Hass, (2014). Thomas'Calculus, 12thEd., Pearson Education, New Delhi,*
- *Joseph L. Taylor, (2012). Foundations of Analysis, Pure and Applied Undergraduate Texts, 18, American Mathematical Society, Providence, RI,*
- *Shanti Narayan, (2001). Integral Calculus, S. Chand and Company Ltd. 4. M.J. Strauss, G.L. Bradley and K. J. Smith, (2007). Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi.*
- *R. Courant and F. John, (1989). Introduction to Calculus and Analysis (Volumes I & II), Springer-Verlag, New York, Inc.*

Course Title: Mathematical Optimization & Operations Research	L	T	P	Cr.
Course Code: BNM5303	4	0	0	4

Total Hours: 60

Course Learning Outcomes: On successful completion of this course, the successful students will be able to:

1. Describe the Operation Research.
2. Categorize Linear Programing Problem for concave and convex set.
3. Classifying and analyzing data relative to Duality, Dual simplex Method.
4. Application related game theory.

Course Content

UNIT-I **15 hours**

Operational Research and Linear programming Origin & Development of OR, Different Phases ofOperation Research study, Methodology of OR, Scope and Limitations of OR, OR in decision making, Applications of Operation Research.

UNIT-II **15 hours**

Linear Programming: Linear combination of vectors, linearly independent/ dependent vectors, Basis of a vector space, convex set and its properties, Extreme points. General Linearprogramming problem (LPP), Standard and canonical form of LPP. Formulation of LPP, Graphical solution. Simplex method.

UNIT-III **15 hours**

Solving system of linear equations using Simplex method. Duality: Definition of the dual problem, Primal-dual relationships, Economic Interpretation of Duality, Dual simplex Method. Sensitivity analysis: Shadow Price, Graphical and simplex method-based approachfor changes in cost and resource vector.

UNIT-IV **15 hours**

Theory of Games: Introduction to Game theory, Formulation of two-person zero-sum rectangular game; Solution of rectangular games with saddle points; dominance principle; rectangular games without saddle point – mixed strategy, Graphical, algebraic and linear programming solution of m x n games.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS:

- *G. Hadley: Linear Programming. Narosa, 2002 (reprint).*
- *A. Ravindran, D. T. Phillips and James J. Solberg: Operations Research-Principles and Practice, John Wiley & Sons, 2005.*
- *Hamdy A. Taha: Operations Research-An Introduction, Prentice Hall, 9th Edition, 2010.*
- *F.S. Hillier. G.J. Lieberman: Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata McGraw Hill. 2010.*
- *P. R. Thie and G. E. Keough: An Introduction to Linear Programming and Game Theory, Wiley, NewJersey, 3rd edition, 2008.*
- *F.S. Hillier and G.J. Lieberman: Introduction to Operations Research-Concepts and Cases, 9th Edition, Tata McGraw Hill, 2010.*

Course Title: Mathematics in the Vedas and Sulva Sutras	L	T	P	Cr.
Course Code: IKS0013	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Explore the presence of mathematical concepts in the Vedas, including numerical systems, geometric principles, and their philosophical significance.
2. Analyze the mathematical principles in the Śulva Sūtras, particularly their applications in geometry, measurement, construction of altars (yajñas), and approximation techniques for square roots and π.
3. Examine the arithmetic operations, algebraic identities, and early combinatorial methods mentioned in Vedic texts and their influence on later mathematical developments.
4. Investigate how the mathematical principles from the Vedas and Śulva Sūtras influenced later Indian mathematicians like Āryabhaṭa and Bhāskara, and their relevance in modern mathematical thought.

Course Content

UNIT I **7 Hours**

Introduction, Mathematical references in Vedas. The extant Śulbasūtra texts & their commentaries. The meaning of the word Śulbasūtra.

UNIT II **8 Hours**

Qualities of a Śulbakāra. Finding the cardinal directions. Methods for obtaining perpendicular bisector. Bodhāyana's method of constructing a square. The Bodhāyana Theorem (so called Pythagoras Theorem)

UNIT III **7 Hours**

Applications of Bodhāyana Theorem. Constructing a square that is the difference of two squares. Transforming a rectangle into a square.

