GURU KASHI UNIVERSITY

Bachelors of Science

(B.Sc. NM.)

Session: 2022-23

Department of Physics

PROGRAMME 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**
BNM101	Inorganic Chemistry	Core	4	0	0	4
BNM102	Matrix and Co-ordinate Geometry	Core	4	0	0	4
BNM103	Mechanics	Core	4	0	0	4
BNM104	Inorganic Chemistry Lab-I	Skill Based	0	0	4	2
BNM105	Physics Lab-I	Skill Based	0	0	4	2
Ability Enhancement (any one of the following)						
BNM106	Communicative skill	Ability Enhancement	2	0	0	2
BNM107	Environmental Science					
Discipline Elective (Any one of the following)						
BNM108	Condensed Matter Physics	Discipline Elective	3	0	0	3
BNM109	Waves & Oscillation					
BNM110	LASER Physics					
BNM111	Radiation Physics					
BNM199		MOOC	--	--	--	2
Total			**17**	**0**	**8**	**23**

Semester – II						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNM201	Physical Chemistry	Core	4	0	0	4
BNM202	Calculus	Core	4	0	0	4
BNM203	Linear Algebra	Core	4	0	0	4
BNM204	Optics	Core	4	0	0	4
BNM205	Physical Chemistry Lab-II	Skill Based	0	0	4	2
BNM206	Physics Lab-II	Skill Based	0	0	4	2
BNM207	MATLAB programming I	Skill Based	0	0	4	2
Discipline Elective (Any one of the following)						
BNM208	Differential Equations	Discipline Elective – II	3	0	0	3
BNM209	Differential Geometry					
BNM210	Probability and Statistics					
BNM211	Number Theory					
Total			**19**	**0**	**12**	**25**

Semester-III						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNM301	Organic Chemistry	Core	4	0	0	4
BNM302	Inorganic Chemistry	Core	4	0	0	4
BNM303	Analytical Geometry and Vector Analysis	Core	4	0	0	4
BNM304	Quantum Mechanics	Core	4	0	0	4
BNM305	Physics Lab-III	Skill Based	0	0	4	2
BNM306	Organic Chemistry Lab-III	Skill Based	0	0	4	2
Discipline Elective (Any one of the following)						
BNM307	Complex Analysis	Discipline Elective- III	3	0	0	3
BNM308	Linear Programming Problem					
BNM309	Riemann Integration & Series of Functions					
BNM310	Mathematical Methods					
Discipline Elective (Any one of the following)						
BNM311	Pharmaceutical Chemistry	Discipline Elective-IV	3	0	0	3
BNM312	Analytical Methods in Chemistry					
BNM313	Polymer Chemistry					
BNM314	Pesticide Chemistry					
BNM399		MOOC	--	--	--	--
Total			**22**	**0**	**8**	**26**

Semester-IV						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNM401	Quantum Chemistry & Spectroscopy	Core	4	0	0	4
BNM402	Abstract Algebra	Core	4	0	0	4
BNM403	Electricity & Magnetism	Core	4	0	0	4
BNM404	Chemistry Lab-IV	Skill Based	0	0	4	2
BNM405	Physics Lab-IV	Skill Based	0	0	4	2
BNM406	Operations Research and Linear Programming Problems	Skill Based	2	0	0	2
Discipline Elective (Any one of the following)						
BNM407	Metric Spaces	Discipline Elective-V	3	0	0	3
BNM408	Mathematical Statistics					
BNM409	Numerical Methods					
BNM410	Mechanics					
Discipline Elective (Any one of the following)						
BNM411	Analog Electronics	Discipline Elective-VI	3	0	0	3
BNM412	Reactor Physics					
BNM413	Nano Science					
BNM414	Atomic Spectroscopy					
Total			**20**	**0**	**8**	**24**

Semester-V						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNM501	Organic Chemistry	Core	4	0	0	4
BNM502	Nuclear and Particle Physics	Core	4	0	0	4
BNM503	Statistical Physics & Thermodynamics	Core	4	0	0	4
BNM504	Real Analysis	Core	4	0	0	4
BNM505	Chemistry Lab - V	Skill Based	0	0	4	2
BNM506	Physics lab-V	Skill Based	0	0	4	2
BNM507	MATLAB programming II	Skill Based	0	0	4	2
Discipline Elective (Any one of the following)						

BNM508	Green Chemistry	Discipline Elective-VII	3	0	0	3
BNM509	Applications of Computers in Chemistry					
BNM510	Chemistry of Main Group Elements, Theories of Acids and Bases					
BNM511	Molecules of Life					
BNM599		MOOC	--	--	--	--
Value Added Course (For other departments also)						
BNM512	Life Skills	Value Added Course	1	0	0	1
Open Elective (For other departments)						
		OEC	2	0	0	2
Total			**22**	**0**	**12**	**28**
Open Elective (For other departments)						
BNM513	Basic Mathematics	OEC	2	0	0	2
BNM514	Physics for competitive exams					
BNM515	Chemistry in Everyday Life					

Semester-VI						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
BNM601	Research Methodology	Research based skill	4	0	0	4
Choose any one of the following						
BNM602	Innovative Research Project in Physics	Research Skill based	NA	NA	NA	12
BNM603	Innovative Research Project in Chemistry					
BNM604	Innovative Research Project in Mathematics					
Total			**4**	**0**	**0**	**16**
Grand Total						**142**

Evaluation Criteria for Theory Courses

A. Continuous Assessment: [25 Marks]

i. Surprise Test (Two best out of three) - (10 Marks)
ii. Term paper (10 Marks)
iii. Quiz (10 Marks)
iv. Assignment(s) (10 Marks)
v. Attendance (5 marks)

B. Mid Semester Test-1: [30 Marks]
C. MST-2: [20Marks]
D. End-Term Exam: [20 Marks]

Evaluation Criteria for other courses has been given separately with the respective courses

SEMESTER: 1st

Course Name: Inorganic Chemistry

Course Code: BNM101

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1. Predict physical and electronic properties of atoms using current models.
2. Describe the physical and electronic properties of solid-state materials.
3. Help in simulated modeling of matter fabricated at Nano levels.
4. Analyze electron gain enthalpy, trends of electron gain enthalpy

Course Content

UNIT -I **14 Hours**

Atomic Structure: Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals.
Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

UNIT -II **16 Hours**

Periodicity of Elements: s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with

reference to s & p-block.
(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
(b) Atomic radii (van der Waals)
(c) Ionic and crystal radii.
(d) Covalent radii (octahedral and tetrahedral)
(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
(f) Electron gain enthalpy, trends of electron gain enthalpy.
(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

UNIT -III **20 Hours**

Chemical Bonding:(i) Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.
(ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N2, O2, C2, B2, F2, CO, NO, and their ions; HCl, BeF2, CO2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.
(iii) Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
(iv) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

UNIT -IV **10 Hours**

Oxidation-Reduction: Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.

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

Case analysis.

SUGGESTED READINGS:-

1. Lee, J.D. Concise(1991).Inorganic Chemistry, ELBS.
2. Douglas, B.E. and Mc Daniel, D.H.,(1970)Concepts & Models of Inorganic Chemistry, Oxford.
3. Atkins, P.W. & Paula, J.(2016) Physical Chemistry, Oxford Press, 2006.
4. Day, M.C. and Selbin, J. (2015) Theoretical Inorganic Chemistry, ACS Publications.

Course Title: Matrices and Co-ordinate geometry

Course Code: BNM102

L	T	P	Credits
4	0	0	4

Total Hours:60

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

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

Course Content

UNIT I **14 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 ofa matrix.

UNIT II **16 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 **13 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 **17 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, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

SUGGESTED READINGS: -

1. Hari Kishan, (2008), *A Textbook of Matrices*, Atlantic Publishers.
2. Fuzhen Zhang, (1999), *Matrix Theory- Basic Results and Techniques*, Springer.
3. Shanti Narayan, P.K. Mittal, (2010), *A Textbook of Matrices*, S Chand & Company.
4. R.G. Bartle & D.R. Sherbert, (1999), *Introduction to Real Analysis*, John Wiley & Sons.
5. T.M. Apostal, (1974), ,Vol. I, John Wiley & Sons Inc.
6. Ajit Kumar and S. Kumaresan, (2019), *A Basic Course in Real Analysis*, CRC Press.
7. S. Balachandra Rao & C. K. Shantha, (1992), *Differential Calculus*, New Age Publication.
8. H. Anton, I. Birens and S. Davis, (2007), *Calculus*, John Wiley and Sons, Inc.
9. G.B. Thomas and R.L. Finney, (2010), Calculus, Pearson Education.
10. P.K. Jain and Khalil Ahmad: A Text Book of Analytical Geometry of two Dimensions, Wiley Eastern Ltd. 1994.
11. Gorakh Prasad and H. C. Gupta: Text Book on Coordinate Geometry, Pothishala Pvt. Ltd., Allahabad. 2000.

