GURU KASHI UNIVERSITY

Bachelors of Science

(B.Sc. N.M.)

Session : 2023-24

Department of Physics

Graduate Outcomes of the Programme: The graduates will be able to apply the knowledge of mathematics and science fundamentals, to the solution of complex physical problems. The graduates will also be able to design solutions for complex science related problems and design system components or processes that meet the specified needs.

Program Learning Outcomes After completion of the program, the students will be able to:

1. Acquire the knowledge with facts and figures related to various subjects in pure sciences.
2. Identify, analyze, evaluate and apply information scientifically to solve problems.
3. Enhance Critical thinking and analytic reasoning to employ critical thinking in understanding the concepts in every area of Math, physics and chemistry to analyze the results.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Learn the laboratory skills needed to design safely and interprets different instruments with an understanding of the limitations.
6. Develop flair by participating in various social and cultural activities in environmental context, and demonstrate the knowledge of, and need for sustainable development.

Programme Structure

Semester –I						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNM112	Communication Skills	Compulsory Foundation	2	0	0	2
BNM103	Mechanics	Core	4	0	0	4
BNM101	Inorganic Chemistry	Core	4	0	0	4
BNM102	Matrix and Co-ordinate Geometry	Core	4	0	0	4
BNM113	Mechanics Lab	Technical Skills	0	0	2	1
BNM104	Inorganic Chemistry Lab	Technical Skills	0	0	2	1
BNM114	Communication Skills Lab	Technical Skills	0	0	4	2
BNM199	XXX	MOOC	--	--	--	2
Discipline Elective (**Any one of the following)**						
BNM108	Condensed Matter Physics	Discipline Elective-I	3	0	0	3
BNM109	Waves & Oscillation					
BNM115	Medical Physics					
BNM111	Radiation Physics					
Total			**17**	**0**	**8**	**23**

Semester-II						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNM212	Electricity &Magnetism	Core	4	0	0	4
BNM201	Physical Chemistry	Core	4	0	0	4
BNM213	Real Analysis	Core	4	0	0	4
BNM214	Electricity & Magnetism Lab	Technical Skills	0	0	2	1
BNM205	Physical Chemistry Lab	Technical Skills	0	0	2	1
BNM215	Computer Lab	Technical Skills	0	0	2	1
Discipline Elective (Any one of the following)						
BNM208	Differential Equations	Discipline Elective-II	3	0	0	3
BNM203	Linear Algebra					
BNM210	Probability and Statistics					
BNM211	Number Theory					
Discipline Elective (Any one of the following)						
BNM216	Pharmaceutical Chemistry	Discipline Elective-III	3	0	0	3
BNM217	Conductance, Electrochemistry & Functional Group Organic Chemistry					
BNM218	Polymer Chemistry					
BNM219	Pesticide Chemistry					
Total			**18**	**0**	**6**	**21**

Semester-III						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNM315	Thermodynamics & Statistical Physics	Core	4	0	0	4
BNM301	Organic Chemistry	Core	4	0	0	4
BNM316	Calculus	Core	4	0	0	4
BNM317	Thermodynamics & Statistical Physics Lab	Technical Skills	0	0	2	1
BNM306	Organic Chemistry Lab	Technical Skills	0	0	2	1
BNM399	XXX	MOOC	-	-	-	2
Discipline Elective (Any one of the following)						
BNM307	Complex Analysis	Discipline Elective-IV	3	0	0	3
BNM308	Linear Programming Problem					
BNM309	Riemann Integration & Series of Functions					
BNM310	Mathematical Methods					
Open Elective						
XXX	XXX	IDC	2	0	0	2
Total			**17**	**0**	**4**	**21**

Open Elective (For other departments)						
BNM318	Basic Mathematics	IDC	2	0	0	2
BNM319	Physics for competitive exams					
BNM320	Chemistry in Everyday Life					

Semester-IV						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNM415	Nuclear and Particle Physics	Core	4	0	0	4
BNM401	Quantum Chemistry & Spectroscopy	Core	4	0	0	4
BNM402	Abstract Algebra	Core	4	0	0	4
BNM416	Organic Synthesis Lab	Technical Skills	0	0	2	1
BNM417	Nuclear and Particle Physics Lab	Technical Skills	0	0	2	1
BNM418	Value Education	Ability Enhancement	2	0	0	2
Discipline Elective (Any one of the following)						
BNM411	Analog Electronics	Discipline Elective- V	3	0	0	3
BNM419	High Energy Physics					
BNM420	Physics of Nanomaterials					
BNM414	Atomic Spectroscopy					
Value Added Course (For other departments)						
BNM421	Life Skills	Value Added Course	2	0	0	2
Total			**19**	**0**	**4**	**21**

Semester-V						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	

						Credit
BNM513	Quantum Mechanics	Core	4	0	0	4
BNM514	Organic Synthesis	Core	4	0	0	4
BNM515	Environmental Science	Compulsory Foundation	2	0	0	2
BNM516	Instrumentation in Physics	Technical Skills	2	0	0	2
BNM517	Instrumentation in Physics Lab	Technical Skills	0	0	2	1
BNM518	Numerical Methods	Technical Skills	2	0	0	2
BNM519	Numerical Methods Lab	Technical Skills	0	0	2	1
BNM599	XXX	MOOC	--	--	--	2
Discipline Elective (Any one of the following)						
BNM520	Special Function	Discipline Elective-VI	3	0	0	3
BNM521	Set Theory					
BNM522	Discrete Mathematics					
BNM523	Graph Theory					
Discipline Elective (Any one of the following)						
BNM524	General Organic Chemistry & Aliphatic Hydrocarbons	Discipline Elective-VII	3	0	0	3
BNM525	Chemical Energetics, Equilibria & Functional Group Organic Chemistry					
BNM526	Analytical Methods in Chemistry					
BNM527	Chemistry of s- and p-block elements, States					

	of matter and Chemical Kinetics					
Total			**20**	**0**	**4**	**24**

Semester-VI						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNM605	Fluid Mechanics	Core	4	0	0	4
BNM606	Bioorganic Chemistry	Core	4	0	0	4
BNM607	Project in Physics	Technical Skills	0	0	4	2
BNM608	Project in Chemistry	Technical Skills	0	0	4	2
BNM609	Project in Mathematics	Technical Skills	0	0	4	2
BNM610	IT Skills for Chemists	Technical Skills	2	0	0	2
BNM611	IT Skills for Chemists Lab	Technical Skills	0	0	2	1
Discipline Elective (Any one of the following)						
BNM612	LASER Physics	Discipline Elective-VIII	3	0	0	3
BNM613	Optics					
BNM614	Advanced Quantum Mechanics					
BNM615	Mathematical Physics					
Total			**13**	**0**	**14**	**20**
Grand Total			**104**	**0**	**38**	**130**

Evaluation Criteria for Theory Courses

A. Continuous Assessment: [25 Marks]
   CA-1 Surprise Test (Two best out of three) - (10 Marks)
   CA-2 Assignment(s) (10 Marks)
   CA-3 Term paper/Quiz/Presentation (05 Marks)
B. Attendance (05 marks)
C. Mid Semester Test: [30 Marks]
D. End-Term Exam: [40 Marks]

Semester -I

Course Title: Communicative Skills

Course Code: BNM112

L	T	P	Credit
2	0	0	2

Total Hours: 30

Learning Outcomes

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

1. Brighten their awareness of correct usage of English grammar in writing and speaking.
2. Improve their speaking ability in English both in terms of fluency and comprehensibility.
3. Upgrade their reading speed and comprehension of academic articles
4. Enhance fluency in reading skills through extensive reading, enrich their vocabulary, refine ability to write academic papers, essays and summaries.

Course Content

UNIT I **8 Hours**

Developing Habits of Independent and Fast Reading : Students will be required to read a prescribed prose. The essays in the anthology will be read by students at home with the help of glossary given in the book. Progressing from one lesson to another, they should learn to read fast. Students are supposed to keep a record of their reading in the form of notes, difficulties, summaries, outlines and reading time for each essay. Class teacher may use this record for awards of internal assessment (if any)

UNIT II **7 Hours**

Developing Comprehension Skills : Teacher will provide guided comprehension of the prescribed texts in the class and help students in answering the questions given at the end of each lesson. Teacher can construct more questions of factual and inferential nature to enhance the comprehension skills of the students. The teacher shall also guide students to do the grammar exercise given at the end of each lesson.

UNIT III **8 Hours**

Developing skills in Personal Writing : Students will be required to learn short personal write-ups involving skills of description and narration. The types of composition task may include personal letter writing, telegram writing. Notice writing, diary writing etc. The teacher shall instruct the students about the appropriate format and usual conventions followed in such writings. The teacher may also prescribe composition /writing book if so required.

Business writing : Business letters; elements of business writing; kinds of business letters – office order memorandum, report, purchase order, quotations and tenders, job application letters, personal resume and curriculum vitae etc.

UNIT -IV **7 Hours**

Development of Speaking Skills: Public speaking, formal speaking-audience analysis, effective use of voice & body language, importance of confidence building, group discussion, presentation skills, seminar ,interview skills development, telephone etiquettes, opinion-based speaking.

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

SUGGESTED READINGS:-

- *Vandana R Singh. (2003). The Written Word Oxford University Press New Delhi.*
- *KK Ramchandran, Etal. (2002). Buisness Communication. Macmilan. New Delhi.*
- *Swati Samantaray. (2001)Business Communication and Communicative English. Sultan Chand, New Delhi.*
- *S.P. Dhanavel. (1999)English and Communication Skills. for Students of Science and Engineering (with Audio CD)*
- *Gimson, A.C.(2001).An Introduction to the Pronunciation of English. ELBS.*

Course Title: Mechanics

Course Code: BNM103

L	T	P	Credit
4	0	0	4

Total Hours: 60

Learning Outcomes

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

1. Illustrate various coordinate systems and its applications.
2. Demonstrate the motion of particle under central force and determine the turning points of orbit.
3. Explain the phenomena of collisions and apply it to the real-world problems.
4. Evaluate the various parameters for elastic and non-elastic collisions

Course Content

UNIT -I **15 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 **15 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 **15 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 **15 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, Vol. I, C. Kittle.*
- *Daniel Kleppner& Robert J. Kolenkow,An Introduction to MachinesTata 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.*

Course Name: Inorganic Chemistry

Course Code: BNM101

L	T	P	Credits
4	0	0	4

Total Hours : 60

Learning Outcomes

After completion of this course, the learner 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 **15 Hours**

Atomic Structure:- Idea of de Broglie matter waves, Heisenberg uncertainity principle, atomic orbitals, Schrodinger wave equation, significance of, Ψ and , Ψ^2, quantum numbers, radial and angular wave functions and probability distribution curve, shapes of s, p, d orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements and ions. Normal and Orthogonal wave functionAtomic radii, Ionic and crystal radii, Covalent radii.

Chemical Periodicity: Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. Atomic radii, Ionic and crystal radii, Covalent radii
Ionization enthalpy, Successive ionization enthalpies, Electron gain enthalpy and its trend in periodic table.
Electronegativity and its scales, Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity

UNIT-II **15 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 **15 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 eIectronegativity difference.

UNIT-IV **15 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 polarisability of ions, Fajan's rule. Metallic bond-free electron, valence bond and bond theories.

Weak Interactions: Hydrogen bonding, van der Walls forces and London Forces.

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*

L	T	P	Credit
4	0	0	4

Course Title: Matrices and Coordinate Geometry
Course Code: BNM102

Total Hours: 60

Learning Outcomes

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

1. Grasp the basics of Matrices and coordinate geometry including applied aspect for enhancing quantitative skills.
2. Develop a wide-ranging application of the subject and enlarge the knowledge of matrices for solving linear homogeneous and as well as non-homogeneous system of equations.
3. Equip themselves with necessary analytic and technical skills by applying the principles of geometry, also learns to solve a variety of practical problems in science and engineering.
4. Acquire the standard concepts and tools at an intermediate to advance level of geometrical techniques that will serve towards taking more advance level course in mathematics.