UNIT IV **8 Hours**

To construct a square that is *n* times a given square. Transforming a square into a circle (approximately measure preserving). Rational approximation for $\sqrt{2}$. Construction of Citis. Details of fabrication of bricks, etc

Transactional Mode

Seminars, Group discussion, Team teaching, Focused group discussion, Assignments, Project-based learning, Simulations, reflection and Self-assessment

SUGGESTED READINGS

- *Datta, B. & Singh, A. N. (1935). History of Hindu Mathematics. Motilal Banarsidass.*
- *Sen, S. N. & Bag, A. K. (1983). The Śulba Sūtras. Indian National Science Academy.*
- *Hayashi, T. (1995). The Bakhshali Manuscript: An Ancient Indian Mathematical Treatise. Egbert Forsten.*
- *Kak, S. (2001). The Astronomical Code of the Rigveda. Munshiram Manoharlal Publishers.*
- *Joseph, G. G. (2000). The Crest of the Peacock: Non-European Roots of Mathematics. Princeton University Press.*
- *Kulkarni, R. (2009). The Mathematics of the Śulvasūtras. Resonance – Journal of Science Education, Indian Academy of Sciences.*
- *Staal, F. (1999). Greek and Vedic Geometry. Journal of Indian Philosophy.*
- *Bag, A. K. (1979). Mathematics in Ancient India. Indian Journal of History of Science.*

Course Title: Spectroscopy Lab	L	T	P	Cr.
Course Code: BNM5304	0	0	2	1

Total Hours:15

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Develop a solid understanding of atomic and molecular spectra.
2. Analyze spectral lines and understand fundamental concepts like quantization, interference, and polarization.
3. Apply spectroscopic methods to determine physical constants and atomic structure.
4. Gain practical knowledge of optical instruments such as spectrometers, monochromators, diffraction gratings, and lasers.

Course Content

1. To study the emission spectrum of hydrogen and determine the Rydberg constant.
2. To determine the wavelengths of mercury spectral lines using a plane transmission diffraction grating.
3. To calibrate a spectrometer using standard spectral lines.
4. To determine the resolving power of a diffraction grating.
5. To determine the separation of the sodium D-lines using a diffraction grating.
6. To verify Malus' Law using a laser and polarizer-analyzer setup.
7. To study the Fabry-Perot Interferometer and determine the wavelength of monochromatic light.
8. To determine the wavelength of laser light using single slit/double slit diffraction.
9. To analyze the rotational-vibrational spectrum of iodine and estimate molecular constants.
10. To determine the energy band gap of a semiconductor using UV-Vis absorption technique.
11. To study the Raman spectrum of a compound and determine the vibrational modes.
12. To study the absorption spectra of different filters and solutions using a spectrophotometer.
13. To observe fluorescence and phosphorescence and compare emission properties.

14. To study the variation of transmitted light intensity with polarizer angle (continuation of Malus' Law).

Note: Students will perform any 7-8 experiments.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

SUGGESTED READINGS:-

- *G. L. Squires, Practical Physics ,Cambridge University Press.*
- *Napier Shaw and Richard Glazebrook, Practical Physics, Nabu Press.*
- *C.L. Arora ,(2010), Practical Physics, S. Chand &Co.*
- *R.S. Sirohi,(2012), Practical Physics, , Wiley Eastern.*

Course Title: Organic Synthesis Lab	L	T	P	Cr.
Course Code: BNM5305	0	0	2	1

Total Hours: 15

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Recognize the appropriate safety measures to deal with chemicals in chemistry laboratory.
2. Separate various constituents of a mixture and their identification.
3. Determine the concentration of unknown compounds through established experiments.
4. Ascertain established facts on working through advance instruments and spectroscopic analysis.