12. Suggested digital platform: NPTEL/SWAYAM/MOOCs
13. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Course Name: Mechanics

Course Code: BNM103

L	T	P	Credits
4	0	0	4

Total Hours:60

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

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

Course Content

UNIT -I **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 cylinders, spherical shell, solid and hollow spheres.

UNIT -II **14 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, Gravitational and Electrostatic self-energy. Gravitational energy of the Galaxy and of uniform sphere; Orbits, equation of orbit, turning points, eccentricity. Two-body problem - reduced mass,Kepler Laws.

UNIT -III **18 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, Transformation of relativistic momentum-,velocity and energy, relation between relativistic momentum and energy.

UNIT -IV **13 Hours**

Elastic and Inelastic Scattering : Types of Scattering and conservation laws, Laboratory and center 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, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

SUGGESTED READINGS:-

1. Berkeley, Mechanics, Vol. I, C. Kittle.
2. H.S. Hans & S.P. Puri (2003), Mechanics. Tata McGraw-Hill Education.
3. Daniel Kleppner& Robert J. Kolenkow,An Introduction to MachinesTata McGraw-Hill.
4. R.G. Takwale& P.S. Puranik (2000), Introduction of Classical Mechanics Tata McGraw-Hill.
5. R.H. Good (1974) ,Basic Concepts of Relativity, East-West Press, New Delhi.
6. S.P. Puri (1972) ,Special Theory of Relativity,Asia Publishing House, Bombay

Course Title: Inorganic Chemistry Lab–I
Course Code: BNM104

L	T	P	Credits
0	0	4	2

Total Hours:30

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

1. Experimental practice of quantitative volumetric analysis.
2. Develop laboratory skills in analyzing samples of different solutions.
3. Determine of the concentration or the mass of the minimum formula from the titrated chemical material composing a pure liquid or a solution.

4. Learn main objective of volumetric analysis is to determine the amount of a substance in a given sample. When dealing with volumetric analysis the concept of concentration cannot be avoided. Molarity i.e. moles per liter or decimeter is widely used Unit of concentration.

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.

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:-

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

Course Title: Physics Lab-I
Course Code: BNM105

L	T	P	Credits
0	0	4	2

Total Hours: 30

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

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

Course Content

1. Analysis of experimental data by:

i) Fitting of given data to a straight line.

ii) Calculation of probable error.

2. To study the magnetic field of a circular coil carrying current.

3. To find out polarizability of a dielectric substance.

4. To study the laser beam characteristics like; wave length using diffraction grating aperture &divergence.
5. To study laser interference using Michelson's Interferometer.

6. Study of diffraction using laser beam and thus to determine the grating element.

7. To determine numerical aperture of an optical fibre.

8. To determine attenuation & propagation losses in optical fibres.

9. To find out the frequency of AC mains using electric-vibrator.

10. To study B-H curve using CRO.

11. To find the value of gravity using simple pendulum.

12. To study one-dimensional collision using two hanging spheres of different materials.

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

SUGGESTED READINGS:-

1. C.L. Arora ,(2010), Practical Physics, S. Chand &Co.
2. R.S. Sirohi,(2012), Practical Physics, , WileyEastern.

Course Title: Communicative Skills

Course Code: BNM106

L	T	P	Credits
2	0	0	2

Total Hours:30

Course Learning Outcomes: On completion of this course, the successful students 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:-

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

Course Name: Environmental science
Course Code: BNM107

L	T	P	Credits
2	0	0	2

Total Hours: 30

Course Learning Outcomes: On completion of this course, the successful students 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. Understand core concepts and methods from ecological and physical sciences and their application in environmental problem-solving.

Course Content

Unit-I **7 Hours**

Introduction: Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness.

Natural Resources: Natural Resources and associated problems, use and over exploitation, case studies of forest resources and water resources.

Unit-II **9 Hours**

Ecosystems: Concept of Ecosystem, Structure, interrelationship, producers, consumers and decomposers, ecological pyramids-biodiversity and importance. Hot spots of biodiversity

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.

Disaster Management: Floods, earthquake, cyclone and landslides.

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. Case studies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act.

Unit-IV **7 Hours**

Air (Prevention and Control of Pollution) Act. Water (Prevention and control of pollution) Act. Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation Public awareness.

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:-

1. Agarwal, K. C. (2015)*Environment Biology*, Nidi Publ. Ltd. Bikaner.

2. Jadhav, H &Bhosale, V.M.(2018)*Environment Protection and Laws*. Himalaya Pub House, Delhi

3. Rao M. N. &Datta A.K.(2019)*Waste Water Treatment.* Oxford & IBH Publ. Co. Pvt. Ltd.

Course Title: Condensed Matter Physics

Course Code: BNM108

L	T	P	Credits
3	0	0	3

Total Hours: 45

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

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

Course Content

UNIT-I **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 zone of scc, fcc and bcc lattices, atomic form factor, structure factor of simple structures.

UNIT-II **8 Hours**

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

UNIT-III **13 Hours**

Magnetic and Dielectric 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. 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.

UNIT-IV **12 Hours**

Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation).

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

SUGGESTED READINGS:-

1. C. Kittel(2003), Introduction to Solid State Physics (Wiley Eastern).

2. S.H. Patil (1985), Elements of Modern Physics TMGH.

3. Puri and Babbar(1998), Solid State Physics, MGH Co.

Course Title: Waves & Oscillations

Course Code: BNM109

L	T	P	Credits
3	0	0	3

Total Hours: 45

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

1. Demonstrate the different types of the waves and their nature, electromagnetic waves & its spectrum.
2. Differentiate periodic motions & simple harmonic motions with examples like Torsion pendulum, Compound Pendulum, Damped Simple harmonic motion, Electrical Oscillations.
3. Solve for the solutions and describe the behavior of a damped and driven harmonic oscillator in both time and frequency domains.
4. Deliver the general equation of wave motion in general and TM waves in stretched strings and longitudinal waves in gases.
5. Explain how to skillfully perform experiments of wave related phenomena, for example in the area of mechanical springs, diffraction, standing mechanical waves, AC circuits etc.

Course Content

UNIT-I **12 Hours**

Simple Harmonic Oscillations:Simple harmonic motion, Equation of SHM, Velocity and acceleration of SHM, energy of a SHO, The force 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, Anharmonic Oscillations.

UNIT II **13 Hours**

Damped and Forced 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. 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, Electrical, nuclear and nuclear-magnetic resonances

UNIT III **10 Hours**

Waves in Physical Media :Types of waves, Transverse and longitudinal waves, wave length, period, angular frequency, Wave motion in one dimension, Transverse and longitudinal waves, progressive harmonic waves and their

energy, Transverse waves on a string, longitudinal waves on a rod, characteristic impedance of a string, waves in an absorbing medium, spherical waves.

UNIT IV **10 Hours**

Electromagnetic Waves : The wave equation, plane Electromagnetic wave in free space, plane Electromagnetic wave in anisotropic non conducting medium, plane Electromagnetic wave in isotropic non conducting medium, plane Electromagnetic wave in conducting medium.

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

SUGGESTED READINGS:-

1. S.P. Puri,, (2005), Text Book of Vibrations and Waves, Macmillan India Ltd.
2. H.J. Pain, ELBS & John Wiley,(2012), Physics of Vibrations and Waves, London.
3. Edward C. Jordan and K.G. Balmain,(2013), EM Waves and Radiating Systems, Prentice Hall.
4. A.P. French,(2008), Vibrations and Waves, Arnold Heinemann India, New Delhi.
5. P.K. Ghosh,(2018), The Mathematics of Waves and Vibrations, McMillan India.

Course Title: LASER Physics

Course Code: BNM110

L	T	P	Credits
3	0	0	3

Total Hours: 45

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

1. Derive the Concept of stimulated emission and population inversion and Broadening of spectral lines.
2. Explain about basic concepts of the LASER and its fundamentals.
3. Explain the principles and design considerations of various lasers, modes of their operation and areas of their application

4. Test the origin and different line spectra and different levels of laser and three and four level laser schemes.
5. 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 CO_2 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, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

SUGGESTED READINGS:

1.W.T. Silfvast(1996), Laser Fundamentals, Foundation Books, New Delhi,

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

3. Svelto,(2003) Lasers, Plenum Press, 3rd Ed., New York.

Course Title: Radiation Physics

Course Code: BNM111

L	T	P	Credits
3	0	0	3

Total Hours: 45

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

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

Course Content

UNIT I **15 Hours**

Ionizing Radiations and Radiation Quantities: Types and sources of ionizing radiation, fluence, energy fluence, kerma, exposure rate and its measurement – The free air chamber and air wall chamber. Absorbed dose and its measurement; Bragg Gray Principle, Radiation dose Units- rem, rad, Gray and Sievert dose commitment, dose equivalent and quality factor.