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: Mechanics Lab

Course Code: BNM113

L	T	P	Credit
0	0	2	1

Total Hours: 15

Learning Outcomes

After completion of this course, the learner 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 using qualitative and quantitative reasoning including sophisticated mathematical techniques.
4. Illustrate experimental, conceptual and theoretical methods

Course Content

List of Practicals:

1. Measurements of length (or diameter) using Vernier calliper, 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

Course Code: BNM104

L	T	P	Credits
0	0	2	1

Total Hours: 15

Learning Outcomes

After completion of this course, the learner 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. Illustrate volumetric analysis to determine the concentration of a substance in a given sample.

Course Contents

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: Communication Skill Lab

Course Code: BNM114

L	T	P	Credit
0	0	4	2

Total Hours : 30

Learning Outcomes

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

1. Identify appropriate expressions in speaking and writing.
2. Understand the style and perfection of language in reading and listening various contexts of engineering and technology.
3. Gain confidence for every day communication, aptitude test and interviews.
4. Enhance their general conversational skills in different socio-cultural contexts.

Course Content

1. **Phonetics**: Introduction to sounds of English. Phonetic transcription of simple words. Word stress or accent**.**
2. **Spoken skills:** Public speaking Debate.
3. **Conversation skills :** Introducing Extending Invitations Apologizing Lodging complaints.
4. **Describing :** Describing an object Describing a process Describing situations.
5. **Group Discussion:** Dynamics of Group Discussion.
6. Self-Introduction, Role play of Celebrities, Sharing memorable incidents.

SUGGESTED READINGS :

- *Butterfield Jeff, Soft Skills of Everyone. Cengage Learning: New Delhi.*
- *Interact English Lab Manual for Undergraduate Students,. Orient BlackSwan.*
- *Raman, Meenakshi and Sangeetha Sharma. Professional Communication. Oxford University Press: Oxford.*
- *S. Hariharanetal. Soft Skills. MJP Publishers.*

Course Title: Condensed Matter Physics

Course Code: BNM108

L	T	P	Credit
3	0	0	3

Total Hours:45

Learning Outcomes

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

1. Categorize 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. Solve problems of Crystal planes, Miller indices, Laue equations and Brillouin zones.

Course Content

UNITI **12 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.

UNITII **11Hours**

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.

UNITIII **11 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.

UNITIII **11 Hours**

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. ClausiusMosotti 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.*

Course Title: Waves & Oscillations

Course Code: BNM109

L	T	P	Credit
3	0	0	3

Total Hours 45

Learning Outcomes

After completion of this course, the learner 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

UNITI **12 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 **11 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 **11 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 **11 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.*

Course Title: Medical Physics

Course Code: BNM115

L	T	P	Credit
3	0	0	3

Total Hours 45

Learning Outcomes

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

1. Explain the working of various organs of human body.
2. Comprehend principles behind the working of components used in Radiography industry.
3. Differentiate between the Conventional and digital radiography techniques.
4. Analyze the thermal regulation of human body.

UNIT I **11 Hours**

Basic Anatomical Terminology: Standard Anatomical Position, Planes. Familiarity with termslike- Superior, Inferior, Anterior, Posterior, Medial, Lateral, Proximal and Distal. Mechanicsof the body: Skeleton, forces, and body stability. Muscles and dynamics of body movement.

UNIT II **12 Hours**

Physics of Locomotors Systems: Joints and movements, Stability and Equilibrium. Energyhousehold of the body: Energy balance in the body, Energy consumption of the body, Heatlosses of the body, Thermal Regulation. Pressure system of body: Physics of breathing, Physicsof cardiovascular system.

UNIT III **11 Hours**

Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics ofthe ear, Diagnostics with sound and ultrasound. Optical system of the body: Physics of the eye.Physics of the nervous system.

UNIT IV **12 Hours**

Physics of Diagnostic and Therapeutic Systems: Electromagnetic spectrum, production of x-rays, x-ray spectra, Bremsstrahlung,Characteristic x-ray x-ray tube design, x-ray tube rating, quality and intensity of x-ray. X-raygenerator circuits, types of X-Ray Generator.

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

SUGGESTED READINGS:

- *J.R. Cameron and J.G. Skofronick,Medical Physics, Wiley*
- *Curry, Dowdey and Murry –Lippincott, Christensen's Physics of DiagnosticsRadiology: Williams and Wilkins.*
- *Irving P. Herman, Physics of the human body, SpringerPublishers.*
- *Bushberg, Seibert, Leidholdt and Boone Lippincot, The essential physics ofMedical Imaging: Williams and Wilkins.*

L	T	P	Credit
3	0	0	3

Course Title: Radiation Physics

Course Code: BNM111

Total Hours 45

Learning Outcomes

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

1. Illustrate 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. Formulate the applications of radiation shielding.

Course Content

UNIT I **12 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 **11 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 **11 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 **11 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, WileyPublishers.*
- *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.*

Semester -II

Course Title: Electricity and Magnetism

Course Code: BNM212

L	T	P	Credit
4	0	0	4

Total Hours 60

Learning Outcomes

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

1. Explain and differentiate the vector and scalar 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-Savartlaw .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.*

Course Title: Physical Chemistry
Course Code: BNM201

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes

After completion of this course, the learner 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 **15 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, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

UNIT-II **15 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, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

UNIT III **16 Hours**

Liquid state: Qualitative treatment of the structure of the liquid state; Radial distribution function; 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 **14 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, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; 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. Glasses and liquid 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

Course Code: BNM213

L	T	P	Credit
4	0	0	4

Total Hours: 60

Learning Outcomes

After completion of this course, the learner 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. Apply knowledge of improper integrals, and their convergences, series of functions in the relevant fields.
4. Develop 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: Electricity and Magnetism Lab

Course Code: BNM214

L	T	P	Credit
0	0	2	1

Total Hours: 15

Learning Outcomes

After completion of this course, the learner 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 qualitatively and quantitatively using sophisticated mathematical techniques.
4. Connect 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) Resonantfrequency, (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 resonantfrequency 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-II

Course Code: BNM205

L	T	P	Credits
0	0	2	1

Total Hours: 15

Learning Outcomes

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

1. Determine Surface tension of different liquids.
2. Prepare Buffer Solution of different pH value.
3. Evaluate 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.

2. 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.

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

4. pHmetry

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: Computer Lab
Course Code: BNM215

L	T	P	Credit
0	0	2	1

Total Hours: 15

Learning Outcomes

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

1. Create and manage professional documents using word.
2. Analyze, manage and present data using excel.
3. Create and manage presentation using power point.
4. Insert a table, picture, or drawing into the document.

Course Content

1. Create a PPT at least 10 slides one slide for comparison, one slide displaying a chart with table.
2. Create a PPT presentation slide import sound and video clips and using hyper linking.
3. Create a PPT presentation and apply themes and transitions.
4. Create a document and insert header, fooder, page title, set the margins etc.
5. Create a document with table and prepare mark sheet of your class subjects.
6. Design a Greeting Card using Microsoft word.
7. Create your bio-data and use page borders and shading.
8. Apply the creating, editing, saving, printing and protecting operations to excel sheets.
9. Prepare a bar chart for analysis of five years results of your institute.
10. Prepare an attendance sheet of 10 students for any 6 subjects of your syllabus. Calculate their total attendance, total percentage of attendance of each student and average of attendance.

Suggested Readings:

- *Peter John, Microsoft Word & Exel 2021 For Beginners & Advanced Learners: A Step-By-Step Practical Guide To Mastering Word & Excel.*
- *Joan Lambert, Microsoft Word Step by Step (Office 2021 and Microsoft 365), Microsoft Press.*
- *Michael Alexander, Microsoft Excel Bible, John Wiley & Sons?*

Course Title: Differential Equations

Course Code: BNM208

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Compare various methods of solving differential equations of first and second order.
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.

UNIT I **10 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 **12 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 **11 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 **12 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

Course Code: BNM203

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Compute the characteristic polynomial, eigen values, eigenvectors, and eigen spaces, as well as the geometric and the algebraic multiplicities of an eigen value.
2. Apply the basic diagonalization result.
3. Analyze the concrete structure of modern algebra with the basic concepts of Group, abelian group, subgroup etc. and with their properties.
4. Develop 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 **10 hours**

Eigen values and Eigen vectors: Eigen vectors and Eigen values of a matrix, product of characteristic roots of a matrix and basic results on characteristic roots, nature of the characteristic roots of Hermitian, skew-Hermitian, unitary and orthogonal matrices, characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding inverse of a matrix.

UNIT II **12 hours**

Definition of a group with examples and simple properties, Abelian group, Finite and infinite group, Order of a finite group, General properties of groups, Composition table for finite groups.
Order of an element of a group, Group homomorphism, Isomorphism on groups, theorems on
subgroups, Coset decomposition, Cayley's theorem, Cyclic group, generating system of group.

UNIT III **11 hours**

Normal subgroups, Simple group, Conjugate elements, Normalizer of an element of a group, Class equation of a group, Centre ofa group, Conjugate subgroups, Invariant sub groups, Quotient group, Homomorphism and Isomorphism on groups, Kernel of a Homomorphism and related theorems.

UNIT IV **12 hours**

Rings, Various types of rings, Rings with unity, Rings without zero divisors, Properties of rings, Sub rings. Ideals, Quotient rings, Principal ideals, Maximal ideals, Prime ideals, Principal ideal domains, Characteristic of a ring.
Integral domain, Field, Skew field etc., Field of quotients of an integral domain, Embedding of an integral domain in a field, Factorization in an integral domain, Divisibility, Units, Associates, Prime and irreducible elements, Unique Factorization Domain, Euclidean rings.

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.*

Course Title: Probability and Statistics

Course Code: BNM210

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Illustrate Probability and its distributions such as binomial distributions, Poisson distribution and basic laws of total probability and compound probability in statistics.
2. Categorize appropriate sampling processes such as random sampling, large sample tests of means and proportion. T-student, (chi square) and F distributions (without derivation) and testing of hypothesis based on them. x2
3. Apply the methods of classifying and analyzing data relative to single variable and multiple variables.
4. Distinguish between the practical purposes of a large and a small sample.

Course Content

UNIT I **10 hours**

Sample space and events, algebra of events, axiomatic approaches, conditional probability, basic laws of total probability and compound probability, Byes' theorem, Independence.

UNIT II **12 hours**

Discrete and continuous random variables, mathematical expectation, variance, moment about a point, central moment, moment generating function, Binomial, Poisson, Normal and Rectangular distributions.

UNIT III **12 hours**

Two-dimensional random variables, joint distribution functions, marginal distributions, covariance, linear regression and correlation, rank correlation, least square method of fitting regression lines.

UNIT IV **11 hours**

Sampling, random sampling, large sample tests of means and proportion. t-student, (chi square)
and F distributions (without derivation) and testing of hypothesis based on them. 2x

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

Suggested Readings:-

- *Irwin Miller and Marylees Miller,(1975).John E. Freund's Mathematical Statistics with Applications, Pearson Education.*
- *Robert V. Hogg, Allen Craig Deceased and Joseph W. McKean,(2002). Introduction to Mathematical Statistics, Pearson Education*
- *Sheldon M. Ross, (2009). Introduction to probability and statistics for engineers and scientists, Elsevier Academic Press.*
- *Goon, A.M., Gupta and M.K., Das Gupta, (1991). Fundamental of Statistics. Vol 1. World , B. Press. Calcutta.*

Course Title: Number Theory

Course Code: BNM211

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Define and interpret the concepts of divisibility, congruence, the greatest common divisor, prime, and prime-factorization.
2. Solve challenging problems related to Chinese remainder theorem effectively.
3. Apply the Law of Quadratic Reciprocity and other methods to classify numbers as primitive roots, quadratic residues, and quadratic non-residues.
4. Demonstrate the logics and methods behind the major proofs in Number Theory and Describe the properties of prime numbers.

Course Contents

UNIT I **11 hours**

Introduction, Divisibility, The Division Algorithm, GCD and LCM, The Euclidean Algorithm, Primes and their properties, Infinitude of primes.

UNIT II **12 hours**

The Fundamental Theorem of Arithmetic, The Prime Number Theorem (statement only). Congruence - Definition and properties of it, Solutions of Congruence, Euler's phi function.