Course Content

List of Experiments:

1. Safety Practices in the Chemistry Laboratory
2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.
4. Determination of the void volume of a gel filtration column.
5. Determination of a Mixture of Cobalt and Nickel (UV/Vis spectroscopy)
6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7. Potentiometric Titration of a Chloride-Iodide Mixture
8. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration
9. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different Units (J molecule-1 , kJ mol-1 , cm-1 , eV).
10. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

SUGGESTED READINGS:-

- *Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).*
- *Instrumental Methods of Analysis, 7th Ed, Willard, Merritt, Dean, Settle.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Chemical Energetics, Equilibria & Functional Group Organic Chemistry	L	T	P	Cr.
Course Code: BNM5306	2	0	0	2

Total Hours: 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Acquire basic knowledge of the fundamental principles of thermo-chemistry.
2. Calculate the bond energy, bond dissociation energy and resonance energy from thermodynamic data.
3. Derive various laws of chemical equilibrium.
4. Evaluate the functional group chemistry for various reactions of organic molecules.

Course Content

UNIT I **8 Hours**

Chemical Energetics: Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.Statement of Third Law of thermodynamics and calculation of absolute e ntropies of substances.

UNIT II **7 Hours**

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^{o}, Le Chatelier's principle. Relationships between K_p, K_c and K_x for reactions involving ideal gases.

UNIT III **8 Hours**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

UNIT IV **7 Hours**

Alcohols and Phenols (Upto 5 Carbons)

Alcohols: Preparation: Preparation of 1^o, 2^o and 3^o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.
Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk.$KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation
Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazoniumsalts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

SUGGESTED READINGS:-

- *T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.*
- *Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.*
- *I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.*
- *R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.*
- *Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.*
- *G. M. Barrow: Physical Chemistry Tata McGraw--Hill (2007).*
- *G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).*
- *J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).*
- *B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).*
- *R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).*

Course Title: : Analytical Methods in Chemistry	L	T	P	Cr.
Course Code: BNM5307	2	0	0	2

Total Hours: 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Get insights to analytical data like errors, accuracy and precision.
2. Analyze fundamental laws of spectroscopy and selection rules.
3. Evaluate different solvent extraction techniques and their efficiency.
4. Estimate the qualitative and quantitative aspects of chromatographic methods of analysis.

Course Content

UNIT-I **08 Hours**

Qualitative and quantitative aspects of analysis: Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

UNIT-II **07 Hours**

Optical methods of analysis: Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Det

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

UNIT-III **08 Hours**

Thermal methods of analysis: Theory of thermos-gravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods: Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

UNIT-IV **07 Hours**

Separation techniques:

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange.Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

SUGGESTED READINGS:-

- *Vogel, Arthur I: A (2005)Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .*
- *Christian, Gary D; (2009)Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.*
- *Harris, Daniel C: (2004)Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.*
- *Khopkar, S.M.(2007)Basic Concepts of Analytical Chemistry. New Age, International Publisher.*
- *Skoog, D.A. Holler F.J. and Nieman, T.A.(1999)Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.*
- *Mikes, O. &Chalmes, R.A.(1998)Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.*

- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

SEMESTER-VI

Course Title: Quantum Mechanics	L	T	P	Cr.
Course Code: BNM6350	3	0	0	3

Total Hours: 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Comprehend Blackbody radiation, Ultraviolet catastrophe, Photoelectric effect and Compton Effect and being aware how quantum theory emerged
2. Explain the need for quantum mechanical formalism and basic principles of wave mechanics and some problems of mechanics.
3. Demonstrate about wave properties of particles, De Broglie waves and its implications on the uncertainty principle.
4. Derive Schrodinger's equation for spherical symmetric potential, complete solution of hydrogen atom and able to solve numerical problems related to these topics.

Course Content

UNIT I **10 Hours**

Foundation of Quantum Mechanics: Brief introduction to need and development of quantum mechanics, Spectral radiation – Planck's law. Photoelectric effect, Compton's effect (quantitative) experimental verification. Limitations of old quantum theory.

UNIT II **12 Hours**

Wave Particle Duality: de Broglie's, properties of matter waves. Phase and group velocities and relation between them. Heisenberg's uncertainty principle. Interpretation of Wave Function Probability and probability current densities in three dimensions, Normalization. Linearity and Superposition Principles. Expectation values of position and momentum. Wave Function of a Free Particle.