UNIT II **10 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 **10 Hours**

Radiation Effects and Protection: Biological effects of radiation at molecular level, Permissible dose to occupational and non-occupational workers, maximum permissible concentration in air and water, safe handling of radioactive materials. The ALARA, ALI and MIRD concepts, Rad waste and its disposal, simple numerical problems.

UNIT IV **10 Hours**

Radiation Shielding: Thermal and biological shields, shielding requirement for medical, industrial and accelerator facilities, shielding materials, radiation attenuation calculations – The point kernal technique, radiation attenuation from a uniform plane source.

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

SUGGESTED READING:

1. S.Glasstone and A. Seasonke (2014), Nuclear Reactor Engineering, Springer Publications.
2. Frederic Alan Smith (2000),Primer In Applied Radiation Physics,World Scientific Publishers.

Semester : 2nd

Course Title: Physical Chemistry
Course Code: BNM201

L	T	P	Credits
4	0	0	4

Total Hours:60

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

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

Course Content

UNIT-I **18 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 (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. 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-II **12 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-III **12 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.

UNIT-IV **18 Hours**

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; dissociation constants of mono-, di-and triprotic acids (exact treatment). Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts – applications of

solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

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

SUGGESTED READINGS:-

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

Course Name: Calculus
Course Code: BNM202

L	T	P	Credits
4	0	0	4

Total Hours: 60

1. Recall the idea of derivative, rules of differentiation and understand the concept of p-r equation.
2. Learn the concepts of curvature, circle of curvature, evaluate and apply the concepts to solve problems.
3. Recognize the rules of identifying asymptotes employ the same to different curves.
4. Acquire the knowledge about hyperbolic functions and compare it with circular functions, trigonometric functions, inverse trigonometric functions and their properties.

UNIT-I **14 Hours**

Derivative of a function, the derivative as a function, derivatives of a polynomial and exponential function, the product and quotient rule, rate of change in social and natural science. Derivatives of Trigonometric , inverse trigonometric, Logarithmic and hyperbolic functions, the chain rule, implicit differentiation. higher derivatives and differentiation of Determinants.

UNIT-II **16 Hours**

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

UNIT-III **16 Hours**

Integration as inverse process of differentiation Integration of a variety of functions by substitution, by partial fractions and by parts. Evaluation of simple integrals of trigonometric, exponential and Logarithmic function. Definite integrals as a limit of a sum, Fundamental Theorem of Calculus (without proof) Basic properties of definite integrals and evaluation of definite integrals.double and Triple Integral.

UNIT-IV **14 Hours**

Integration of hyperbolic and inverse hyperbolic functions, Reduction Formulae, application of definite integral to find quadrature, length of an arc. Improper integrals and their convergence, Comparison tests, Absolute and conditional convergence, Abel's and Dirichlet's tests.

SUGGESTED READINGS:-

1. Rudin, W., Principles of Mathematical Analysis, McGraw-Hill (2013).
2. Malik, S.C. and Arora, S., Mathematical Analysis, Wiley Eastern (2010).
3. Simmons G. F., Introduction to Topology and Modern Analysis, Tata McGraw Hill (2008).
4. Jain, P. K., Ahmad Khalil, Metric Spaces, Alpha Science Publishers (2004).
5. https://www.britannica.com/science/calculus-mathematics
6. https://www.khanacademy.org/math/calculus-1

Course Title: Linear Algebra
Course Code: BNM203

L	T	P	Credits
4	0	0	4

Total Hours:60

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

1. Learn the fundamental concept of subspaces, linear combinations, linear spans, linear dependence and independence, Bases and dimensions and some of its applications.

2. Understand the concept of linear transformations, rank and nullity, and algebra of linear transformations, Invertible linear transformations etc and apply these concepts practically in real life situations.
3. Compute with the characteristic polynomial, eigen values, eigenvectors, and eigen spaces, as well as the geometric and the algebraic multiplicities of an eigen value and apply the basic diagonalization result.
4. Utilize the acquired knowledge to advance level course like fields with applications in Cryptography.

Course Content

UNIT I **14 Hours**

Vector space: Introduction, subspaces, Linear combinations, linear spans, Sums and direct sums, Linear dependence and independence, Bases and dimensions, Dimensions and subspaces, Coordinates and change of bases.

UNIT II **16 Hours**

Linear transformations: Linear transformations, rank and nullity, Linear operators, Algebra of linear transformations, Invertible lineartransformations, isomorphism.

Matrix and linear transformation: Matrix of a linear transformation, Matrix of the sum and product of linear transformations, Changeof basis, similarity of matrices.

UNIT III **16 Hours**

Linear functional: Linear functional, Dual space and dual basis, Double dual space, Annihilators, Hyperspace, Transpose of a linear transformation.

UNIT IV **14 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.

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

SUGGESTED READINGS:-

1. Friedberg, Stephen H., Insel, Arnold J., & Spence, Lawrence E. (2003). *Linear Algebra* (4th ed.). Prentice-Hall of India Pvt. Ltd. New Delhi.
2. Hadley, G, (2002), *Linear Algebra,*Narosa Publishing House, New Delhi.
2. Hoffman and Kunze, (1972),*Linear Algebra*, Prentice Hall of India, New Delhi.

3. H. Helson, (1994),*Linear Algebra*, Hindustan Book Agency, New Delhi.
4. Dutta, K. B. (2004), *Matrix and Linear Algebra*, Prentice Hall of India.
5. S. Lang, (1987), Linear Algebra, Springer.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Course Name: Optics
Course Code: BNM204

L	T	P	Credits
4	0	0	4

Total Hours:60

Course Learning Outcomes: On completion of this course, the successful students 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

UNIT-I **14 Hours**

Simple Harmonic Motion : Oscillations, Simple harmonic motion, Equation of SHM, Velocity and acceleration of SHM, energy of a SHO, The force of SHM, Differential equation and solution of SHM . Electrical Oscillations, Torsion Pendulum, Transverse Vibrations of a mass on a string, composition of two perpendicular SHMs of same period, Anharmonic Oscillations. Damped Simple Harmonic Vibrations: Decay of free Vibrations due to damping, types of damping, Determination of damping coefficients – Logarithmic decrement, relaxation time and Q-factor. Electromagnetic damping.

UNIT-II **17 Hours**

Interference: Concept of coherence, Spatial and temporal coherence. Coherence time, Coherence length, Area of coherence, 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, Interference in thin films, Role of interference in anti-

reflection and high reflection dielectric coatings. Multiple beam interference, Fabry-Perot interferometer, Nature of fringes, Newton Rings.

UNIT-III **16 Hours**

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

UNIT-IV **13 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, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

SUGGESTED READINGS:-

1. Born and Wolf (1965.), Optics ,Pergamom Press, 3rd edition
2. F.A. Jenkins and Harvery E. White (2001), Fundamentals of Optics, McGraw Hill 4th edition
3. AjoyGhatak(1997), Optics, McMillan India 2nd edition, 7th reprint
4. H.E. White, (1997) Introduction to Atomic Spectra, McGraw Hill Book Co.

Course Title: Physical Chemistry Lab-II
Course Code: BNM205

L	T	P	Credits
0	0	4	2

Total Hours:30

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

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

Course Content

List of Practical's:

1.Surface tension measurements.

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension of detergent solutions with concentration.

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.pH metry

a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.

b. Preparation of buffer solutions of different pH

i. Sodium acetate-acetic acid

ii. Ammonium chloride-ammonium hydroxide.

c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.

d. Determination of dissociation constant of a weak acid.

Note: Each student is required to perform at least ten

Experiments.

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

SUGGESTED READINGS:-

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

Course Title: Physics Lab-II
Course Code: BNM206

L	T	P	Credits
0	0	4	2

Total Hours:30

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

5. Demonstrate conceptual understanding of fundamental physics principles.
6. Communicate physics reasoning in oral and in written form.
7. Solve physics problems use qualitative and quantitative reasoning including sophisticated mathematical techniques.
8. Use experimental, conceptual and theoretical methods

Course Contents

List of Practical's:

1. Familiarization of electronics component and equipment like C.R.O., Function Generator and power supplies etc.
2. To study and verify the ohm's law.
3. To study the V-I characteristics of PN-Junction diode and determine static resistance and dynamic resistance.
4. To plot lissajous figures and determine phase angle by CRO.
5. To find maximum, minimum and range of a given set ofnumbers.
6. To compile a frequency distribution and evaluate moments such as mean: standarddeviation etc.
7. To evaluate sum of finite series and the area under acurve.
8. To establish relationship between torque and angular acceleration using fly wheel andhence to find inertia offlywheel.
9. To check the losses of transformer using open circuit and short circuittest.
10. Study of R-L-C Seriescircuit.