UNIT III **10 hours**

Fermat's Theorem, Euler's Theorem, Wilson's Theorem, The Chinese Remainder Theorem, Multiplicative property of Euler's phi function, Primitive Roots.

UNIT IV **12 hours**

Quadratic Reciprocity,Quadratic Residues, The Legendre Symbol and its proper-ties, Lemma of Gauss, The Gaussian Reciprocity Law, The Jacobi symbol. Arithmetic functions $\mu(n)$, $d(n)$, $\Phi(n)$, $\sigma\alpha(n)$, Mobious inversion formula.

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

Suggested Readings:-

- *G. H. Hardy and E. M. Wright, (2008). An Introduction to Theory of Numbers, Oxford University Press, 6th Ed ,*
- *I. Niven, H. S. Zuckerman and H. L. Montgomery, (2004). An Introduction to the Theory of Numbers, John Wiley and Sons, (Asia) 5th Ed., 107*
- *H. Davenport, (1999). The Higher Arithmetic, Camb. Univ. Press, 7th edition,*
- *David M. Burton, (2007). Elementary Number Theory, Tata McGraw Hill, 6th Edition,*
- *Hardy, G. H., and Wright, E. M., (1979). An Introduction to the Theory of Numbers, 5th Edition, Clarendon Press (Oxford),*

Course Name: Pharmaceutical chemistry
Course Code: BNM216

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Describe the various pharmaceutical drugs, their application and synthesis.
2. Explain the action and discovery, the structure activity and drug targets.
3. Classify antimicrobial, antibacterial, antifungal, antiviral, antimalarial drugs.
4. Analyze fermentation and such related methods to produce products at industrial levels.

Course Content

UNIT-I **15 Hours**

Drugs & Pharmaceuticals: Drug discovery, design and development; Basic Retrosynthetic approach;Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, antiinflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol)

UNIT-II **10 Hours**

Antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol; Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT-Zidovudine)

UNIT-III **10 Hours**

Fermentation: Aerobic and anaerobic fermentation; Production of ethyl alcohol and citric acid; Antibiotics; Penicillin, Chloromycetin and Streptomycin; Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C

UNIT-IV **10 Hours**

Preparation of Aspirin and its analysis; Preparation of magnesium bisilicate (Antacid)

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

SUGGESTED READINGS:-

1) *Patrick, G. L. (2013). An introduction to medicinal chemistry. Oxford university press.*
2) *Singh, H., & Kapoor, V. K. (2005). Medicinal and Pharmaceutical Chemistry. VallabhPrakashan.*
3) *Foye, W. O. (1974). Principles of medicinal chemistry. Lea &Febiger.*
4) Suggested digital platform: NPTEL/SWAYAM/MOOCs

Course Name: Conductance, Electrochemistry and Functional Group Organic Chemistry

L	T	P	Credits
3	0	0	3

Course Code: BNM217

Total Hours: 45

Learning Outcomes

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

1. Evaluate conductance of strong and weak electrolyte.

2 Derive Nearnst equation for calculation of e.m.f of cell.

3. Recognize the importance of electrochemistry in various fields.

4 Predict the activity of various functional group in synthesis of organic compounds and in various reactions.

Course Content

UNIT-I **12 Hours**

Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes; Kohlrausch law of independent migration of ions.

Transference number and its experimental determination using Hittorf and Moving boundary methods; Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base)

UNIT-I **11 Hours**

Electrochemistry

Reversible and irreversible cells; Concept of EMF of a cell;; Measurement of EMF of a cell. Nernst equation and its importance; Types of electrodes; Standard electrode potential; Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data.

Calculation of equilibrium constant from EMF data; Concentration cells with transference and without transference; Liquid junction potential and salt bridge; pH determination using hydrogen electrode and quinhydrone electrode; Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only)

UNIT-III **10 Hours**

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

Amines and Diazonium Salts

Amines (Aliphatic and Aromatic): (Upto 5 carbons)

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis,Hofmann Bromamide reaction; Reactions*:* Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten: Baumann Reaction; Electrophilic substitution (case aniline): nitration, bromination, sulphonation

Diazonium salts: *Preparation:* from aromatic amines.Reactions:conversion to benzene, phenol, dyes.

UNIT-IV **12 Hours**

Amino Acids, Peptides and Proteins:

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis

Reactions of Amino acids: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test; Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins; Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme); Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

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

SUGGESTED READINGS:-

- *G. W. Castellan: Physical Chemistry 4th Ed. Narosa (2004).*
- *J. C. Kotz, P. M. Treichel, J. R. Townsend, General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).*

- *B. H. Mahan: University Chemistry, 3rd Edn. Narosa (1998).*
- *R. H. Petrucci, General Chemistry, 5th Edn., Macmillan Publishing Co.: New York (1985).*
- *Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
- *Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
- *Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
- *Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.*
- *Digital platform: NPTEL/SWAYAM/MOOCs*

Course Name: Polymer Chemistry
Course Code: BNM218

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Distinguish between addition and condensation polymers.
2. Evaluate average degree of polymerization.
3. Determine 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, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

UNIT-II **10 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 **11 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 **09 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 Name: Pesticide Chemistry
Course Code: BNM219

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Explain chemical composition and nutritional quality of various field and horticultural crops.
2. Acquire the skills on quality monitoring of crops and pesticides through Practices.
3. Impart the knowledge on agrochemicals viz., fertilizers and pesticides
4. Analyze the importance of pesticides and insecticides along with their chemical composition.

Course Content

UNIT-I **10 Hours**

General introduction to pesticides (natural and synthetic), benefits and adverse effects

UNIT-II **10 Hours**

Changing concepts of pesticides, structure activity relationship

UNIT-III **10 Hours**

Synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor)

UNIT-IV **15 Hours**

1 To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
2 Preparation of simple organophosphates, phosphonates and thiophosphates.

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

SUGGESTED READINGS:-

- *R. Cremlyn (2018) Pesticides, John Wiley.*
- *Digital platform: NPTEL/SWAYAM/MOOCs*

Semester -III

Course Title: Thermodynamics and Statistical Mechanics
Course Code: BNM315

L	T	P	Credit
4	0	0	4

Total Hours: 60

Learning Outcomes

After completion of this course, the learner will be 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 **15 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 **15 Hours**

Maxwell's thermodynamical relations : Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Derivation of Maxwell's thermo dynamical relations, Cooling produced by adiabatic streching, 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 **15 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 **15 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-team 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*

Course Title: Organic Chemistry
Course Code: BNM301

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes

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

1. Illustrate 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 **15 Hours**

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.

Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; 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 **15 Hours**

Stereochemistry: Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations. Cycloalkanes.

UNIT-III **15 Hours**

Chemistry of Aliphatic Hydrocarbons

A. Carbon-Carbon sigma bonds Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

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 oxymercuration-demercuration, 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; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

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

C. Cycloalkanes and Conformational Analysis Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

UNIT-IV **15 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: Calculus

Course Code: BNM316

L	T	P	Credit
4	0	0	4

Total Hours: 60

Learning Outcomes

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

1. Validate the concavity and convexity of a curve.
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 and apply to find quadrature, length of an arc, Improper integrals and their convergence.
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: Thermodynamics and Statistical Mechanics Lab
Course Code: BNM317

L	T	P	Credit
0	0	2	1

Total Hours: 15

Learning Outcomes

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

1. Estimate and evaluate the errors in related experiments.

2. Demonstrate skills and competencies to conduct wide range of scientific experiments.

3. Apply the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and

4. Connect general statistical theory to 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 behaviour (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 Name: Organic Chemistry Lab

Course Code: BNM306

L	T	P	Credits
0	0	2	1

Total Hours:15

Learning Outcomes

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

1. Apply the fundamentals of acid/base equilibria, including pH calculations, buffer behavior for performing acid/base titrations.
2. Illustrate general periodicity patterns of (organic/inorganic) molecules, and the ability to design.
3. Estimate of ferrous and ferric by dichromate method.
4. Disseminate 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.*

Course Title: Complex Analysis

Course Code: BNM307

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Acquire the basic ideas of analysis for complex functions in complex variables with visualization.
2. Apply Cauchy Residue theorem to evaluate integrals.
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

Course Content

UNIT I **12 hours**

Analytic Functions and Cauchy-Riemann Equations: 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 **10 hours**

Elementary Functions and Integrals: 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 **12 hours**

Cauchy's Theorems and Fundamental Theorem of Algebra: 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 **11 hours**

Series and Residues: 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:- Linear Programming Problem

Course Code: BNM308

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Interpret the dual variables and perform sensitivity analysis in the context of economics problems.
2. Explain the concept of complementary slackness and its role in solving primal/dual problem pairs,
3. Formulate an LPP with linear constraints and solve real-world problem.
4. Explain, how to maximize the profit, minimize the cost, minimize the time in transportation problem

Course Content

UNIT-1 **12 hours**

Operations Research (OR) and its Scope, Modeling in OR, Scientific Method in Operations Research, Linear Programming: Definition, mathematical formulation, standard form, Solution space, solution – feasible, basic feasible, optimal, infeasible, multiple, redundancy, degeneracy, Solution of LP Problems - Graphical Method, Simplex Method.

UNIT-II **12 hours**

Transportation Problem, Basic feasible solution using different methods (North-West corner, Least Cost, Vogel's Approximation Method), Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Assignment Problem, Hungarian Method for Assignment Problem.

UNIT-III **11 hours**

Artificial variable techniques- Two Phase Method; Big M Method, Special cases in LPP. Finding Inverse of a matrix using Simplex method, Solving system of linear equations using Simplex method.

UNIT-IV **10 hours**

Duality: Definition of the dual problem, Primal-dual relationships, Economic Interpretation of Duality, Dual simplex Method.

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:-

- *Sharma, J. K. (2016). Operations research: theory and applications. Trinity Press, an imprint of Laxmi Publications Pvt. Limited*
- *J. K. Sharma, (2012). Operations Research – Problems and Solutions, Macmillian Pub.*
- *G. Hadly (1975). Linear Programming, Narosa Publishing House*
- *A. H. Taha, (25005). Operations Research – An Introduction. Prentice HaLL.*
- *Hillier and Lieberman, (2017). Introduction to Operations Research, McGraw Hill*

Course Title:-Riemann Integration & Series of Functions	L	T	P	Credit
Course Code: BNM309	3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Illustrate the properties of Riemann integrable functions,
2. Apply Fundamental theorems of integration.
3. Illustrate the applicability of Cauchy criterion for uniform convergence and Weierstrass M-test for uniform convergence.
4. Approximate transcendental functions in terms of power series as well as, differentiation and integration of power series.

Course Content

UNIT-I **12 hours**

Riemann Integration Definition of Riemann integration, Inequalities for upper and lower Darboux sums, Necessary and sufficient conditions for the Riemann integrability, Definition of Riemann integration by Riemann sum and equivalence of the two definitions, Riemann integrability of monotone functions and continuous functions, Properties of Riemann integrable functions, Definitions of piecewise continuous and piecewise monotone functions and their Riemann integrability, intermediate value theorem for integrals, Fundamental theorems (I and II) of calculus, and the integration by parts.

UNIT-II **10 hours**

Improper Integral Improper integrals of Type-I, Type-II and mixed type, Convergence of beta and gamma functions, and their properties.

UNIT-III **13 hours**

Sequence and Series of Functions Pointwise and uniform convergence of sequence of functions, Theorem on the continuity of the limit function of a sequence of functions, Theorems on the interchange of the limit and derivative, and the interchange of the limit and integrability of a sequence of functions. Pointwise and uniform convergence of series of functions, Theorems on the continuity, derivability and integrability of the sum function of a series of functions, Cauchy criterion and the Weierstrass M-test for uniform convergence.

Unit-IV **10 hours**

Power Series Definition of a power series, Radius of convergence, Absolute convergence (Cauchy–Hadamard theorem), Uniform convergence, Differentiation and integration of power series, Abel's theorem.