UNIT III **10 Hours**

Time independent Schrodinger Wave Equation: Time independent Schrodinger equation in one, two and three dimensions. Particle in a one dimensional box with finite walls. Two dimensional square with infinite walls. Three dimensional rectangular box with infinite walls. Isotropic Harmonic oscillator, Degeneracy.

UNIT IV **13 Hours**

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order

partial differential equation; angular momentum operator & quantum numbers; Radial wave-functions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d shells.

Transaction Mode: Lecture/Demonstration/Project Method/ Co Operative learning/ Seminar/Group discussion/Team teaching /Tutorial/Problem solving/E-team teaching/Self-learning.

SUGGESTED READINGS:-

- *Sakurai, Jun John, and Jim Napolitano.* Modern Quantum Mechanics*. Cambridge University Press*
- *V.K. Thankappan(2000), Quantum Mechanics, McGraw Hill Pub. Co. Delhi*
- *P.M. Mathews and K. Venkatesan (2002), A Text Book of Quantum Mechanics, Tata McGraw Hill Pub. Co. Delhi,.*
- *J .L. Powell and B. Crasemann(1997), Quantum Mechanics,Narosa Pub. House, N.Delhi.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Quantum Chemistry and Spectroscopy	L	T	P	Cr.
Course Code: BNM6351	3	0	0	3

Total Hours: 45

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Differentiate different types of spectroscopic techniques.
2. Derive the laws of photochemistry.
3. Verify Lambert-Beer's law.
4. Separate the molecular energies into translational, rotational, vibration and electronic components.

Course Content

UNIT-I **12 Hours**

Spectroscopy and its importance in Chemistry Wave-particle duality, Link between spectroscopy and quantum chemistry, Electromagnetic radiation and its interaction with matter, Types of spectroscopy, Difference between atomic and molecular spectra. Born Oppenheimer approximation: Separation of molecular energies into translational, rotational, vibrational and electronic components

UNIT-II **13 Hours**

Postulates of quantum mechanics, quantum mechanical operators, free particle, Particle in a 1-D box (complete solution), quantization, normalization of wave functions, concept of zero-point energy

Rotational Motion: Schrödinger equation of a rigid rotator and brief discussion of its results (solution not required), Quantization of rotational energy levels
Microwave (Pure rotational) spectra of diatomic molecules. Selection rules, Structural information derived from rotational spectroscopy.

UNIT-III **10 Hours**

Vibrational Motion: Schrödinger equation of a linear harmonic oscillator and brief discussion of its results (solution not required). Quantization of vibrational energy levels, Selection rules, IR spectra of diatomic molecules. Structural information derived from vibrational spectra, Vibrations of polyatomic molecules, sGroup frequencies. Effect of hydrogen bonding (inter- and intramolecular) and substitution on vibrational frequencies.

Electronic Spectroscopy: Electronic excited states. Free Electron model and its application to electronic spectra of polyenes. Colour and constitution, chromophores, auxochromes, bathochromic and hypsochromic shifts.

UNIT-IV **10 Hours**

Photochemistry: Laws of photochemistry. Lambert-Beer's law, Fluorescence and phosphorescence, Quantum efficiency and reasons for high and low quantum yields. Primary and secondary processes in photochemical reactions, Photochemical and thermal reactions, Photoelectric cells

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk.

SUGGESTED READINGS:-

- *Morrison, R. T., & Boyd, R. N. (2012). Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.).*
- *Finar, I. L. (2007). Organic Chemistry, Vol-1, Dorling Kindersley (India) Pvt).*
- *Solomons, T. G. (1980). Organic Chemistry. New York Chichester Brisbane Toronto.*

Course Title: Analytical Geometry and Vector Analysis	L	T	P	Cr.
Course Code: BNM6352	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Describe the various forms of equation of a plane, straight line, Sphere, Cone and Cylinder.
2. Find the angle between planes, Bisector planes, Perpendicular distance from a point to a plane, Image of a line on a plane, Intersection of two lines
3. Formulate exterior derivative and know basic properties of the induced mappings by using Stokes's Theorem for integrals of differential forms.
4. Analyse the integrals of functions and vector fields on surfaces express and prove Stokes's and Divergence Theorems.