11. Study of R-L-C parallelcircuit.
12. To verify Kirchhoff'sLaw.

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

SUGGESTED READINGS:-

1. C.L. Arora ,(2010), Practical Physics, S. Chand &Co.
2. R.S. Sirohi,(2012), Practical Physics, , WileyEastern.

Course Title: MATLAB Programming Lab I

Course Code: BNM207

L	T	P	Credits
0	0	4	2

Total Hours:30

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

1. Understand the main features of the developing environment of MATLAB program.
2. Design simple algorithms to solve mathematical problems by using operators and conditional statements.
3. Write simple programs in MATLAB to solve scientific and mathematical problems.
4. Interpret and visualize simple mathematical functions and operations thereon using plots

List of Practical's:

1. Operating MATLAB desktop.
2. Sum of any finite number of terms.
3. Product of any finite number of terms.
4. Computation of Factorial.

5. Computation of ex ,sinh(x), cosh(x), cos(x), sin(x) etc.

6. LCM and GCD of finite number of positive integers.

7. Sorting of numbers in ascending or descending order.

8. Addition and Subtraction, multiplication of vectors.

9. Addition subtraction, multiplication of matrices.

10. Plotting of different curves along with styles, width etc.

11. Plotting of different surfaces along with styles, width etc.

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, Quiz, Case analysis.

SUGGESTED READINGS:-

1. Gilat, Amos (2004). MATLAB: *An Introduction with Applications* 2nd Edition. John Wiley & Sons. ISBN 978-0-471-69420-5.
2. Quarteroni, Alfio; Saleri, Fausto (2006). *Scientific Computing with MATLAB and Octave*. Springer. ISBN 978-3-540-32612-0.
3. Ferreira, A.J.M. (2009). *MATLAB Codes for Finite Element Analysis*. Springer. ISBN 978-1-4020- 9199-5.
4. Lynch, Stephen (2004). *Dynamical Systems with Applications using MATLAB*. Birkhäuser. ISBN 978-0-8176-4321-8.
5. Stormy Attaway , (2013), MATLAB, *A Practical Introduction to Programming and Problem Solving*, 3rd edition, , Elsevier

Core Course Title: Differential Equations
Course Code: BNM208

L	T	P	Credits
3	0	0	3

Total Hours:45

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

1. Familiarize with various methods of solving differential equations of first and second order and to have qualitative applications.
2. Solve various working rule for finding solution of linear differential equations with constant coefficients, homogeneous linear equations or Cauchy-Euler equations, linear differential equations of second orderwith variable coefficients, initial and boundary value problems etc. and model problemsin nature using ordinary differential equations.
3. Create an understanding of rings, various types of rings, characteristic of a ring, field, skew field etc. on the previous concepts of groups in 3rd semester.
4. Explore the topics polynomials over a ring, addition andmultiplication of polynomials, polynomial rings, embedding of a ring R into R[x] etc. which will lead the student to advanced course in Algebra.

Course Content

UNIT I **12 Hours**

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

UNIT II **10 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, Various methods of solution, Clairaut's form, Singular solutions, Trajectory, Orthogonal Trajectory, Self-Orthogonal family of Curves.

UNIT II **13 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 **10 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, Total differential equations, Series solutions of differential equations, Linear differential equations of second order with variable coefficients, Initial and boundary value problems.

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

SUGGESTED READINGS:-

1. G.F. Simmons, (2002), *Differential Equations with Application and Historical Notes*, Tata –McGraw Hill.

2. B. Rai, D.P. Choudhary & H. J. Freedman, (2002), A Course of Ordinary Differential Equations, Narosa.
3. Ian N. Snedden, (2013), *Elements of Partial Differential Equations,* Dover Publication.
4. L.E. Elsgolts, (1970), *Differential Equation and Calculus of variations*, University Press of the Pacific.
5. M. D. Raisinghania, (2018), *Ordinary and Partial Differential Equations*, S Chand.
6. J.B. Fraleigh, (2003), *A first course in Abstract Algebra*, Addison-wiley.
7. Joseph A Gallian, Contemporary Abstract Algebra, Brooks/Cole Cengage Learning, 2016
8. I. N. Herstein,(2006), *Topics in Algebra*, John Wiley & Sons.
9. Thomas W Hungerford, (1990), *Abstract Algebra – An Introduction*, Sauders College Publishing.
10. Suggested digital platform: NPTEL/SWAYAM/MOOCs.
11. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Core Course Title: Differential Geometry
Course Code: BNM209

L	T	P	Credits
3	0	0	3

Total Hours:45

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

1. Express the definition and parameterization of Surfaces.
2. List the surfaces of Arcs by applying some theorems.
3. Explain differential maps between surfaces and Find derivatives of such maps.
4. Give examples of Geodesics , Parallel Vector Fields Along a Curve and Parallelism

Course Content

UNIT I **10 Hours**

Curves in R^2 and R^3: Basic Definitions and Examples. Arc Length. Curvature and the FrenetSerret apparatus. The Fundamental Existence and Uniqueness Theorem for Curves. Non-Unit Speed Curves

UNITII **12 Hours**

Surfaces in R^3: Basic Definitions and Examples. The First Fundamental Form. Arc length of curves on surfaces. Normal curvature. Geodesic curvature. Gauss and Weingarten 6 Formulas

UNIT III **13 Hours**

Geodesics, Parallel Vector Fields Along a Curve and Parallelism. The Second Fundamental Form and the Weingarten Map, Principal, Gaussian and Mean Curvatures. Isometries of surfaces, Gauss's Theorem Egregium.

UNIT IV **10 Hours**

The Fundamental Theorem of Surfaces, Surfaces of Constant Gaussian Curvature. Exponential map, Gauss Lemma, Geodesic Coordinates. The Gauss-Bonnet Formula and the Gauss-Bonnet Theorem (description only).

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

SUGGESTED READINGS:-

1. Christian Bär, Elementary Differential Geometry, Cambridge University Press, 2010.
2. M. P. do Carmo, Differential geometry of curves and surfaces, Prentice Hall 1976.
3. A. Gray, Differential Geometry of Curves and Surfaces, CRC Press, 1998.
4. R. S. Millman and G. D. Parkar, Elements of Differential Geometry, Prentice Hall 1977.
5. S. Montiel and A. Ros, Curves and Surfaces, American Mathematical Society, 2005.
6. B. O'Neill, Elementary Differential Geometry, Elsevier 2006
7. John Oprea, Differential Geometry and its applications, Prentice Hall 1997.
8. A. Pressley, Elementary Differential Geometry, Springer 2010.
9. John A. Thorpe, Elementary Topics in Differential Geometry, Springer, 1979.
10. V. A. Toponogov, Differential geometry of curves and surfaces - A concise guide, Birkhauser, 2006.)

Course Title: Probability and Statistics
Course Code: BNM210

L	T	P	Credits
3	0	0	3

Total Hours:45

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

1. Understand the concepts of sample space, probability space, random variables and calculation of probability.
2. Explore the concept of Moment generating function and characteristic functions with examples also learn various concepts behind discrete and continuous distributions and calculation of their joint behaviour of two random variables.
3. Establish formulation techniques to predict one variable in terms of the other, i.e., correlation and linear regression.
4. Understand the remarkable fact that the empirical frequencies of so many natural populations, exhibit a bell shaped curve by the application of Central limit theorem.

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.

UNIT II **12 Hours**

Probability Functions and Moment Generating Function: Sample space, Probability set function, Real random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions, Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

UNIT III **13 Hours**

Bivariate Distribution :Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

UNIT IV **10 Hours**

The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers.

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

SUGGESTED READINGS:-

1. Hogg, Robert V., McKean, Joseph W., & Craig, Allen T. (2013). *Introduction to Mathematical Statistics* (7th ed.). Pearson Education, Inc.
2. Miller, Irwin & Miller, Marylees. (2014). John E. Freund's *Mathematical Statistics with Applications* (8th ed.). Pearson. Dorling Kindersley (India).

3. Ross, Sheldon M. (2014). *Introduction to Probability Models* (11th ed.). Elsevier Inc. AP.
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Course Title: Number Theory
Course Code: BNM211

L	T	P	Credits
3	0	0	3

Total Hours:45

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

1. Grasp some of the open problems related to prime numbers, viz., Goldbach conjecture etc.
2. Solve some number theoretic functions and modular arithmetic.
3. Explore the solving methods of order of an integer modulo *n*, Primitive roots for primes, Composite numbers etc.
4. Establish formulation techniques on public crypto systems, in particular, RSA

Course Content

UNIT I **12 Hours**

Distribution of Primes and Theory of Congruencies: Linear Diophantine equation, Prime counting function, Prime number theorem, Goldbach conjecture, Fermat and Mersenne primes, Congruence relation and its properties, Linear congruence and Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

UNIT II **11 Hours**

Number Theoretic Functions: Number theoretic functions for sum and number of divisors, Multiplicative function, The Mobius inversion formula, The greatest integer function. Euler’s phi-function and properties, Euler’s theorem.