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

Suggested Readings:-

- *Bartle, Robert G., & Sherbert, Donald R. (2015). Introduction to Real Analysis (4th ed.). Wiley India Edition. Delhi.*
- *Denlinger, Charles G. (2011). Elements of Real Analysis. Jones & Bartlett (Student Edition). First Indian Edition. Reprinted 2015.*
- *Ghorpade, Sudhir R. & Limaye, B. V. (2006). A Course in Calculus and Real Analysis. Undergraduate Texts in Mathematics, Springer (SIE). First Indian reprint.*
- *Ross, Kenneth A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer.*

Course Title:-Mathematical Methods

Course Code: BNM310

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Apply Integral Transforms, Volterra and Fredholm integral equations.
2. Illustrate the basic concepts of Laplace transforms of elementary functions.
3. Explain the method of reduction of Inverse Laplace transforms using partial fractions, Convolution etc.
4. Apply Fourier Transforms, properties of Fourier Transforms, Inverse Fourier transforms methods.

Course Content

UNIT I **12 hours**

Integral Transforms: Definition, Kernel. Integral Equations, Definition, Volterra and Fredholm integral equations. Solution by separable kernel, Neumann's series resolvent kernel and transform methods.

UNIT II **12 hours**

Laplace Transforms: Definition, Existence theorem, Linearity property, Laplace transforms of elementary functions, First Shifting Theorem, Second Shifting Theorem, Initial-Value Theorem, Final-Value Theorem, The Laplace Transform of derivatives, integrals and Periodic functions.

UNIT III **11 hours**

Inverse Laplace transforms: Inverse Laplace transforms of simple functions, Inverse Laplace transforms using partial fractions, Convolution, Solutions of differential and integro-differential equations using Laplace transforms. Dirichlet's condition.

UNIT IV **10 hours**

Fourier Transforms: Fourier Complex Transforms, Fourier sine and cosine transforms, Properties of Fourier Transforms, Inverse Fourier transforms.

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

Suggested Readings:-

- *I.N. Sneddon, (1974),The use of Integral Transforms, Tata Mc Graw Hill, Publishing Company Ltd, New Delhi, 1974.*
- *R.P. Kanwal, (1971), Linear integral equations theory and techniques, Academic Press, New York.*
- *C.M. Bender and S.A. Orszag, (1978), Advanced mathematical methods for scientists and engineers, McGraw Hill, New York.*
- *J. H. Davis, (2004), Methods of Applied Mathematics with a MATLAB Overview, Birkhäuser, Inc.,Boston, MA.*
- *Murry R. Spiegal: Laplace Transform (SCHAUM Outline Series), McGraw-Hill.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Basic Mathematics

Course Code: BNM318

L	T	P	Credit
2	0	0	2

Total Hours: 30

Learning Outcomes

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

1. Prove basic set equalities Demonstrate the ability to write and evaluate a proof.
2. Relate the concept of Arithmetic progression and Geometric progression and their sum.
3. Explain the description of algebraic properties of complex numbers.
4. Explore the theory of Matrices and Determinants.

Course Content

UNIT-I **8 hours**

Sets: Basic Definitions, subsets, power set, set operations. Ordered pairs, Cartesian product of sets. Functions and Relations: Definition of relation, domain, co-domain and range of a relation. Binary relations, equivalence relations, partition. Function as a special kind of relation from one set to another. Domain, co-domain and range of a function.Composition, inverse.Real valued function of the real variable, constant, identity, Polynomial, rational, Functions. Activity: Students will try to find the applications of functions and relations.

UNIT-II **7 hours**

Sequence and series, Arithmetic Progression (A.P), Arithmetic Mean (A.M), Geometric Progression (G.P), general term of a G.P, sum of n terms of a G.P. Arithmetic and Geometric series, infinite G.P. and its sum. Geometric mean (G .M), relation between A.M and G.M. Activity: Students will solve some problems related to these sequences and series.

UNIT-III **8 hours**

Need for complex numbers, especially $\sqrt{-1}$, to be motivated by inability to solve every Quadratic equation. Brief description of algebraic properties of complex numbers.Argand plane and polar representation of complex numbers, Statement of Fundamental Theorem of Algebra, nth roots of Unity. Activity: Students will solve some problems related to the complex number.

UNIT-IV **7hours**

Matrices and types of matrices, Operations on Matrices, Determinants of Matrix and Properties of Determinants, Minors and Cofactor and Adjoint of a square matrix, Singular and non-singularMatrices, Inverse of a Matrix, Eigenvalues and Eigenvectors, Cayley Hamilton theorem.

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

Suggested Readings:-

- *E. Kreyszig. (1990).Advanced Engineering Mathematics.9th edition, John Wiley & Sons.*
- *E.Kreyszig. (2002).Advanced Engineering Mathematics. 9th edition, John Wiley & Sons.*
- *G. B. Thomas and R. L. Finney. (2015). Calculus and Analytic Geometry. 11th edition, Pearson India.*
- *R. K. Jainand S.R.K. Iyengar. (2002).Advanced Engineering Mathematics.8th Edition, Narosa Publications.*

Course Title: Physics for Competitive Exams

Course Code: BNM319

L	T	P	Credit
2	0	0	2

Total Hours: 30

Learning Outcomes

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

1. Demonstrate their knowledge of the basic scientific principles and fundamental concepts and skills of the field.
2. Solve problems utilizing scientific reasoning, quantitative methods, and acquired knowledge and skills.
3. Demonstrate knowledge of the basic physics, and technological advancements.
4. Apply knowledge of linear motion, forces, energy, and circular motion to explain natural physical processes and related technological advances.

Course Content

UNITI **8 Hours**

Introduction to Physics, The Universe: Stars, Sun, Asteroids: In a nutshell, The Solar System and Satellites, S.I. UNITs of Measurement, Motion and Mechanics, Laws of Motion, Fundamental Forces in nature, rotation and revolution of the earth, Work, Energy & Power, Gravitation.

UNIT –II **7 Hours**

Light and electromagnetic radiations, Refraction of Light , Reflection of light from Spherical Mirrors, Reflection of Light, Refraction of light by Spherical Lenses, Refraction of light through a glass prism, The Human Eye and its defects, Electromagnetism, Sound: Doppler Effect and Echo

UNIT III **10 Hours**

Electricity & Magnetism, Electric current, resistance of a conductor, Magnetic effect of electric current. Thermal Expansion of Solids, Liquids and Gases, Mechanical Properties of Fluids, Radioactivity ,Nuclear Fission and Fusion, Atomic Theories, Modern physics .

UNIT IV **5 Hours**

Various Scientific Instruments, First in Space, Important Inventions, recent phenomenon in the news, Nobel Prize winners and their achievements, ISRO, DRDO, Ministry of Science & Technology.

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

SUGGESTED READINGS:

1. *How Things Work: The Physics of Everyday Life, 3rd edition, by Louis A. Bloomfield, Wiley, 2006.*

2. B.B. Laud (2002), Lasers and Non-linear Optics, New Age Pub.

Course Title: Chemistry in Everyday Life

Course Code: BNM320

L	T	P	Credit
2	0	0	2

Total Hours: 30

Learning Outcomes

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

1. Explore the various air pollutant and its control measures.
2. Differentiate between different types of soaps based on properties like lather formation and cleaning effect.
3. Analyze the strategies of eco-friendly polymers.
4. Evaluate the kinetics, mechanism of condensation polymerization & methodology used of control molecular weight of polymers.

Course Content

UNIT-I **7 Hours**

Air pollution: Air pollutants, prevention and control, Greenhouse gases and acid rain; Ozone hole and CFC's; Photochemical smog and PAN; Catalytic converters for mobile sources; Bhopal gas tragedy; Control measures.

UNIT-II **8 Hours**

Polymers in everyday life: Types and classification of polymers. Source and general characteristics of natural and synthetic polymers; Typical examples of polymers used as commodity plastics, textiles, electronic and automobile components, medical and aerospace materials; Problems of plastic waste management; Strategies for development of environmental friendly polymers.

UNIT III **7 Hours**

Detergents- pollution aspects, eutrophication; Pesticides and insecticides- pollution aspects; Heavy metal pollution; Solid pollutants - treatment and disposal; Treatment of industrial liquid wastes; Sewage and industrial effluent treatment; Composition of soil - inorganic and organic components in soil- micro and macro nutrients

UNIT IV **8 Hours**

Fertilizers: Classification of Fertilizers- Straight Fertilizers, Compound/Complex Fertilizers, Fertilizer Mixtures. Manufacture and general properties of Fertilizer products- Urea and DAP. Ceramics: General properties, porous and non-porous wares; Manufacturing process, extrusion, turning, drying, and decoration

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

SUGGESTED READINGS:-

- *Swaminathan and Goswamy(2006)Handbook on Fertilizer Technology, 6 th ed. 2001, FAI.*
- *J. R. Fried(2007)Polymer Science and Technology, (Prentice Hall).*
- *P. Atkins and J. de Paula(2002)Physical Chemistry –-7 th Ed., Oxford University Press.*

Semester -IV

Course Title: Nuclear and Particle Physics
Course Code:- BNM415

L	T	P	Credit
4	0	0	4

Total Hours: 60

Learning Outcomes

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

1. Analyze the 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 model to explain the nucleus structure
4. Categorize the different types of the radioactive decay and kinetics of nuclear reactions.

Course Content

UNITI **15 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.Experimentalevidence of magic numbers and its explanation.

UNITII **15 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.

UNITIII **15 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. SECTION –C Radiation

Detectors:Ionization chamber, Proportional counter, GM counter, Scintillation counter, Solid state detectors.

UNITIV **15 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.*

Course Name: Quantum Chemistry & Spectroscopy

L	T	P	Credits
4	0	0	4

Course Code: BNM401
Total Hours: 60

Learning Outcomes

After completion of this course, the learner 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 **15 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 **16 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 **16 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 **13 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: Abstract Algebra

L	T	P	Credit

Course Code: BNM402

4	0	0	4

Total Hours: 60

Learning Outcomes

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

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

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: Organic Synthesis Lab
Course Code: BNM416

L	T	P	Credit
0	0	2	1

Total Hours: 15

Learning Outcomes

After completion of this course, the learner 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 CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration
9. Study the 200-500 nm absorbance spectra of KMnO4 and K2Cr2O7 (in 0.1 M H2SO4) and determine the λmax 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 K2Cr2O7.

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: Nuclear and Particle Physics Lab
Course Code:- BNM417

L	T	P	Credit
0	0	2	1

Total Hours: 15

Learning Outcomes

After completion of this course, the learner 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: Value Education
Course Code: BNM418

L	T	P	Credit
2	0	0	2

Total Hours: 30

Learning Outcomes

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

1. Explain the meaning of values and culture.
2. Create a communal harmonious society and practice unity in diversity
3. Identify the power of thoughts and words.
4. Correlate the relationship between values and human rights.

Course Content

UNIT I **8 Hours**

Introduction to Value Education – Definition, Views on Education – Socrates, Plato, Aristotle, Mahatma Gandhi, Swami Vivekananda, Sri Aurobindo, Rabindrath Tagore and Dr. R. Radhakrishnan, Concept of Human Values, Family Values, Aesthetic Values, Ethical Values, Spiritual Values.

UNIT II **7 Hours**

Character Formation: Self-Discipline, Self-Confidence, Self-Initiative, Self-awareness – Empathy – Compassion – Forgiveness – Honesty and Courage.
Leadership qualities, Personality Development

UNIT III **8 Hours**

Religious Values and Communal Harmony : Karma Yoga in Hinduism – Love and Justice in Christianity – Brotherhood in Islam – Compassion in Buddhism – Ahimsa in Jainism – Courage in Sikhism – Need for Religious Harmony.

UNIT IV **7 Hours**

The Power of Mind : Controlling Mind, Meditation – Mudras – Yoga – Asanas, Concept of Mind in the Upanishads – Moralization of Desires – Neutralization of Anger, Five Ways to Check Worry Habit and Eradication, Benefits of Blessings, The Power of Positive Thinking.