Course Content

UNIT–I **15 hours**

Pair of Straight lines: Joint equation of pair of straight lines and angle between them, condition of parallelism and perpendicular, joint equation of the angle bisectors, joint equation of lines joining origin to the intersection of a line and a curve. Conic: General equation of conic, Tangents, normal, chord of contact, pole and polar, of tangents from a point, equation of chord in terms of midpoint, diameter.

UNIT–II **15 hours**

Conjugate diameters of ellipse and hyperbola, special properties of parabola, ellipse and hyperbola, conjugate hyperbola, asymptotes of hyperbola, rectangular hyperbola .Transformation of axes in two dimensions: shifting of origin, rotation of axes, the second-degree equation $S=ax^2+2hxy+by^2+2gx+2fy+c=0$, its invariants t, and O. Reduction of the second-degree equation into standard form.

UNIT–III **15 hours**

Scalar and vector functions of a single variable, magnitude of a vectorfunction, limit and continuity of vector functions and their properties. Differentiation of a vector function. Geometrical interpretation and properties of the derivatives. Directional derivative and gradient, vector field; curl and divergence, deloperator and their elementary properties.

UNIT–IV **15 hours**

Curvilinear coordinates and curves in E 3 , tangent , principal normal, binormal, curvature, torsion, Serret – Frenet formulae . Fundamental planes Connected and simply connected regions. Riemann integral ,line integral, multiple integral, Line integrals as integrals of vectors. Circulation ,irrotational vector. Work done, conservative force, potential . Orientation. Statements of Stokes, Green's and Divergence theorems and simple problems related to these theorems.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

SUGGESTED READINGS:-

- *P.K Jain and Khalil Ahmed. (1994).A text book of Analytical Geometry of two dimension Wiley Eastern Ltd.*
- *P.K Jain and Khalil Ahmed. (1999).A text book of Analytical Geometry of three dimensions. Wiley Eastern Ltd.*
- *Shanti Narayan and P.K Mittal. (2006). Analytical Solid Geometry 17th Revised Edition S. Chand and Co. New Delhi.*
- *S.L. Loney.(1992). The Elements of Coordinate Geometry, McMillan and Company, London.*
- *R.J.T. Bill. (1994). Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd.*
- *M.C. Chaki.(1999).Vector Analysis.*
- *B. Spain .(2001).Vector Analysis.*
- *C.E. Weatherburn.(2001).Advance Vector Analysis.*
- *H. Lass.(2000).Vector and Tensor Analysis.*
- *I.S. Sokolnikoff.(2004)Vector Analysis, Theory and Applications.*

Course Title: Food Chemistry and Quality Control	L	T	P	Cr.
Course Code: BNM6353	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. To study the chemical composition of food.
2. To understand the principles and techniques of food analysis.
3. To gain knowledge about quality control systems and safety standards.
4. To familiarize students with food regulations and their application in the industry.

Course Content

UNIT I **10 Hours**

Introduction to Food Chemistry: Water, carbohydrates, proteins, lipids, vitamins, and minerals, Function and classification of nutrients, Micronutrients and macronutrients, Non-nutrient compounds in food: flavors, colorants, and preservatives, Metabolism of food components, Enzymatic activity and role in food chemistry, Food enzymes and their effects on food preservation.

UNIT II **12 Hours**

Chemical Composition and Properties of Food: Carbohydrates in Foods-Simple sugars: monosaccharides and disaccharides, Complex carbohydrates: starches, cellulose, pectin, Role in texture, sweetness, and preservation, Proteins in Foods-Structure and function of proteins, Amino acids and protein quality, Protein denaturation and its role in food processing, Lipids in Foods-Types of fats and oils (saturated, unsaturated, trans fats)Lipid oxidation and its effects on food quality, Emulsifiers and their role in food products