UNIT III **12 Hours**

Primitive Roots : The order of an integer modulo *n*, Primitive roots for primes, Composite numbers having primitive roots; Definition of quadratic residue of an odd prime, and Euler's criterion.

UNIT IV **10 Hours**

Quadratic Reciprocity Law and Public Key Encryption: The Legendre symbol and its properties, Quadratic reciprocity, Quadratic congruencies with composite moduli; Public key encryption, RSA encryption and decryption.

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

SUGGESTED READINGS:-

1. Burton, David M. (2007). *Elementary Number Theory* (7th ed.). Tata Mc-Graw Hill Edition, Indian Reprint.
2. Jones, G. A., &Jones, J. Mary. (2005). *Elementary Number Theo*ry. Undergraduate Mathematics Series (SUMS). First Indian Print.
3. 1. Neville Robinns. (2007). *Beginning Number Theory* (2nd ed.). Narosa Publishing House Pvt. Limited, Delhi.
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Semester: 3rd

Course Title: Organic Chemistry
Course Code: BNM301

L	T	P	Credits
4	0	0	4

Total Hours:60

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

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

Course Content

UNIT-I **16 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 **16 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 **13 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:-

1. Morrison, R. N. & Boyd, R. N.(2010)Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L.(2005)Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. Finar, I. L. Organic Chemistry(2009) (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Eliel, E. L. &Wilen, S. H. (2008)Stereochemistry of Organic Compounds; Wiley: London, 1994.
5. Kalsi, P. S. (2016)Stereochemistry Conformation and Mechanism; New Age International, 2005.

Course Title: Inorganic Chemistry

L	T	P	Credits
4	0	0	4

Course Code: BNM302

Total Hours: 60

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

1. Predict geometries of simple molecules
2. Predict about the various shapes of organic molecules.
3. Explain different types of bonds formed by the atoms. l differentiate between ionic and covalent bonds.
4. Explain the effect of hydrogen bonding on the properties of molecules.

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 function

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:-

1. Basic Inorganic Chemistry. F. A. Cotten ,. G. Wilkinson.
2. Concise Inorganic Chemistry. J. D. Lee 5thEdition .
3. Basic Principles of Inorganic chemistry. Puri. Sharma. Kalia.

Core Course Title: Analytical Geometry and Vector Analysis

Course Code: BNM303

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1. Visualize the fundamental ideas about coordinate geometry and learn to describe some of the surface by using analytical geometry
2. Gain knowledge about regular geometrical figures and their properties like distance between two points, Polar equation of a Straight line, Polar equation of a circle which are the foundation for higher course in geometry.
3. Equip with the concepts of vector analysis like vector products, general equation of a Plane, normal and intercept forms, intersection of three planesetc. for application point of view in practical problems of science and engineering.
4. Apply the acquired knowledge in ordinary differentiation of vectors, finding velocity and accelerationetc. for handling more advance level problems in mathematics

Course Content

UNIT I **16 Hours**

Polar Equation of conics, Polar coordinate system, Distance between two points, Polar equation of a Straight line, Polar equation of a circle, Polar equation of a conic, Chords, Tangent and Normal to a conic, Curvilinear coordinates, Spherical and Cylindrical coordinates, Definition and equation of a sphere, Plane section of a sphere,
Intersection of two spheres, Intersection of a sphere and a line, Power of a point, tangent plane, Plane of contact, Polar plane, Pole,
Angle of Intersection of two spheres, Radical plane, Co-axial system of spheres.

UNIT II **13 Hours**

Definition and equation of a cone, Vertex, Guiding curve, Generators, Three mutually perpendicular generators, Intersection of a line with a cone, Tangent line and tangent plane, Reciprocal cone, Right circular cone, Definition and equation of a cylinder, Right circular
cylinder, Enveloping cylinder.
General equation of second degree, Tangent plane, Director sphere, Normal, Plane of contact, Polar plane, Conjugate plane and conjugate points.

UNIT III **16 Hours**

Triple product, Reciprocal vectors, Product of four vectors, General equation of a Plane, Normal and Intercept forms, Two sides of a plane, Length of perpendicular from a point to a plane, Angle between two planes, System of planes.
Direction Cosines and Direction ratios of a line, Projection on a straight line, Equation of a line, Symmetrical and unsymmetrical forms, Angle between a line and a plane, Coplanar lines, Lines of shortest distance, Length of perpendicular from a point to a line,
Intersection of three planes, Transformation of coordinates.

UNIT IV **15 Hours**

Ordinary differentiation of vectors, Velocity and Acceleration, Differential operator-Del, Gradient, Divergence and Curl. Line, Surface and volume integrals, Simple applications of Gauss divergence theorem, Green's theorem and Stokes theorem (withoutproof).

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

SUGGESTED READINGS:-

1. J. B. Fraleigh, (2003), *A first course in Abstract Algebra*, Addison-Wiley.
2. I. N. Herstein, (2006), *Topics in Algebra*, John Wiley & Sons.
3. Thomas W Hungerford, (1990), *Abstract Algebra–An Introduction*, Sauders College Publishing.
4. Joseph A Gallian, (2016), *Contemporary Abstract Algebra*, Brooks/Cole Cengage Learning.
5. V. K. Khanna and S. K. Bhambri, (2014), *A course in Abstract Algebra*, Vikas Publishing House Pvt (Ltd).
6. Robert J.T Bell, (1923), An Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd.
7. Suggested digital platform: NPTEL/SWAYAM/MOOCs.
8. P.R. Vittal, (2013), *Analytical Geometry*, 2d & 3D, Pearson.
9. S.L. Loney, (2018), *The Elements of Coordinate Geometry*, McMillan and Company, London.
10. N. Saran and S. N. Nigam (2016), *Elements of Vector Analysis*, Pothishala Pvt. Ltd. Allahabad.
11. Duraipandian, P and Pachaiyappa, K, (2017), S chand Company, New Delhi.
12. Suggested digital platform: NPTEL/SWAYAM/MOOCs
13. Suggested digital platform: NPTEL/SWAYAM/MOOCs.
14. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Course Title: Quantum Mechanics

Course Code: BNM304

L	T	P	Credits
4	0	0	4

Total Hours:60

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

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

Course Content

UNIT-I **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.de Broglie's hypothesis – wavelength of matter waves, properties of matter waves. Phase and group velocities and relation between them. Davisson and Germer experiment. Heisenberg's uncertainty principle for position and momentum (x and px), Energy and time (E and t).

UNIT II **15 Hours**

Time independent Schrodinger Wave Equation: Review of wave mechanical principles. Time independent Schrodinger equation in one, two and three dimensions. Eigen values and Eigen functions. Bound states. Discrete eigen values. Orthogonality of eigen functions. Completeness of eigen functions. Particle in a one dimensional box with finite walls. Two dimensional square with infinite walls. Three dimensional rectangular box with infinite walls and three dimensional square well potential. Isotropic Harmonic oscillator. Degeneracy.

UNIT-III **15 Hours**

Time dependent Schrodinger Wave Equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.

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:-

1. 1. V.K. Thankappan(2000), Quantum Mechanics, McGraw Hill Pub. Co. Delhi
2. P.M. Mathews and K. Venkatesan (2002), A Text Book of Quantum Mechanics, Tata McGraw Hill Pub. Co. Delhi,.
3. J .L. Powell and B. Crasemann(1997), Quantum Mechanics,Narosa Pub. House, N.Delhi

Course Name- Physics Lab-III
Course Code: BNM306

L	T	P	Credits
0	0	4	2

Total Hours:30

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

1. Develop skills in assessing the quality of one's own and others' work.

2. Apply the principles and skills learned in the classroom to on-the-job practices.

3. Recognize the relationship between the conceptual description of nature and its mathematical expression

4. Estimate sources of error in a measurement.

Course Content

List of Practical's:

1. Adiabatic expansion of a gas
2. Thermal expansion of crystal using interference fringes
3. Probability distribution using colored dice coins.
4. To determine the refractive index of liquid using spectrometer
5. To determine the Cauchy's constants

6 To study the refractive index of doubly refracting prism
7 To determine the wave length of a given light using bi-prism
8 To determine the resolving power of a telescope
9 To determine the principal points of a lens system
10 Study the photoelectric effect and determine the value of Planck's constant
11 To study the gas discharge spectrum of hydrogen
12 To determine the angle of wedge using interference method
13 To check if triangle exists and the type of the triangle

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

SUGGESTED READINGS:-

1. 1. C.L. Arora ,(2010), *Practical Physics,* S. Chand &Co.
2. R.S. Sirohi,(2012), *Practical Physics*, , WileyEastern.