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

SUGGESTED READINGS:-

- *Jash, P. Glimpses of Hindu Cults and Culture, Sundeep Prakashan, Delhi.*
- *NCERT,Education in Values, New Delhi.*
- *R. C. Pradhan, Language and Mind in the Upanishads, Language and Mind: The Classical*
- *Indian Perspective, ed. K. S. Prasad, Hyderabad Studies in Philosophy no. 5, Decent Books,New Delhi.*
- *Vincent Peale, Norman. Six Attitudes for Winners, Jaico Publishers.*
- *Vivekananda, Swami, Personality Development, Advaita Ashrama, Kolkata.*

Course Title: Analog Electronics
Course Code: BNM411

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Differentiate between bipolar and unipolar devices.
2. Explain how to construct a transistor amplifier and how its gain varies with frequency.
3. Analyze the depth of CB and CE characteristics, Structure of JFET and MOSFET, Transistor biasing and stabilization of operating point.
4. Design and verify electronic devices and systems which will increase their employability scope in various electronics related companies.

Course Content

UNIT I **11 Hours**

Diodes: Concepts of current and voltage sources, p-n junction, Biasing of diode, V-A characteristics. Zener diode. LED, Low Capacitance Diode.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. Voltage multiplier circuits.

UNIT II **12 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, Fixed bias, Collector to base bias, Bias circuit with emitter resistor, Voltage divider biasing circuit.

UNIT III **11 Hours**

Amplifiers : Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. 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 **11 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.*

Course Title: High Energy Physics
Course Code: BNM419

L	T	P	Credit
3	0	0	3

Total Hours : 45

Learning Outcomes

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

1. Explain the need of standard model and its limitations and the properties of QCD.
2. Draw Feynman diagrams and to check if interactions are allowed or forbidden.
3. Apply the quark model for understanding the properties ofhadrons e.g. neutrons and protons.
4. Explain the symmetry in baryon decuplets and octets for JP states.

Course Content

UNIT I **12 Hours**

Introduction: Fermions and bosons, Particles and antiparticles, Quarks and leptons, Yukawa picture, Types of fundamental interactions - electromagnetic, weak, strong and gravitational, HEP Units, Bound states of quarks, Hadron, Mesons and Baryons.

UNIT II **11 Hours**

Invariance Principles and Conservation Laws: Interactions and fields in particle physics, Classical and quantum pictures Invariance in classical mechanics and in quantum mechanics types of symmetries and their breaking, Parity, Pion parity, Charge conjugation, Time reversal invariance, CP violation, CPT theorem.

UNIT III **11 Hours**

Hadron-Hadron Interactions: Cross section and decay rates, Pion spin, Isospin, Two-nucleon system, Pion-nucleon system, Strangeness and Isospin, and Hypercharge.

UNIT IV **11 Hours**

Static Quark model of Hadrons: The Eightfold way, Meson nonet, Baryon octet, Baryon Decuplet, hypothesis of quarks, SU (3) symmetry, Quark spin and color, Quark-antiquark combinations.

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

SUGGESTED READINGS :

- *D.H.Perkins,Introduction to High Energy Physics, Addison Wesley.*
- *F. Halzen and A.D.Martin,Quarks and Leptons: An Introductory Course in Modern Particle Physics, John Wiley & Sons.*
- *G.D.Coughlan, J.E.Dodd and B.M.Gripaios ,The ideas of Particle Physics: An introduction for Scientists , Cambridge University Press.*
- *D. Bailin & A. Love , Introduction to Gauge Field Theory --, Overseas Press (India) Private Limited.*
- *A. Bettini, Introduction to Elementary Particle Physics -- Cambridge University Press.*
- *Cheng & Li, Gauge Field Theory of Elementary Particle Physics -- Oxford University Press.*

Course Title: Physics of Nanomaterials
Course Code: BNM420

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Explain the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale.
2. Choose appropriate synthesis technique to synthesize quantum nanostructures of desired size, shape and surface properties.
3. Correlate properties of nanostructures with their size, shape and surface characteristics.
4. Appreciate enhanced sensitivity of nanomaterial-based sensors and their novel applications in industry.

Course Content

UNIT I **12 Hours**

Introduction to Nanomaterials: Features of nanosystems, Characteristic length scales of materials and their properties, Density of states in 1-D, 2-D and 3-D bands, Variation of density of states and band gap with size of crystal.

UNIT II **11 Hours**

Quantum Size Effect: Electron confinement in infinitely deep square well, Confinement in one dimensional well, Idea of quantum well structure, Formation of quantum well, Quantum dots and quantum wires.

UNITIII **11 Hours**

Synthesis Methods: Top-down and bottom-up approach, cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques, mechanical milling, chemical methods and self-assembly

UNIT IV **11 Hours**

Properties of Nanomaterials: Size and shape dependence of optical, electronic, photonic, mechanical, magnetic and catalytic properties.

SUGGESTED READINGS :

- *Bimerg, D., Grundmann, M., and Ledentsov, N.N., Quantum Dot Heterostructures, John Wiley Publications.*
- *Poole,C.P., Owens,F.J., Introduction to NanotechnologyJohn Wiley &Sons.*
- *Jain, K.P., Physics of Semiconductor Nanostructures, Narosa.*
- *Fendler, J.H., Nano particles and Nano-structured Films, John Wiley &Sons.*
- *Timp, G., Nanotechnology, Springer-Verlag.*

Course Title: Atomic Spectroscopy
Course Code: BNM414

L	T	P	Credit
3	0	0	3

Total Hours : 45

Learning Outcomes

After completion of this course, the learner will be 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.*

Course Title: Life Skills
Course Code: BNM421

L	T	P	Credit
2	0	0	2

Total Hours 30

Learning Outcomes

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

1. Define and Identify different life skills required in personal and professional life
2. Explain the basic mechanics of effective communication and demonstrate these through presentations
3. Apply appropriate thinking and problem solving techniques to solve new problems.
4. Take part in group discussions and understand the basics of teamwork

Course Content

UNIT I **7 Hours**

Overview of Life Skills: Meaning and significance of life skills, Life skills identified by WHO: Self- awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem solving, Effective communication, interpersonal relationship, coping with stress, coping with emotion.

UNIT II **8 Hours**

Self-awareness: definition, need for self-awareness; Coping With Stress and Emotions, Human Values, tools and techniques of SA: questionnaires, journaling, reflective questions, meditation, mindfulness, psychometric tests, feedback.

UNIT III **7 Hours**

Stress Management: Stress, reasons and effects, identifying stress, stress diaries, the four A's of stress management, techniques, Approaches: action-oriented, emotion oriented, acceptance- oriented, resilience, Gratitude Training

UNIT IV **8 Hours**

Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques.Self-Confidence, Character, Spirituality, Avoiding Procrastination, Sense of Engineering Ethics.

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

SUGGESTED READINGS:-

- *Shiv Khera, You Can Win , Macmillan Books, New York.*
- *Braun K. Mitra, Personality Development & Soft Skills, Oxford Publishers, Third impression.*
- *ICT Academy of Kerala, Life Skills for Engineers, McGraw Hill Education (India) Private Ltd.*
- *Caruso, D. R. and Salovey, The Emotionally Intelligent Manager: How to Develop and Use the Four Key Emotional Skills of Leadership, John Wiley & Sons.*
- *Kalyana, Soft Skill for Managers, First Edition; Wiley Publishing Ltd.*
- *Larry James, The First Book of Life Skills , First Edition, Embassy Books.*

Semester-V

Course Title: Quantum Mechanics

Course Code: BNM513

L	T	P	Credit
4	0	0	4

Total Hours: 60

Learning Outcomes

After completion of this course, the learner 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.

Course Content

UNITI **15 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 **15 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 **15 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 **15 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 wavefunctions 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.*

Course Title: Organic Synthesis

Course Code: BNM514

L	T	P	Credit
4	0	0	4

Total Hours: 60

Learning Outcomes

After completion of this course, the learner 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.

UNITII **14 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 **15 Hours**

Heterocyclic Compounds: Principles of hetero cyclic 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 **18 Hours**

Carboxylic Acids

Inroduction: 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 basecatalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium 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). Advancedinorganicchemistry(Vol. 6,p. 1455).NewYork:Wiley.*
- *Katritzky, A. R., & Rees, C. W. (1984). Comprehensive heterocyclic chemistry. Pergamum*Press.
- *Sainsbury, M. (Ed.). (1992). Aliphatic Compounds: Monocarboxylic Derivatives ofAliphaticHydrocarbons,TheirAnaloguesandDerivatives.Elsevier.*

Course Title: Environmental Science

Course Code: BNM515

L	T	P	Credit
2	0	0	2

Total Hours: 30

Learning Outcomes

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

1. Appreciate key concepts from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
2. Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
3. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
4. Explain core concepts and methods from ecological and physical sciences and their application in environmental problem-solving.

Course Content

UNIT I **7 Hours**

Introduction: Natural Resources and associated problems, use and over exploitation, case studies of forest resources and water resources. Concept of Ecosystem, Structure, interrelationship, producers, consumers and decomposers, ecological pyramids-biodiversity and importance. Hot spots of biodiversity

UNIT II **8 Hours**

Environmental Pollution: Definition, Causes, effects and control measures of air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measure of urban and industrial wastes. Role of an individual in prevention of pollution, Pollution case studies.

UNIT III **7 Hours**

Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

UNIT IV **7 Hours**

Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health, Human Rights, Value Education, HIV/AIDS. Women and child Welfare. Role of Information Technology in Environment and human health. Case studies

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

SUGGESTED READINGS:-

- *Aggarwal, K. C., Environment Biology, Nidi Publ. Ltd. Bikaner.*
- *Jadhav, H &Bhosale, V.M., Environment Protection and Laws. Himalaya Pub House, Delhi*
- *Rao M. N. &Datta A.K., Waste Water Treatment. Oxford & IBH Publ. Co. Pvt. Ltd.*

Course Title: Instrumentation in Physics
Course Code: BNM516

L	T	P	Credit
2	0	0	2

Total Hours: 30

Learning Outcomes

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

1. Familiarize and analyze the signal accordance to accuracy, precision, sensitivity, resolution, errors etc.
2. Use and measure frequency, phase etc. of the signal with CRO.
3. Acquire purpose, scope and concepts of signal generator and wave analyzer.
4. Design different types of bridges and their construction to find unknown values.

UNIT-I **8 Hours**

Multimeter and Voltmeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Advantage over conventional multimeter for voltage measurement.. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance.

UNIT-II **7 Hours**

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Special features of dual trace, Introduction to digital oscilloscope.

UNIT-III **7 Hours**

Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea fortesting, specifications. Distortion factor meter, wave analysis.

Impedance Bridges & Q-Meters: Block diagram of bridge. working principles of basic(balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & workingprinciples of a Q- Meter. Digital LCR bridges.

UNIT-IV **8 Hours**

Digital meters : Characteristics of a digital meter. Working principles of digital voltmeter. Block diagram and working of a digital multimeter.

Working principle oftime interval, frequency and period measurement using universal counter/ frequency counter.

SUGGESTED READINGS :

- *B L Theraja ,A text book in Electrical Technology , S Chand and Co.*
- *S. Salivahanan , Electronic Devices and circuits.*

Course Title: Instrumentation in Physics Lab

Course Code: BNM517

L	T	P	Credits
0	0	2	1

Total Hours :15

Learning Outcomes

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

1. Familiarize and analyze the signal accordance to accuracy, precision, sensitivity, resolution, errors etc.
2. Use and measure frequency, phase etc. of the signal with CRO.
3. Acquire purpose, scope and concepts of signal generator and wave analyzer.
4. Explain different types of bridges and their construction to find unknown values.

Course Content

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q-meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. To measure unknown frequency using CRO.
8. Measurement of distortion of a RF signal generator using distortion factor meter.
9. Measurement of R, L and C using a LCR bridge/ universal bridge.
10. To study Lissajous figures to know about the phase difference between the two signals and the ratio of their frequencies.
11. To configure the function generator to output a 10Vpp, 1 KHz sinusoidal wave.
12. Observe the wave forms of different frequency by using Function generator and draw its diagram measure the amplitude and frequency & calculates average & R.M.S. Values, frequency, Time Periods using CRO.