UNIT III **10 Hours**

Food Additives and Preservatives: Types of food additives: preservatives, colorants, antioxidants, flavor enhancers**,** Regulations and safety of food additives. Impact of additives on health and sensory properties**,** Chemical preservatives: types, mechanisms, and applications**,** Natural preservatives: salt, sugar, vinegar, and their effects**,** Techniques: pasteurization, canning, freezing, and dehydration

UNIT IV **13 Hours**

Food Quality Control Principles: Definition and importance of food quality**,** Instrumental methods of food analysis (spectroscopy, chromatography)**,** Standard operating procedures (SOPs) in food production**,** HACCP (Hazard Analysis and Critical Control Points) system**,** Good Manufacturing Practices (GMP) and quality standards**,** Materials and technology for food packaging**,** Impact of packaging on food quality**,** Food labelling regulations and consumer protection

Transaction Mode: Lecture/Demonstration/Project Method/ Co Operative learning/ Seminar/Group discussion/Team teaching /Tutorial/Problem solving/E-team teaching/Self-learning.

SUGGESTED READINGS:-

- *Belitz, H.-D., Grosch, W., &Schieberle, P. (2009). Food Chemistry (4th ed.). Springer-Verlag.*
- *Marsh, R. J., &Lawlor, R. H. (1999). Introduction to Food Chemistry. Springer.*
- *Wang, D. K. T. (2004). Food Quality Assurance: Principles and Practices. CRC Press.*
- *Nielsen, S. S. (2010). Food Analysis (4th ed.). Springer.*
- *Bishop, P. L., & Foo, L. I. (2011). Food Safety: Theory and Practice. Wiley.*
- *DeMan, J. M. (1999). Food Chemistry and Food Processing. Springer Science & Business Media.*

Course Title: Digital Communication and Media Literacy	L	T	P	Cr.
Course Code: BNM6354	2	0	0	2

Total Hours: 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Compose clear, concise, and audience-appropriate digital messages, demonstrating tone management in different online contexts.
2. Demonstrate media literacy by evaluating the credibility, bias, and reliability of digital media sources and distinguishing between facts, opinions, and misinformation.
3. Critically assess the influence of digital media on public discourse and cultural perception, recognizing ethical considerations in its use.
4. Analyze the impact of digital media on public discourse and culture, and recognize the ethical responsibilities of digital communicators.

Course Content

UNIT I **8 Hours**

Introduction to Digital Communication: Definition and evolution of digital communication, Differences between traditional and digital communication methods. Social media platforms, blogs, emails, podcasts, and video sharing. Role of multimedia in modern communication. Writing clear and concise messages, Audience awareness and tone management in digital spaces.

UNIT II **7 Hours**

Media Literacy in the Digital Era: Definition and importance of media literacy, the role of media in shaping public opinion and culture, Media sources for credibility and bias, difference between facts, opinions, and misinformation, Impact of social media on public discourse, the ethical use of digital media.

UNIT III **8 Hours**

Digital Media Tools and Techniques: Social Media and Content Creation platforms and their uses, basics of content creation: writing, images, video, and

audio. Strategies for effective engagement and audience interaction. Use of blogs, podcasts, infographics, and vlogs in communication. Tools for measuring and analyzing media reach.

UNIT IV **7 Hours**

Ethical and Legal Aspects of Digital Communication: Privacy, consent, and ethical responsibility in digital content creation, Digital harassment, trolling, and cyberbullying. Understanding copyright, plagiarism, and intellectual property rights. Legal issues surrounding online communication (defamation, online contracts). The role of fact-checking and responsible media consumption.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

SUGGESTED READINGS:

- *Levine, T. R., & McCornack, S. A. (2019). The communication skills workbook: A practical guide to improving your communication skills. SAGE Publications.*
- *Rosen, J., & McCaffrey, M. (2020). Digital communication: A guide to digital media literacy. Oxford University Press.*
- *Silver, D. (2018). Media literacy in the digital age: A guide for educators. Routledge.*
- *Ramanathan, V. (2020). Media literacy and digital culture: Engaging with modern media technologies. Palgrave Macmillan.*
- *Vargo, C. J., & Guo, L. (2019). The new media literacy handbook: Teaching and learning in a digital world. Wiley-Blackwell.*

Course Title: Quantum Mechanics Lab	L	T	P	Cr.
Course Code: BNM6355	0	0	2	1

Total Hours: 15

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Demonstrate fundamental principles of quantum mechanics through experiments and simulations.
2. Understand the wave-particle duality, quantization, tunneling, and uncertainty principles.
3. Apply computational tools and simulations to visualize and solve quantum mechanical systems.
4. Work effectively in laboratory teams, demonstrating responsible scientific conduct, safety awareness, and collaborative problem-solving.