Course Name- Organic Chemistry Lab-III
Course Code: BNM306

L	T	P	Credits
0	0	4	2

Total Hours:30

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

1. Describe the fundamentals of acid/base equilibria, including pH calculations, buffer behavior acid/base titrations, and their relationship to electrophones and nucleophiles
2. Use General periodicity patterns of (organic/inorganic) molecules, and the ability to design
3. Estimation of ferrous and ferric by dichromate method.
4. Estimate the calcium content in chalk as calcium oxalate by permanganometry.

Course Contents

List of Practical's:

A.Volumetric Analysis and TLC

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

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:-

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

Course Title: Complex Analysis
Course Code: BNM307

L	T	P	Credits
3	0	0	3

Total Hours:45

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

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

Course Content

UNIT I **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 **12 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 **10 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, ted talks, E team Teaching, Quiz, Case analysis.

SUGGESTED READINGS:-

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

Course Title: Linear Programming Problems
Course Code: BNM308

L	T	P	Credits
3	0	0	3

Total Hours:45

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

1. Describe the origin, Scope, development of Operations Research and use the scientific methods of Operation research.
2. Interpret the dual variables and perform sensitivity analysis in the context of economics problems as shadow prices, imputed values, marginal values, or replacement values and Explain the concept of complementary slackness and its role in solving primal/dual problem pairs,
3. Define how to formulate an LPP with linear constraints and identify a problem in your locality, formulate it as an LPP and solve.Prove basic set equalities
4. Explain, how to maximize the profit, minimize the cost, minimize the time in transportation problem. For example, travelling salesman problem, Assignment problems.

Course Content

UNIT I **10 Hours**

Linear Programming Problem(LPP): Mathematical Formulation - Graphical Method of Solution – Simplex Method – Big „M‟ Method – Two Phase Simplex Method – Duality – Dual Simplex Method

UNIT II **13 Hours**

Transportation Problems: Mathematical Formulation – Balanced and unbalanced TP – North-West Corner Rule – Least Cost Method – Vogel‟s Approximation Method – Test for Optimality – Maximization problems in TP

UNIT III **10 Hours**

Assignment Problems(AP): Mathematical Formulation – Method of Solution – Maximization in AP

UNIT IV **12 Hours**

Inventory Control: Basics – Types of Inventory Models: Deterministic Models: Model I Purchase Model without Shortages – Model II Production Model without Shortages – Model III Purchase Model with Shortages – Model IV Production Model with Shortages

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

SUGGESTED READINGS:-

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

Course Title: Riemann Integration & Series of Functions
Course Code: BNM309

L	T	P	Credits
3	0	0	3

Total Hours:45

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

1. To understand the integration of bounded functions on a closed and bounded interval and its extension to the cases.
2. Familiarize with properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.
3. Recognize Beta and Gamma functions and their properties.
4. Identify the valid situations for the inter-changeability of differentiability and integrability with infinite sum, and approximation of transcendental functions in terms of power series.

Course Content

UNIT I **13 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.

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 **12 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, 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-Lecture,Demonstration, Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Quiz.

SUGGESTED READINGS:-

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

Course Title: Mathematical Methods
Course Code: BNM310

L	T	P	Credits
3	0	0	3

Total Hours:45

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

1. Learn and practice Integral Transforms, Volterra and Fredholm integral equations.

2. Understand the basic concepts of Laplace transforms of elementary functions, First Shifting Theorem, Second Shifting Theorem, Initial-Value Theorem, Final-Value Theorem.

3. Understand 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 **10 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 **10 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 **10 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, ted talks, E team Teaching, Quiz.

SUGGESTED READINGS:-

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

Course Name: Pharmaceutical chemistry
Course Code: BNM311

L	T	P	Credits
3	0	0	3

Total Hours:45

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

1. Describe the various pharmaceutical drugs, their application and synthesis.
2. Define medicinal chemistry, the action and discovery. CO-5. Study the structure activity and drug targets.
3. Study of antimicrobial drugs, antibacterial, antifungal, antiviral, antimalarial etc.
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 **15 Hours**

Fermentation : Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii)Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine,Glutamic acid, Vitamin B2, Vitamin B12 and VitaminC.

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.

Course Name: Analytical Methods in Chemistry

L	T	P	Credits
3	0	0	3

Course Code: BNM312

Total Hours:45

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

1.Evaluate analytical data like errors, accuracy and precision.

2.Analyze fundamental laws of spectroscopy and selection rules.

3.Learn about different solvent extraction techniques and their efficiency.

4.Understand qualitative and quantitative aspects of chromatographic methods of analysis.

Course Content

UNIT-I **10 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 **10 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.

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral 43 chromatographic techniques using chiral columns (GC 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:-

1. 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 .

2. Christian, Gary D; (2009)Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
3. Harris, Daniel C: (2004)Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
4. Khopkar, S.M.(2007)Basic Concepts of Analytical Chemistry. New Age, International Publisher.
5. Skoog, D.A. Holler F.J. and Nieman, T.A.(1999)Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
6. Mikes, O. &Chalmes, R.A.(1998)Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.

Course Name: Polymer Chemistry

Course Code: BNM313

L	T	P	Credits
3	0	0	3

Total Hours: 60

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

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

Course Content

UNIT-I **15 Hours**

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

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

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 **10Hours**

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 **14 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 **9 Hours**

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

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefin's, polystyrene and styrene copolymers, poly(vinyl chloride) and related 50 polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), 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:-

1. G. Odian(2014)Principles of Polymerization, John Wiley.
2. F.W. Billmeyer,(2017) Text Book of Polymer Science, John Wiley.

3. P. Ghosh,(2019)Polymer Science & Technology, Tata Mcgraw-Hill.
4. R.W. Lenz,(2019)Organic Chemistry of SyntheticHigh Polymers.

Course Name: Pesticide Chemistry
Course Code:BNM314

L	T	P	Credits
3	0	0	3

Total Hours: 45

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

1. Discuss on 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:-

1. R. Cremlyn(2018)Pesticides, John Wiley.

Semester: 4th

Course Name: Quantum Chemistry & Spectroscopy

Course Code: BNM401

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1. Differentiate different types of spectroscopic techniques.
2. Learn the importance of different photochemistry laws.
3. Verify Lambert-Beer's law.
4. Separate the molecular energies into translational, rotational, vibrational 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. BornOppenheimer approximation: Separation of molecular energies into translational, rotational, vibrational and electronic components.

UNIT-II **15 Hours**

Postulates of quantum mechanics, quantum mechanical operators. Free particle. Particle in a 1-D box (complete solution), quantization, normalization of wavefunctions, 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 91 spectra. Vibrations of polyatomic molecules. Group 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 **14 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:-

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

Core Course Title: Abstract Algebra
Course Code: BNM402

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1. Build the concrete structure of modern algebra with the basic concepts of Group, abelian group, subgroup etc. and with their properties.
2. Explore the concepts for understanding and analyzing more advanced topics like Conjugate subgroups, Invariant sub groups,

Quotient group, Homomorphism and Isomorphism on groups etc. for strong grip on modern algebra.

3. Create an understanding of rings, various types of rings, characteristic of a ring, field, skew field etc. on the previous concepts of groups in 3rd semester.
4. Explore the topics polynomials over a ring, addition and multiplication of polynomials, polynomial rings, embedding of a ring R into R[x] etc. which will lead the student to advanced course in Algebra.

Course Content

UNIT I **16 Hours**

Cartesian product of Sets, Functions or mappings, Binary operations, Relation, Equivalence relations and partitions, Congruence, Modulo n, 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 II **13 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 III **16 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.

UNIT IV **15 Hours**

Polynomials over a ring, Degree of a polynomial, Zero, Constant and monic polynomials, Equality of polynomials, Addition and multiplication of polynomials, Polynomial rings, Embedding of a ring R into R[x], Division algorithm, Euclidean algorithm, Units and
associates in polynomials, Irreducible polynomials.

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

SUGGESTED READINGS:-

1. J. B. Fraleigh, (2003), *A first course in Abstract Algebra*, Addison-Wiley.

2. I. N. Herstein, (2006), *Topics in Algebra*, John Wiley & Sons.
3. Thomas W Hungerford, (1990), *Abstract Algebra–An Introduction*, Sauders College Publishing.
4. Joseph A Gallian, (2016), *Contemporary Abstract Algebra*, Brooks/Cole Cengage Learning.
5. V. K. Khanna and S. K. Bhambri, (2014), *A course in Abstract Algebra*, Vikas Publishing House Pvt (Ltd).
6. Robert J.T Bell, (1923), An Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd.
7. Suggested digital platform: NPTEL/SWAYAM/MOOCs.
8. P.R. Vittal, (2013), *Analytical Geometry*, 2d & 3D, Pearson.
9. S.L. Loney, (2018), *The Elements of Coordinate Geometry*, McMillan and Company, London.
10. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Course Title: Electricity and Magnetism

Course Code: BNM403

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1. Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.
2. Apply the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions and magnetic energy density.
3. Analyze different problems in electromagnetism using mathematical methods involving vectors and simple differential and integral calculus, both analytically and numerically
4. Design experiments and acquire data in order to explore physical principles, effectively communicate results, and critically evaluate related scientific studies.