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: Numerical Methods

Course Code: BNM518

L	T	P	Credit
2	0	0	2

Total Hours: 30

Learning Outcomes

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

1. Characterize the basic concepts of operators like Solution of algebraic and transcendental equations: Bisection method, False position method, Fixed-point iteration method.
2. Solve problems using Newton forward formula and Newton backward formula and its convergence.
3. Derive Gauss's formula and Stirling's formula using Newton forward formula and Newton backward formula.
4. Calculate Simpson's 1/3, 3/8 rules using Trapezoidal rule and evaluate the summation of series finite difference techniques

Course Content

UNIT I **10 Hours**

Solution of algebraic and transcendental equations: Bisection method, False position method, Fixed-point iteration method, Newton's method and its convergence, Solution of system of non-linear equations by Iteration and Newton-Raphson method.

UNIT II **8 Hours**

Finite difference operators and finite differences, Interpolation and interpolation formulae: Newton's forward and backward difference, Central difference: Sterling's and Bessel's formula, Lagrange's interpolation formula and Newton's divided difference interpolation formula, Hermite interpolation. Program in C/C++ for Newton's forward and backward formula, Newton's divided difference formula

UNIT III **6 Hours**

Direct methods to solve system of linear equations: Gauss elimination method, Gauss-Jordan method, Gauss-Jacobi and Gauss-Seidal methods. The algebraic eigen value problems.

UNIT IV **6 Hours**

Numerical differentiation and Numerical integration by Newton cotes formulae, Trapezoidal rule, Simpson's rule, Romberg formula and their

error estimation. Numerical solution of ordinary differential equations by Euler's method, Picard's method, Taylor series and Runge-Kutta methods.

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

Suggested Readings:-

- *B. Bradie, (2007). A Friendly Introduction to Numerical Analysis, Pearson Education, India,*
- *M. K. Jain, S. R. K. Iyengar and R. K. Jain, (2007). Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India, 5th edition,*
- *C. F. Gerald and P. O. (2008). Wheatley, Applied Numerical Analysis, Pearson Education, India, 7th edition.*
- *M. Pal (2007). Numerical Analysis for scientific and engineering computation, Narosa Publication*
- *N. Ahmad (2008). Fundamental Numerical Analysis with error estimation, Anamaya Publisher.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Course Title: Numerical Methods Lab

Course Code: BNM519

L	T	P	Credit
0	0	2	1

Total Hours: 15

Learning Outcomes

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

1. Characterize the basic concepts of operators like Solution of algebraic and transcendental equations: Bisection method, False position method, Fixed-point iteration method.
2. Solve problems using Newton forward formula and Newton backward formula and its convergence.
3. Derive Gauss's formula and Stirling's formula using Newton forward formula and Newton backward formula.
4. Calculate Simpson's 1/3, 3/8 rules using Trapezoidal rule and evaluate the summation of series finite difference techniques

Course Content

1. To Find The Roots Of Non-Linear Equation Using Bisection Method.
2. To Find The Roots Of Non-Linear Equation Using Newton's Method.
3. Curve Fitting By Least – Square Approximations.
4. To Solve The System Of Linear Equations Using Gauss - Elimination Method.
5. To Solve The System Of Linear Equations Using Gauss - Seidal Iteration Method.
6. To Solve The System Of Linear Equations Using Gauss - Jorden Method.
7. To Integrate Numerically Using Trapezoidal Rule.
8. To Integrate Numerically Using Simpson's Rules.
9. To Find The Largest Eigen Value Of A Matrix By Power - Method.
10. To Find Numerical Solution Of Ordinary Differential Equations By Euler's Method. 11. To Find Numerical Solution Of Ordinary Differential Equations By Runge- Kutta Method.
12. To Find Numerical Solution Of Ordinary Differential Equations By Milne's Method. 13. To Find The Numerical Solution Of Laplace Equation.
14. To Find The Numerical Solution Of Wave Equation.
15. To Find The Numerical Solution Of Heat Equation.

Suggested Readings:-

- *Numerical methods by B.S.Grewal*
- *Numericalk method :E. Balagurusamy T.M.H*

Course Title: Special Function

Course Code: BNM520

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

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

After successful completion of the course students will be able to:

1. Solve, expand and interpret solutions of many types of important differential equations by making use of special functions and orthogonal polynomials.
2. Derive the formulas and results of certain classical special functions and orthogonal polynomials by different methods.
3. Derive the generating relations involving special functions by applying the Lie algebraic techniques.
4. Achieve the knowledge to analyze the problems using the methods of special functions and orthogonal polynomials, which helps in exploring the role of special functions and orthogonal polynomials in other areas of mathematics.

Course Content

UNIT I **13Hours**

Gamma, Hypergeometric, Bessel and Neumann Functions Introduction; Gamma Function; Hypergeometric Functions: Definition and special cases, convergence, analyticity, integral representation, differentiation, transformations and summation theorems; Bessel Functions: Definition, connection with hypergeometric function, differential and pure recurrence relations, generating function, integral representation; Neumann polynomials, Neumann series and related results; Examples on above topics.

UNIT II **12Hours**

Legendre, Hermite and Laguerre Polynomials Legendre polynomials: (i) Generating function (ii) Special values (iii) Pure and differential recurrence relations (iv) Differential equation (v) Series definition (vi) Rodrigues' formula (vii) Integral representation; Hermite polynomials: Results (i) to (vii) and expansion of xn in terms of Hermite polynomials; Laguerre polynomials: Results (i) to (vii); Examples on above topics.

UNIT III **10Hours**

Orthogonal Polynomials Simple sets of polynomials; Orthogonal polynomials: Equivalent condition for orthogonality; Zeros of orthogonal polynomials; Expansion of polynomials; Three-term recurrence relation; Christoffel Darboux formula; Normalization and Bessel's inequality.

UNIT IV **10Hours**

Orthogonality of Legendre, Hermite and Laguerre polynomials; Ordinary and singular points of differential equations, Regular and irregular singular points of hypergeometric, Bessel, Legendre, Hermite and Laguerre differential equations; Examples on above topics.

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

Suggested Readings:-

- *E. D. Rainville: Special Functions, Chelsea Publishing Co., Bronx, New York, Reprint, 1971.*
- *W. Jr. Miller: Lie Theory and Special Functions, Academic Press, New York and London, 1968.*
- *E. B. McBride: Obtaining Generating Functions, Springer Verlag, Berlin Heidelberg, 1971*

Course Title: Set Theory

Course Code: BNM521

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Apply the basic axioms and concepts of set theory.
2. Read, write and present theorems and proofs in higher mathematics.
3. Apply set theory concepts to solve problems in probability, logic and discrete mathematics.
4. Develop critical thinking skills by solving set theory problems and constructing proofs.

Course Content

Unit I **12 Hours**

Introduction: Review of informal set theory, Russell's Paradox, the need for axioms, formal language, history. Ordered pairs, relations and functions, equivalence relations, ordering relations, partial order and well orderings, trees.

Unit II **12 Hours**

The axiomatic foundation of Set Theory. Power and limitations of the axiomatic method. Axiom of choice and equivalents, paradoxes.

Unit III **11 Hours**

Cardinal and ordinal numbers, arithmetic, induction, and recursion on ω and well-founded sets.

Unit IV **10 Hours**

Infinitary combinatorics, stationery sets and clubs, filters and ideals. Further axioms and applications. Ramsey Theory

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

Course Title: Discrete Mathematics

Course Code: BNM522

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

1. Acquire knowledge in simple mathematical modeling.
2. Study advance courses in mathematical modeling, computer science, statistics, physics, chemistry etc.
3. Apply discrete mathematics concepts to analyze and design data structures and algorithms.
4. Collaborate effectively in solving complex mathematical problems and communicate solutions clearly and rigorously.

Course Content

UNITI **12 hours**

Sets, relations, Equivalence relations, partial ordering, well ordering, axiom of choice, Zorn's lemma, Functions, cardinals and ordinals, countable and uncountable sets, statements, compound statements, proofs in Mathematics, Truth tables, Algebra of propositions, logical arguments, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, modular arithmetic, Chinese remainder theorem, Fermat's little theorem.

UNITII **12 Hours**

Principles of Mathematical Induction, pigeonhole principle, principle of inclusion and exclusion Fundamental Theorem of Arithmetic, permutation combination circular permutations binomial and multinomial theorem, Recurrence relations, generating functions, generating function from recurrence relations.

UNITIII **11 Hours**

Matrices, algebra of matrices, determinants, fundamental properties, minors and cofactors, product of determinant, adjoint and inverse of a matrix, Rank and nullity of a matrix, Systems of linear equations, row reduction and echelon forms, solution sets of linear systems, applications of linear systems, Eigen values, Eigen vectors of a matrix.

UNITIV **10 Hours**

Graph terminology, types of graphs, subgraphs, isomorphic graphs, Adjacency and incidence matrices, Paths, Cycles, and connectivity, Eulerian and Hamiltonian paths, Planar graphs.

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

Suggested Readings:-

- *Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.*
- *Kenneth Rosen Discrete mathematics and its applications Mc Graw Hill Education 7th edition.*
- *V Krishna Murthy, V. P. Mainra, J. L. Arora, An Introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd.*
- *J. L. Mott, A. Kendel and T.P. Baker: Discrete mathematics for Computer Scientists and Mathematicians, Prentice Hall of India Pvt Ltd, 2008.*

Course Title: Graph Theory

Course Code: BNM523

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Explain the concepts and examples of groups and their properties.
2. Illustrate the concepts of cyclic groups, permutation groups, normal subgroups, and related results.
3. Choose thecourses in ring theory, field theory, commutative algebras, linear classical groups etc.
4. Apply the knowledge to problems in physics, computer science, economics, and engineering.

Course Content

UNITI **12 Hours**

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups, Subgroups and examples of subgroups, centralizer, normalizer, center of a group,

UNITII **12 Hours**

Product of two subgroups, Properties of cyclic groups, classification of subgroups of cyclic groups, Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group

UNITIII **11 Hours**

Properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem, external direct product of a finite number of groups, normal subgroups, factor groups.

UNITIV **10 Hours**

Cauchy's theorem for finite abelian groups, group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, first, second and third isomorphism theorems.

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

Suggested Readings:-

- *M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.*
- *Joseph 1. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.*
- *N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.*
- Joseph A. Gallian, Contemporary Abstract Algebra (4th Edition), Narosa Publishing House, New Delhi
- John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.

Course Title: General Organic Chemistry and Aliphatic Hydrocarbons
Course Code: BNM524

L	T	P	Credit
3	0	0	3

Total Hours 45

Learning Outcomes

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

1. Acquire basic knowledge of the cleavage of bonds
2. Evaluate the role of stereochemistry in synthesis of drugs
3. Recognize the different functional groups approach to various reactions
4. Analyze the synthesis of various organic compounds.

Course Content

UNIT I **12 Hours**

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect,Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles.Reactive Intermediates: Carbocations, Carbanions and free radicals.Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

UNIT II **13 Hours**

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis - trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

UNIT III **10 Hours**

Aliphatic Hydrocarbons

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

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction.Kolbe's synthesis from Grignard reagent.Reactions:Free radical, Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides

(Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation

UNIT IV **10 Hours**

Alkynes: (Upto 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.Reactions; formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

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. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.*
- *F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.*
- *Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.*

Course Title: Chemical Energetics, Equilibria and Functional Group Organic Chemistry
Course Code: BNM525

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes

After completion of this course, the learner 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.

UNIT I **12 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 entropies of substances.

UNIT II **13Hours**

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.

Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle

UNIT III **10 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).

Alkyl and Aryl Halides

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions.Preparation: from alkenes *and* alcohols; Reactions: hydrolysis, nitrite & nitro formation, nitrile& isonitrileformation.Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OHgroup) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

UNIT IV **10 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 Name: Analytical Methods in Chemistry

Course Code: BNM526

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes

After completion of this course, the learner 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 **12 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 **10 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 **15 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*

Course Name: Chemistry of s- and p-block elements, States of matter and Chemical Kinetics

Course Code: BNM527

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes

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

1. Explain the methods of extractions and purification of metals.
2. Predict the various properties of s and P block elements.
3. Differentiate between ionic and covalent and interstitial compounds of study.
4. Derive the rate equations for different order reactions.

Course Content

UNITI **11 Hours**

General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials, Ellingham diagrams for reduction of metal oxides using carbon as reducing agent.

Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process

UNIT-II **10 Hours**

***s*- and *p*-Block Elements**

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow scales), Allotropy in C, S, and P

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group

UNIT-III **12 Hours**

Compounds of *s*- and *p*-Block Elements

Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements.Concept of multicentre bonding (diborane).Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial, organic and environmental chemistry, Hydrides of nitrogen (NH_3, N_2H_4,

N_3H, NH_2OH)Oxoacids of P, S and Cl, Halides and oxohalides: PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2

UNIT IV **12 Hours**

Chemical Kinetics

The concept of reaction rates, Effect of temperature, pressure, catalyst and other factors on reaction rates,Order and molecularity of a reaction, Derivation of integrated rate equations for zero, first and second order reactions, Half–life of a reaction, General methods for determination of order of a reaction, Concept of activation energy and its calculation from Arrhenius equation.Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only)

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

Suggested Books:-

- *G. W. Castellan, (2004): Physical Chemistry 4th Edn. Narosa.*
- *J. C. Kotz, P. M. Treichel & J. R. Townsend(2009): General Chemistry Cengage Lening India Pvt. Ltd., New Delhi.*
- *J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.*
- *F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.*
- *D. F. Shriver and P. W. Atkins: Inorganic Chemistry, Oxford University Press.*
- *Gary Wulfsberg: Inorganic Chemistry, Viva Books Pvt. Ltd.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Semester VI

Course Title: Fluid Dynamics

Course Code: BNM605

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes

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

1. Determine the fluid pressure and use various devices for measuring fluid pressure.
2. Calculate Kinematics and use of law of conservation mass to fluid flow.
3. Apply Newtonian and non-Newtonian fluids and principles to analyze viscosity problems.
4. Use of different fluid study for similarity of flows.

Course Content

UNIT I **15 Hours**

Fluid Dynamics Kinematics, Equation of continuity: Eulerian and Lagrangian equations, Equations of Motions: Euler, Bernoulli, Lamb, Lagrange equations and Helmholtz equation of motion, Kinematics of vorticity and circulation.

UNIT II **15 Hours**

Motion in two dimensions: Stream function, Irrotational motion, Velocity and Complex potentials, Cauchy-Riemann's equations, Sources and Sinks, Doublets; Image system of a simple source and a doublet with respect to a plane and a circle, Milne-Thomson Circle Theorem, Blasius Theorem.

UNIT III **15 Hours**

Motion of circular cylinders and sphere, Vortex motion, Kinematics of Deformation: Newton's Law of viscosity, Newtonian and non-Newtonian fluids, Theory of stress and Rate of strain, Body and Surface forces. Navier-Stokes equations and energy equations, Laminar flow of viscous incompressible fluid,

UNIT IV **15 Hours**

Similarity of flows: Reynolds and other numbers. Boundary layer concept, 2-dimensional boundary layer equations, separation phenomena; boundary layer on a semi-infinite plane, Blasius solution; boundary layer thickness, Karman's Integral method Elementary concept on conformal Representation.

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

Suggested Readings:-

- *F. Charlton, Text book of Fluid Dynamics, CBS Publishers.*
- *J. Happel and H. Brenner, Low Reynolds Number Hydrodynamics, Kluwer Academic Publishers group (1983)*
- *N. Curle & amp; H.J. Davies, Modern Fluid Dynamics (Vol.-I), D.Van Nostrand Comp. Ltd. (London), (1964)*
- *T.C. Papanastasiou, G.C.Georgiou, A.N.Alexandrou, Viscous Fluid Flow; CRC Press (2000).*
- *W.E. Langlois, Slow Viscous flow, Macmillan, (1964)*
- *W.H. Besant and A.S. Ramsey, A Treatise on Hydrodynamics, CBS Publishers.*
- *Z.U.A. Warsi, Fluid Dynamics, CRC Press (2005)*

L	T	P	Credit
4	0	0	4

Course Title: Bioorganic Chemistry

Course Code: BNM606

Total Hours: 60

Learning Outcomes

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

1. Categorize biomolecules based on their functions and structures.
2. Explain about the synthesis of biomolecules and its role in life.
3. Study in depth about the chemistry behind the natural products.
4. Recognize the synthesis of natural products

Course Content

UNIT I **13 Hours**

Biomolecules: Carbohydrates, lipids, proteins and nucleic acids. The life of cells – The cell theory, general characteristics of cells, difference between prokaryotic and eukaryotic cells, difference between plant and animal cells, cell organells. Tissues, organs and organ systems: Animal tissues; epithelial tissues, connective tissues, muscle tissue, nervous tissue, plant tissue: maristematic tissue, permanent tissues.

UNIT II **17 Hours**

Biopolymers-DNA, RNA and Proteins-structures of monomers, bonding, and hierarchy of structural organization. Chemical methods involved in sequencing of DNA and Proteins. Chemical and biochemical synthesis of DNA: Phosphoramidite method and replication. Chemical and biochemical synthesis of peptides/proteins: solution phase and solid phase peptide synthesis methods and ribosomal synthesis of proteins.

UNIT III **15 Hours**

Chemistry of terpenes: General methods, classification andspecial isoprene rule, Characterization of terpenes: Citral, limonene, carotene, Biosynthesis of acyclicandmonocyclic terpenes from acetyl CoA,Chemistry of steroids-Structure ofcommonsteroidssuch as cholesterol and steroidal hormones.

UNIT IV **15 Hours**

Chemical and biochemical synthesis of cholesterol,Chemical synthesis of hormones using cholesterol, Chemistry of alkaloids: structure determinationandsynthesisofnicotine,morphine,cocaine.

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

SUGGESTED READINGS:-

- *David Van Vranken and Gregory A, Introduction to Bioorganic Chemistry and ChemicalBiology.GarlandScience(Taylor&Francis),2012.*
- *R.H.Thomson,ChemistryofNaturalProducts-Wiley,NewYork,1996.*
- *W.Kaim.;BioinorgnicChemistry,2nd Edition,JohnWiley.2013.*
- *I.L.Finar, AdvancedOrganic Chemistry,Vol.2ELBS,NewDelhi,1975.*
- *Bhat,S.V.,Nagasampagi,B.A.,Meenakshi,S.(2009).NaturalProd uctChemistry&Applications,NarosaPublishingHouse,NewDelhi*

Course Title: Project in Physics

Course Code: BNM607

L	T	P	Credit
0	0	4	2

Total Hours: 30

Learning Outcomes

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

1. Choose an appropriate topic for study and will be able to clearly formulate& state a research problem.
2. Compile the relevant literature and frame hypotheses for research as applicable.
3. Plan a research design including the sampling, observational, statistical and operational designs if any.
4. Arrive at logical conclusions and propose suitable recommendations on the research problem.

Guidelines for Dissertation:

The purpose of the dissertation in B.Sc NM 6thsemester is to introduce research methodology to the students. It may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem related to subject, participation in some ongoing research activity, analysis of data, etc. The work can be carried out in any thrust areas of subject(Experimental or Theoretical) under the guidance of allotted supervisor of the department. The students must submit their dissertation in the department as per the date announced for the submission**.**

Internal assessment of the dissertation work will be carried out by respective supervisor through power point presentation given by candidates during the semester. External assessment of the dissertation work will be carried out by an external examiner (nominated by the Chairperson of the Department) through power-point presentation given by candidates. This load (equivalent to 2 Hours per week) will be counted towards the normal teaching load of the teacher.

1. Dissertation will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, Objective, Literature review, methodology, results and discussions conclusion, and references.
   - The paper size to be used should be A-4 size.
   - The font size should be 12 with Times New Roman.
   - The text of the dissertation may be typed in 1.5 (one and a half) space.
   - The print out of the dissertation shall be done on both sides of the paper (instead of single side printing)
   - The total no. of written pages should be between 40 to 60 for dissertation.

2. The candidate shall be required to submit two soft bound copies of dissertation along with a CD in the department as per the date announced.

3. Dissertation will be evaluated internally by the supervisor allotted to the student during the Semester.

4. The candidate will defend her/his dissertation/project work through presentation before the External examiner at the end of semester and will be awarded marks.

5. In case, a student is not able to score passing marks in the dissertation exam, he/she will have to resubmit her/his dissertation after making all corrections/improvements & this dissertation shall be evaluated as above. The candidate is required to submit the corrected copy of the dissertation in hardbound within two weeks after the viva -voce.

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

L	T	P	Credit
0	0	4	2

Course Title: Project in Chemistry

Course Code: BNM608

Total Hours: 30

Learning Outcomes

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

1. Acquire deep insights to go for literature review.
2. Develop their knowledge through in-class discussions and survey.
3. Make use of research principles, terms, and methodology for identification of problem.
4. Find the possible project topics in the thrust areas.

Guidelines for Course:

The purpose of the course Project in Chemistry in B.Sc NM 6thsemester is to introduce research methodology to the students. It may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem related to subject, participation in some ongoing research activity, analysis of data, etc. The work can be carried out in any thrust areas of subject(Experimental or Theoretical) under the guidance of allotted supervisor of the department. The students must submit their dissertation in the department as per the date announced for the submission**.**

Internal assessment of the project work will be carried out by respective supervisor through power point presentation given by candidates during the semester. External assessment of the Project work will be carried out by an external examiner (nominated by the Chairperson of the Department) through power-point presentation given by candidates. This load (equivalent to 2 Hours per week) will be counted towards the normal teaching load of the teacher.

1. Project Report will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, Objective, Literature review, methodology, results and discussions conclusion, and references.
   - The paper size to be used should be A-4 size.
   - The font size should be 12 with Times New Roman.
   - The text of the dissertation may be typed in 1.5 (one and a half) space.
   - The print out of the dissertation shall be done on both sides of the paper (instead of single side printing)
   - The total no. of written pages should be between 40 to 60 for dissertation.

2. The candidate shall be required to submit two soft bound copies of dissertation along with a CD in the department as per the date announced.
3. Project Report will be evaluated internally by the supervisor allotted to the student during the Semester.
4. The candidate will defend her/his project work through presentation before the External examiner at the end of semester and will be awarded marks.
5. In case, a student is not able to score passing marks in the project work exam, he/she will have to resubmit her/his project work after making all

corrections/improvements &the project work shall be evaluated as above. The candidate is required to submit the corrected copy of the dissertation in hardbound within two weeks after the viva -voce.

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

Course Title: Project in Mathematics

Course Code: BNM609

L	T	P	Credit
0	0	4	2

Learning Outcomes

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

1. Study the theoretical underpinning of issues concerned with Math learning and its application at elementary, secondary, and senior secondary levels and further propose innovative solutions after real-time field testing.

2. Able to develop mathematical models around the problems**.**

3. Get hands-on experience in collecting, analyzing, and presenting numerical data.

4. Solve the problems through innovation, intervention, and entrepreneurship.

Course Content

Semester projects are practical based and involve field surveys for data collection, analysis, and interpretation. Students work in groups or individually and identify a problem from a real-world problem of pure or applied mathematics. Through fieldwork, they collect data to understand the problem and then work towards creating a sustainable solution to the issue. For implementation of the solution, relevant authorities (govt. or non-government) are roped in. Problem-solving through community involvement is one of the main focuses of these projects. The group is supervised by a mentor from the department or an External Mentor from academia, administration, industry, or any field relevant to the project objectives. Students need to identify and work on real-time Math classroom problems or Math content-related problems that can be solved through mathematical modeling and problem-solving.

Option I: Solving real time problem/context that can be translated into mathematical model.

Option II: Concretizing abstract mathematical concepts using manipulative or technology.

Option III: Developing innovative Mathematics teaching learning resources.

Guidelines for Dissertation:

The purpose of the dissertation in B.Sc NM 6thsemester is to introduce research methodology to the students. It may consist of a review of some research papers, the development of a laboratory experiment, fabrication of a device, working out some problems related to the subject, participation in some ongoing research activity, analysis of data, etc. The work can be carried out in any thrust areas of the subject (Experimental or Theoretical) under the guidance of the allotted supervisor of the department. The students must submit their dissertations in the department as per the date announced for the submission**.**

Internal assessment of the dissertation work will be carried out by the respective supervisor through power point presentation given by candidates during the semester. External assessment of the dissertation work will be carried out by an external examiner (nominated by the Chairperson of the Department) through a PowerPoint presentation given by candidates. This load (equivalent to 2 hours per week) will be counted towards the normal teaching load of the teacher.