Course Content

1. To study the Photoelectric Effect and determine Planck's constant.
2. To verify Heisenberg's Uncertainty Principle using single slit diffraction.
3. To determine the e/m ratio of an electron using Thomson's method.
4. To study the Davisson-Germer experiment (electron diffraction) using simulation or actual setup.
5. To observe and analyze the Zeeman Effect and determine the splitting of spectral lines.
6. To study quantization of angular momentum using the Stern-Gerlach experiment (simulation-based).
7. To determine the band gap of a semiconductor using absorption spectroscopy.
8. To study quantum tunneling using a tunnel diode and plot I-V characteristics.
9. To investigate atomic spectra and calculate fine structure splitting in sodium D-lines.
10. To simulate and analyze the wave function of a particle in a 1D box using Python/Matlab.
11. To simulate the time evolution of a wave packet and its spreading using a Schrödinger equation solver.
12. To determine Planck's constant using LEDs of different colors (Threshold voltage method).

13. To simulate quantum harmonic oscillator and analyze eigenstates using computational tools.

Note: Students will perform any 7-8 experiments.

SUGGESTED READINGS:-

- *G. L. Squires, Practical Physics ,Cambridge University Press.*
- *Napier Shaw and Richard Glazebrook, Practical Physics, Nabu Press.*
- *C.L. Arora ,(2010), Practical Physics, S. Chand &Co.*
- *R.S. Sirohi,(2012), Practical Physics, Wiley Eastern.*

Course Title: Quantum Chemistry and Spectroscopy Lab	L	T	P	Cr.
Course Code: BNM6356	0	0	2	1

Total Hours: 15

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Provide hands-on experience with various computational and experimental techniques in quantum chemistry and spectroscopy.
2. Understand molecular structures, electronic transitions, and spectral analysis.
3. Enhance practical knowledge in using spectrometers and computational tools for chemical analysis.

Course Content

1. To perform molecular orbital calculations using the Hartree-Fock method to understand the electronic structure of molecules.
2. To construct a calibration curve for a substance by measuring absorbance at different concentrations and using it to find the concentration of an unknown sample.
3. To measure the absorbance of a solution at various wavelengths and calculate the concentration using Beer-Lambert's law.
4. To measure UV-Vis absorption spectra of organic compounds and analyze their electronic transitions.
5. To measure lambda maximum using UV-Vis absorption spectra of organic compounds
6. To record and analyze the IR spectra of organic compounds and identify their functional groups.
7. To analyze ^1H NMR spectra of organic compounds and deduce their molecular structure.
8. To record and interpret ^13C NMR spectra to determine the carbon skeleton of organic molecules.
9. To explore vibrational modes of molecules using Raman spectroscopy and analyze their spectral features.
10. To understand and apply X-ray diffraction techniques to determine the molecular structure of crystalline compounds.

Note: Students will perform any 7-8 experiments.

SUGGESTED READINGS:-

- *Pavia, D. L., Lampman, G. M., Kriz, G. S., & Vyvyan, J. R. (2014). Introduction to Spectroscopy (5th ed.). Cengage Learning.*

- *Banwell, C. N., &McCash, E. M. (1994). Fundamentals of Molecular Spectroscopy (4th ed.). McGraw-Hill.*
- *Willard, H. H., Merritt, L. L., Dean, J. A., & Settle, F. A. (1988). Instrumental Methods of Analysis (7th ed.). Wadsworth Publishing.*
- *Druker, B. J., & Tisdale, M. J. (1986). Applications of UV-Visible Spectroscopy in Analytical Chemistry. Springer.*
- *Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). Fundamentals of Analytical Chemistry (9th ed.). Cengage Learning.*