Course Content

UNIT I **15 Hours**

Vector calculus: Basic ideas of Vector Calculus, Scalar & vector fields, Gradient of a vector field, Line, Surface and Volume integrals of a vector

and their physical significance, Flux of a vector field, combination of grad, div & curl, Gradient, Divergence, curl and their physical significance, Stroke's theorem, Gauss's divergence theorem.

UNIT II **15 Hours**

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

UNIT III **15 Hours**

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

UNIT IV **15 Hours**

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

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

SUGGESTED READINGS :-

1.Arthur F. Kipp(2005), *Fundamentals of Electricity and Magnetism*, Tata McGraw Hill.

2. E.M. Purcell,(2008), *Electricity and Magnetism,* Berkeley Physics Course, Vol. II

3. David Griffith.(2010) ,*Introduction to Classical Electrodynamics*, Prentice Hall.

4. A.S. Mahajan& A.A. Rangwala, (2002), *Electricity & Magnetism*, Tata McGraw Hill.

5. W.J. Duffin (2012), *Electricity & Magnetism*, 4th Edition, Tata McGraw Hill

6. Edward C. Jordan and K. G. Balmain,(2015*), EM Waves and Radiating Systems*, Prentice Hall.

Course Name- Chemistry Lab-IV
Course Code: BNM404

L	T	P	Credits
0	0	4	2

Total Hours:30

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

1. Determine the thermodynamic and kinetic forces involved in chemical reactions which determine how much and how soon products are formed.
2. Use the Methods to measure equilibrium concentrations and equilibrium constants for acid-base, solubility, and complexation reactions given initial concentrations of reactant
3. Derive the key concepts of inorganic and organometallic chemistry including those related tosynthesis, reaction chemistry, and structure and bonding
4. Apply the enthalpy of solution of solid calcium.

Course Content

List of Practical's:

Colourimetry

1. Verify Lambert-Beer's law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration
2. Analyze the given vibration-rotation spectrum of HCl(g).

UV/Visible spectroscopy

1. 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).
2. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K2Cr2O7.
3. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Physical Chemistry

1. To determine the solubility of benzoic acid at different temperatures and to determine $\Delta H_{of}$the dissolutionprocess.
2. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weakbase.
3. To determine the enthalpy of solution of

   solid calcium chloride.

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:-

1. A.I. Vogel,(2005)Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel,(2017)Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. B.D. Khosla,(2015)Senior Practical Physical Chemistry, R. Chand & Co.

Course Title: Physics Lab-IV
Course Code: BNM405

L	T	P	Credits
0	0	4	2

Total Hours: 30

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

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

Course Contents:

LIST OF EXPERIMENTS

1. Thermal conduction in poor conductor (variation with geometry) by Lee's method
2. Thermoe.m.f. calibration comparison
3. Total radiation law, temperature dependence of radiation
4. Study of rotation of plane of polarization with a polarimeter.
5. Set up Newton's rings to determine wave length of sodium light
6. To determine the wave length and dispersive power using

plane diffraction grating(Use Hg source)
7. To determine the resolving power of a grating
8. To measure an inaccessible height using sextant
9. To determine the divergence and wave length of a given laser source.
10. To study the absorption spectra of iodine vapours
11. To determine the ionization potential of mercury
12. Study of variation of light intensity using photovoltaic cell/inverse square law
13. To determine the angle of wedge using interference method
14. Calculation of days between two dates of a year.

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

SUGGESTED READINGS:-

1. C.L. Arora ,(2010), *Practical Physics,* S. Chand &Co.
2. R.S. Sirohi,(2012), *Practical Physics*, , WileyEastern.

Course Name:-Operations Research and Linear Programming
Course Code:BNM406

L	T	P	Credits
2	0	0	2

Total Hours: 30

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

1. Describe the origin, Scope, development of Operations Research and use the scientific methods of Operation research.
2. Interpret the dual variables and perform sensitivity analysis in the context of economics problems as shadow prices, imputed values, marginal values, or replacement values and Explain the concept of complementary slackness and its role in solving primal/dual problem pairs,
3. Define how to formulate an LPP with linear constraints and identify a problem in your locality, formulate it as an LPP and **solve.**Prove basic set equalities
4. Explain, how to maximize the profit, minimize the cost, minimize the time in transportation problem. For example, travelling salesman problem, Assignment problems.

Course Content

UNIT-1 **8 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 **7 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 **7 Hours**

Elementary inventory models, Replacement models, Group replacement problem, Sequencing theory, *m* machines and *n* jobs problem, Graphical method for sequence problem.

UNIT-IV **8 Hours**

Game Theory, pure and mixed strategies, Saddle point, Two-Persons-Zero-Sum Game, Game with mixed strategies, Dominance rule, Graphical Method, Inter - relation between the theory of games and linear programming, Solution of game using Simplex method.

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

SUGGESTED READINGS:-

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

Course Title: Metric Space
Course Code: BNM407

L	T	P	Credits
3	0	0	3

Total Hours: 45

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

1. Provide the basic knowledge pertaining to metric spaces such as open and closed balls, neighborhood, interior, closure, subspace, continuity, compactness, connectedness etc.
2. Understand the topology of metric space and its necessity.
3. Correlate these concepts to their counter parts in real analysis.
4. Appreciate the abstractness of the concepts such as open balls, closed balls, compactness, connectedness etc. beyond their geometrical imaginations.

Course Content

UNIT I **10 Hours**

Metric spaces: Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space.

UNIT II **12 Hours**

Topology of Metric Spaces: Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set, Cantor's theorem, Subspaces, Dense set.

UNIT III **13 Hours**

Continuity & Uniform Continuity in Metric Spaces: Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem.

UNIT IV **10 Hours**

Connectedness, Connected subsets of , Connectedness and continuous mappings, Compactness, Compactness and boundedness, Continuous functions on compact spaces.

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

SUGGESTED READINGS:-

1. Dhananjay Gopal, (2020.), *An Introduction to Metric Spaces*, Chapman and Hall/CRC; 1st edition
2. Kumaresan, S., (2014*), Topology of Metric Spaces*Narosa Publishing House, 2014
3. Simmons, G. F. (2004). *Introduction to Topology and Modern Analysis*, Tata McGraw Hill. New Delhi.
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Course Title: Mathematical Statistics
Course Code: BNM408

L	T	P	Credits
3	0	0	3

Total Hours:45

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

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

1. Illustrate various properties of Discrete and continuous Distributions.
2. Explain concepts of sampling distribution and its standard error, Chi square, t and F distribution.
3. Grasp the concepts behind estimation and evaluate the various estimation techniques.
4. Explore the concepts of hypothesis and various useful techniques for various distributions.

Course Content

UNIT I **12 Hours**

Discrete distributions**:** Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson.
Continuous distributions**:** Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

UNIT II **10 Hours**

Sampling distributions: Sampling distribution of statistics .Sampling distribution of the sample mean and variance. Sampling distribution for the normal population .

UNIT III **12 Hours**

Theory of estimation: Estimation and estimate – consistent and biased . Maximum
likelihood estimation. Applications to binomial, Poisson and normal populations. Confidence
interval. Interval estimation for parameters of normal population. Confidence intervals for mean and standard deviation of a normal population.

UNIT-IV **11 Hours**

Statistical hypothesis: Simple and composite hypotheses. Tests of hypothesis - large sample tests of means and proportion. *t*-student, (chi square) and *F* distributions (without derivation) and testing of hypothesis based on them.

Test on mean and standard deviation of normal population. Comparison of means and standard deviations of two normal populations

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

SUGGESTED READINGS:-

1. Medhi, J. (2000). *Statistical Methods: An introductory Text*, New Age International (P) Ltd.
2. Gupta, S.C. and Kapoor, V. K.(2007). *Fundamentals of Mathematical Statistics*, S. Chand & Co.
3. Cochran, W.G. (1977). *Sampling Techniques*, third edition ,John Wiley & Sons.
4. Feller, W.(2005). An *Introduction to Probability Theory and Its Applications*, Vol. I, Wiley.
5. Uspensky, J.V.(2005). *Introduction to Mathematical Probability*,(McGraw Hill.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Course Title: Numerical Methods
Course Code: BNM409

L	T	P	Credits
3	0	0	3

Total Hours: 45

Course Learning Outcomes: On successful completion of this course, the successful students 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 andNewton 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.