1. The dissertation will contain a cover page, a certificate signed by the student and supervisor, table of contents, introduction, Objective, Literature review, methodology, results, and discussions, Conclusion, and references.
    - The paper size to be used should be A-4 size.
    - The font size should be 12 with Times New Roman.
    - The text of the dissertation may be typed in 1.5 (one and a half) space.
    - The printout of the dissertation shall be done on both sides of the paper (instead of single-side printing)
    - The total number of written pages should be between 40 and 60 for the dissertation.
2. The candidate shall be required to submit two soft-bound copies of the dissertation along with a CD in the department as per the date announced.

3. The dissertation will be evaluated internally by the supervisor allotted to the student during the Semester.

4. The candidate will defend her/his dissertation/project work through a presentation before the External examiner at the end of the semester and will be awarded marks.

5. If a student cannot score passing marks in the dissertation exam, he/she will have to resubmit her/his dissertation after making all corrections/improvements & and this dissertation shall be evaluated as above. The candidate is required to submit the corrected copy of the dissertation in hardbound within two weeks after the viva voce.

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

SUGGESTED READINGS:-

• *Bell, Judith. Doing your research project: AGuidefor First-time Researchers in Education, Health and Social Sciences.(Fourth Edition). England: Open University Press, 2005.*

- *Guthrie, G. Basic Research Methods: An Entry to Social Science Research. Sage Publications, 2010.*
- *Mukherjee, Neela. Participatory Learning and Action with 100 Field Methods. New Delhi: Concept Publication, 2002.*
- *Thomas, G. How to do your Research Project.Los Angles: Sage Publication, 2009.*
- *Wolcott, H. TheArt of Fieldwork.Alta Mira Press, Walnut Creek, CA, 1995.*

Course Title: IT Skills for Chemists
Course Code: BNM610

L	T	P	Credit
2	0	0	2

Total Hours: 30

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

1. Get deep insights into computer fundamental knowledge and languages.
2. Use the simple programs for statistical analysis.
3. Draw the chemical structures using IT tools.
4. Analyze the chemical data with the help of excel software and spreadsheet.

Course Content

UNIT I **8 Hours**

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions, Elements of the BASIC language, BASIC keywords and commands, Logical and relative operators

UNIT II **7 Hours**

Simple programs using these concepts, Matrix addition and multiplication, Statistical analysis, BASIC programs for curve fitting, numerical differentiation and integration.

UNIT III **7 Hours**

Introductory writing activities: Introduction to word processor and structure drawing (Chem Sketch) software. Incorporating chemical structures, chemical equations, expressions from chemistry (e.g. Maxwell-Boltzmann distribution law, Bragg's law, van der Waals equation, etc.) into word processing documents.

UNIT IV **8 Hours**

Handling numeric data: Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs, Incorporating tables and graphs into word processing documents.

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

SUGGESTED READINGS :-

- *Yates, P. Chemical calculations. 2ndEd. CRC Press (2007).*
- *Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.*
- *Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001) 487 pages.*
- *Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co.(1985).*
- *Venit, S.M. Programming in BASIC: Problem solving with structure and style. Jaico Publishing House: Delhi (1996).*

Course Title: IT Skills for Chemists Lab
Course Code: BNM611

L	T	P	Credit
0	0	2	1

Total Hours: 15

Learning Outcomes

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

1. Explain the use of computer software and other statistical tools in chemical analysis.
2. Derive the mathematical relationships between different chemical variables using computational and statistical skills.
3. Analyze the chemical kinetic data using different softwares.
4. Test the simulation of chemical reactions using IT tools.

Course Content

List of Practicals

1. Excel functions LINEST and Least Squares.
2. Numerical curve fitting
3. Calculation of rate constants from concentration-time data
4. Calculation of molar extinction coefficients from absorbance data
5. Handling data from potentiometric and pH metric titrations
6. Calculation of p_{Ka} of weak acid
7. Simulation of pH metric titration curves.

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

SUGGESTED READINGS:-

- *Mortimer, R. Mathematics for Physical Chemistry. 3 rd Ed. Elsevier (2005).*
- *Yates, P. Chemical calculations. 2 nd Ed. CRC Press (2007).*
- *Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.*
- *Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001) 487 pages.*
- *Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co. (1985).*
- *Venit, S.M. Programming in BASIC: Problem solving with structure and style. Jaico Publishing House: Delhi (1996).*

L	T	P	Credit
3	0	0	3

Course Title: LASER Physics

Course Code: BNM612

Total Hours 45

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

1. Derive the Concept of stimulated emission and population inversion and broadening of spectral lines.
2. Explain the principles and design considerations of various lasers, modes of their operation and areas of their application
3. Test the origin and different line spectra and different levels of laser and three and four level laser schemes.
4. Analyze the working of optical fiber and their applications in communication,

Course Content

UNIT I **13 Hours**

Laser Fundamentals: Derivation of Einstein's coefficient. Concept of stimulated emission Absorption, spontaneous emission and population inversion coherence. Broadening of spectral lines, natural, collision and Doppler broadening. Line width, line profile, Absorption and amplification of a parallel beam of light passing through a medium.

UNIT II **12 Hours**

Derivation of Threshold condition: Introduction of three levels and four levels laser schemes, elementary theory of optical cavity, Longitudinal and transverse modes. Q- switching, Mode locking, Applications of lasers-a general outline. Basic of holography.

UNIT III **10 Hours**

Laser Systems: Types of lasers, Ruby and Nd: YAG lasers, He-Ne and CO2 leasers-construction, mode of creating population inversion and output characteristics. Semiconductor lasers, Dye lasers.

UNIT IV **10 Hours**

Optical Fiber: Fiber types, Fiber Materials, Fiber structure, optical paths Acceptance angle and numerical aperture Measurement of fiber characteristics optical fiber communication system.

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

SUGGESTED READINGS:

- *W.T. Silfvast, Laser Fundamentals, Foundation Books, New Delhi,*
- *B.B. Laud, Lasers and Non-linear Optics, New Age Pub.*
- *Andrews, "An Introduction to Laser Spectroscopy (2e)", Ane Books India.*
- *K R Nambiar, "Lasers: Principles, Types and Applications", New Age International (P) Ltd.*
- *T Suhara, "Semiconductor Laser Fundamentals", Marcel Dekker.*
- *Svelto, Lasers, Plenum Press.*

Course Title: Optics

Course Code: BNM613

L	T	P	Credit
3	0	0	3

Total Hours 45

Learning Outcomes

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

1. Explain the basic difference between interference and diffraction, and the concept of polarization and its applications
2. Analyze the Michelson's interferometer experiment, nature of fringes, fringes width and its failure and outcomes.
3.Solve problems in optics by selecting the appropriate equations and performing numerical or analytical calculations like Fabry Perot and Newton rings
4. Interpret various natural optical phenomenon which is happening in their surroundings.

Course Content

UNITI **10 Hours**

Coherence: Concept of coherence, Spatial and temporal coherence. Coherence time, Coherence length, Area of coherence.

UNITI **12 Hours**

Interference: Conditions for observing interference fringes, Young's double slit experiment, Interference due to reflected and transmitted light, Interference by wave front division and amplitude division. Michelson's interferometers: working, Principle and nature of fringes.

UNITIII **12 Hours**

Diffraction: Huygens-Fresnel theory, half-period zones, Zone plates, Distinction between Fresnel and Fraunhofer diffraction, Fraunhofer diffraction at rectangular and circular apertures, Effects of diffraction in optical imaging, The diffraction grating, its use as a spectroscopic element and its resolving power.

UNITIV **11 Hours**

Polarization: Concept and analytical treatment of un-polarized, plane polarized and elliptically polarized light. Double refraction, Nicol prism, Sheet polarizer, Wire grid polarizers, Retardation plates, Production and analysis of polarized light (quarter and half wave plates)

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

SUGGESTED READINGS:-

- *Born and Wolf, Optics , Pergamom Press, 3rd edition*
- *F.A. Jenkins and Harvery E. White, Fundamentals of Optics, McGraw Hill 4th edition*
- *AjoyGhatak, Optics, McMillan India 2nd edition, 7th reprint*
- *H.E. White, Introduction to Atomic Spectra, McGraw Hill Book Co.*

Course Title: Advanced Quantum Mechanics

Course Code: BNM614

L	T	P	Credit
3	0	0	3

Total Hours 45

Learning Outcomes

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

1. Explain the operator postulates.
2. Illustrate the key approximation methods in quantum mechanics.
3. Apply the mathematical frameworks (e.g. perturbation theory) to physics problems
4. 4.Evaluate approximation methods in quantum mechanics.

Course Content

UNIT I **12 Hours**

Scattering Theory: Formulation of scattering theory, scattering amplitude, cross section, Partial wave analysis, optical theorem

UNIT II **11 Hours**

Born approximation: Phase shifts, scattering length and effective range, Low energy scattering Born approximation and its validity.

UNIT III **11 Hours**

Perturbation Theory I: Time dependent perturbation theory, Transition probability Constant Perturbation and Fermi's-Golden rule, Harmonic Perturbation, Selection rules for electric dipole radiation.

UNIT IV **11 Hours**

Perturbation Theory II: Adiabatic approximation, Sudden approximation, semi classical treatment of an atom with electromagnetic radiation.

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

SUGGESTED READINGS :

- *P.M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, Tata Mc Graw-Hill, New Delhi.*
- *L.I. Schiff, Quantum Mechanics, McGraw-Hill*
- *David J. Griffiths, Introduction to Quantum mechanics, Pearson.*

- *V. Devanathan, Quantum Mechanics, Narosa Publishing House, New Delhi.*
- *P.A.M. Dirac, The Principles of Quantum Mechanics, Oxford University Press, London.*
- *B.K. Agarwal, Quantum Mechanics and Field Theory, Lokbharti Publications, India.*

Course Title: Mathematical Physics

Course Code: BNM615

L	T	P	Credit
3	0	0	3

Total Hours 45

Learning Outcomes

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

1.Write a problem in Physics in the language of Mathematics.
2.Identify a range of diverse mathematical techniques to formulate and solve a problem in basic Physics.
3.Analyze some of the basic mathematical concepts and methods.
4. Apply the knowledge and understanding of these mathematical methods to solve problems in a number of elementary branches of Physics.

Course Content

UNIT I **12 Hours**

Vectors Algebra : Cartesian system of base vectors: orthogonal basis, position vector.Cauchy's inequality, Vector differentiation: derivative of a vector, del operator, Gradient and its concept, Divergence, Curl and Laplacian operators! line integral, conservative forces, Gauss' divergence theorem, applications to electrostatics, heat conduction.

UNIT II **11 Hours**

Vector Calculus : Green's theorem, Applications of Green's theorem, Stokes theorem, Applications of Stokes theorem. Standard vector identities involving operator with their proofs.

UNIT III **11 Hours**

Generalised curvilinear coordinates: orthogonal curvilinear coordinates, scale factors and unit vectors, expressions for gradient, divergence, curl and Laplacian, expressions in plane polar coordinates, cylindrical coordinates, spherical polar coordinates.

UNIT IV **11 Hours**

Matrices : Column matrix, row matrix, null matrix, matrix operations: addition, multiplication, inner product, direct product. Derivative of a matrix, integral of a matrix. Partitioned matrices, sub-matrices.
Transpose, complex conjugate, hermitian conjugate. Special matrices: unit matrix, diagonal matrix, singular matrix, cofactor matrix, adjoint of a matrix, self-adjoint matrix, symmetric matrix, skew-symmetric matrix.

SUGGESTED READINGS :

- *G.B. Arfken, H.J. Weber, F.E. Harris,Mathematical Methods for Physicists, Elsevier.*
- *James Nearing,Mathematical Tools for Physics,Dover Publications.*
- *D.A. McQuarrie, Mathematical methods for Scientists and Engineers, Viva Book.*
- *D.G. Zill and W.S. Wright Advanced Engineering Mathematics, Jonesand Bartlett Learning*
- *S.Pal and S.C. Bhunia, Engineering Mathematics, Oxford University Press.*