Course Title: Electronics	L	T	P	Cr.
Course Code: BNM6357	2	0	0	2

Total Hours: 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Demonstrate the basic concepts of the diode, its applications, relationship between semiconductors devices and applications.
2. Differentiate bipolar and unipolar devices and different types of biasing used for their stability.
3. Analyze the depth of CB and CE characteristics, Structure of JFET and MOSFET, Transistor biasing and stabilization of operating point.
4. Design and verification of electronic devices and systems which will increase their employability scope in various electronics related companies.

Course Content

UNIT I **8 Hours**

Diodes: Concepts of current and voltage sources, p-n junction, Biasing of diode, V-A characteristics. Zener diode. LED. Rectifier and filters: half wave, full wave rectifiers and bridge rectifiers, Qualitative analysis of Filter circuits (RC LC and π filters), Efficiency, Ripple factor, Voltage regulation.

UNIT II **7 Hours**

Junction transistor and its biasing: Structure and working, relation between different currents in transistor, Sign conventions. Amplifying action, Different configurations of a transistor and their comparison. CB and CE characteristics, Transistor biasing and stabilization of operating point, Voltage divider biasing circuit.

UNIT III **7 Hours**

Amplifiers: Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Frequency response of a CE amplifier.

UNIT IV **8 Hours**

Communication: Modulation and detection. AM and FM, Power in AM and generation of AM, AM detector, Radio wave propagation.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

SUGGESTED READINGS:

- *J. Millman and C.C. Halkias , Integrated Electronics, Tata Mc-Graw Hill.*
- *J.D. Ryder, Electronics: Fundamentals and Applications, Prentice Hall.*
- *R. A. Gayakwad, OP-Amps and Linear Integrated Circuit, Prentice Hall.*
- *S.M. Sze , Semiconductor Devices: Physics and Technology,Wiley India*
- *N.N. Bhargave, D.C. Kulshreshtha and S.C.Gupta, Basic Electronics and linear Circuits, McGraw Hill Education; 2nd edition*
- *D. Chatopadhyay, P.c. Rakshit, B. Saha and N.N. Purkit(2001), Foundations of Electronics, New Age International (P) Ltd.*
- *Suggested digital platform: NPTEL/ SWAYAM/ MOOCs.*

Course Title: Radiation Physics	L	T	P	Cr.
Course Code: BNM6358	2	0	0	2

Total Hours 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand properties of ionizing radiation and their applications
2. Explain the fundamental principles and working of dosimeters
3. Analyze the effects of radiations on human body
4. Learn the basics of radiation shielding and its applications.

Course Content

UNIT I **8 Hours**

Ionizing Radiations and Radiation Quantities: Types and sources of ionizing radiation, Absorbed dose and its measurement; Bragg Gray Principle, Radiation dose UNITs- rem, rad, Gray and Sievert dose commitment..

UNIT II **7 Hours**

Dosimeters: Pocket dosimeter, films, solid state dosimeters such as TLD, SSNTD, chemical detectors and neutron detectors, simple numerical problems on dose estimation.

UNIT III **8 Hours**

Radiation Effects and Protection: Biological effects of radiation at molecular level, Permissible dose to occupational and non-occupational workers, safe handling of radioactive materials.

UNIT IV **7 Hours**

Radiation Shielding: Thermal and biological shields, shielding requirement for medical, industrial and accelerator facilities, shielding materials.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, E-team teaching, Group discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READING:

- *Knoll G.F, Radiation Detection and Measurements, Wiley Publishers.*
- *Herman Cember, Introduction to Health Physics, Pergamon Press*
- *Attix F H et al,Radiation Dosimetry, Academic Press.*

- *Ronald L. Kathren, Radiation Protection, Adam Hilger Ltd. International PublishersServices*
- *Merril Eisenbud, Environmental Radioactivity, Academic Press, Orlando.*
- *James E Turner, Atoms, Radiation & Radiation Protection, Pergamon Press, 1986.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*