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UNITII **13 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 for Newton's forward and backward formula, Newton's divided difference formula.

UNIT III **10 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 **12 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:-

1. B. Bradie, (2007). *A Friendly Introduction to Numerical Analysis*, Pearson Education, India,
2. 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,

3. C. F. Gerald and P. O. (2008). *Wheatley, Applied Numerical Analysis*, Pearson Education, India, 7th edition.
4. M. Pal (2007*). Numerical Analysis for scientific and engineering computation*, Narosa Publication
5. N. Ahmad (2008). *Fundamental Numerical Analysis with error estimation,* Anamaya Publisher.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Course Title: Mechanics
Course Code: BNM410

L	T	P	Credits
3	0	0	3

Total Hours: 45

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

1. Define Resultant, Component of a Force, Coplanar forces, like and unlike parallelforces, Moment of a force and Couple with examples.
2. Prove the Parallelogram of Forces, Triangle of Forces, Converse of the Triangle of forces, Polygon of Forces, Lami's Theorem, Varignon's theorem of moments.
3. Find the resultant of coplanar couples, equilibrium of couples and the equation to the line of action of the resultant.
4. Discuss Friction, Forces of Friction, Cone of Friction, Angle of Friction and Laws of friction, define catenary and obtain the equation to the common catenary and find the tension at any point and discuss the geometrical properties of a catenary.

Course Content

UNIT I **12 Hours**

Statics:Basic notation, Newton Laws of motion, system of two forces, parallelogram law of forces, resultant of two collinear forces, resolution of forces, moment of a force, couple, theorem on moments of a couple,

UNIT II **10 Hours**

Coplanar forces, resultant of three coplanar concurrent forces, theorem of resolved parts, resultant of two forces acting on a rigid body, Varignon's theorem, generalized theorem of moments.

UNIT III **10 Hours**

Equilibrium of two concurrent forces, equilibrium condition for any number of coplanar concurrent forces, Lami's theorem. λ - μ theorem, theorems of moments, resultant of a force and a couple.

UNIT IV **13 Hours**

Dynamics: Motion in a straight line, Newton's law of motion, Motion on an inclined plane. Motion under variable acceleration, Simple harmonic motion, Relative Motion, Projectiles, Work, Power, Energy

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. Elsegolc, (2007), L.D., *Calculus of Variation*, Dover Publication.
2. Gantmacher, F., (1975), *Lectures in Analytic Mechanics*, Moscow: Mir Publisher.
3. Goldstien, H., Poole, C. and Safco, J.L., (2002), *Classical Mechanics*, 3rd Edition. Addison Wesely, 2002.
4. Marsden, J.E., (1992*), Lectures on Mechanics*, Cambridge University Press.
5. Biswas, S. N., (1999), *Classical Mechanics*, Books and Applied (P) Ltd.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Course Title: Analog Electronics
Course Code: BNM411

L	T	P	Credits
3	0	0	3

Total Hours: 45

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

2. Demonstrate the basic concepts of the diode,its applications, relationship between semiconductors devices and applications.

3. Explain how to construct a transistor amplifier and how its gain varies with frequency, Concepts of the filter circuits and their application to reduce the ripple factor.
4. Differentiate bipolar and unipolar devices and different types of biasing used for their stability.
5. Analyze the depth of CB and CE characteristics, Structure of JFET and MOSFET, Transistor biasing and stabilization of operating point.
6. Design and verification of electronic devices and systems which will increase their employability scope in various electronics related companies.

Course Content

UNIT I **13 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 **10 Hours**

Amplifiers: Working of CE amplifier, Amplifier analysis using h-parameters, Equivalent circuits, Determination of current gain, Power gain, Input impedance, FET amplifier and its voltage gain SECTION B Feedback in Amplifiers: Feedback in amplifiers: Different types, Voltage gain, Advantage of negative feedback, Emitter follower as negative feedback circuit.

UNIT IV **10 Hours**

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

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. N.N. Bhargave, D.C. Kulshreshtha and S.C.Gupta ((1 July 2017), *Basic Electronics and linear Circuits*, McGraw Hill Education; 2nd edition

2. D. Chatopadhyay, P.c. Rakshit, B. Saha and N.N. Purkit(2001), *Foundations of Electronics*, New Age International (P) Ltd.

3. D.C. Tayal(2003) ,*Basic Electronic* (Himalaya Pub.)

Course Title: Reactor Physics
Course Code: BNM412

L	T	P	Credits
3	0	0	3

Total Hours: 45

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

1.Explain basic reactor science.
2. Critically examine reactor types to identify their advantages and disadvantages.
3. Compare the merits of new generation reactors and appraise their technical status.
4. Discuss nuclear accidents and evaluate reactor safety measures.

Course Content

UNIT I **15 Hours**

Interaction of Neutrons with Matter in Bulk: Thermal neutron diffusion, Transport and diffusion equations, transport mean free path, solution of diffusion equation for a point source in an infinite medium and for an infinite plane source in a finite medium, extrapolation length and diffusion length-the albedo concept.

UNIT II **10 Hours**

Moderation of Neutron: Mechanics of elastic scattering, energy distribution of thermal neutrons, average logarithmic energy decrement, slowing down power and moderating ratio of a medium, slowing down density, slowing down time, Fast neutron diffusion and Fermi age theory, solution of age equation for a point source of fast neutrons in an infinite medium, slowing down length and Fermi age.

UNIT III **10 Hours**

Theory of Homogeneous Bare Thermal and Heterogeneous Natural Uranium Reactors: Neutron cycle and multiplication factor, four factor formula, neutron leakage, typical calculations of critical size and composition in simple cases, the critical equation, material and geometrical buckling,

effect of reflector. Advantages and disadvantages of heterogeneous assemblies, various types of reactors with special reference to Indian reactors and a brief discussion of their design feature.

UNIT IV **10 Hours**

Power Reactors Problem of Reactor Control : Breeding ratio, breeding gain, doubling time, Fast breeder reactors, dual purpose reactors, concept of fusion reactors, Role of delayed neutrons and reactor period, Inhour formula, excess reactivity, temperature effects, fission product poisoning, use of coolants and control rods.

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

SUGGESTED READING:

1. E.Lewis (2008),*Fundamentals of Nuclear Reactor Physics,* Academic Press Publishers.
2.W.M.Stacey (2018), *Nuclear Reactor Physics*, Wiley-VCHPublishers

Course Title: Nano Science
Course Code: BNM413

L	T	P	Credits
3	0	0	3

Total Hours:45

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

1. Analyze the internal structure of materials, atoms and Crystals.
2. Conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
3. Demonstrate the application of diffusion in sintering and doping of semiconductors.
4. Interpret mechanical properties of materials and optical properties of Materials.

Course Content

UNIT I **10 Hours**

Nanoscale systems: Introduction to Nanoscale – Size-Dependent properties - Size effect - surface tension, wettability - specific surface area and surface area to volume ratio – Reason for change in optical properties, electrical properties and mechanical properties – nanoscale catalysis - Principles of Top-Down and Bottom-Up approaches.

UNIT II **12 Hours**

Synthesis of nanostructure materials: Gas phase condensation – Vacuum deposition -Physical vapor deposition (PVD)- chemical vapor deposition (CVD) - Sol-Gel- Ball milling –spray pyrolysis – plasma-based synthesis process (PSP) - hydrothermal synthesis - Etching technologies: wet and dry etching - photolithography – Drawbacks of optical lithography for nanofabrication - electron beam lithography – ion beam lithography - dip-pen nanolithography.

UNIT III **10 Hours**

Quantum dots: Quantum confinement - Excitons and excitonic Bohr radius – difference between nanoparticlesandquantumdots-preparationthroughcolloidalmethods-Epitaxialmethods- MOCVD and MBE growth of quantum dots - current-voltage characteristics - magneto tunneling measurements - Absorption and emission spectra of quantum dots - photo luminescence spectrum.

UNIT IV **13 Hours**

Applications of nanotechnology: Nanodiodes, Nano switches, molecular switches, Nanologic elements - Single electron transistors-smallmetallictunneljunctions-nanoparticlesbasedsolarcells and quantum dots based white LEDs – CNT based transistors –Surface acoustic wave (SAW) devices, microwaves MEMS,fieldemissiondisplaydevices,-Super hard nano-compositecoatingsandapplications in tooling - Biochemistry and medical applications: lab-on-a-chip systems.

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. S. Shanmugam, (2018*)"Nanotechnology*", TBH Edition.
2. T. Praddetp, (2004)"*Nano-the essential*" , Mc graw hill education, Chennai.
3. ,KennethJ.Klabunde (2001), "*NanoscaleMaterials*", Wiley&Sons,Publcn.

Course Title: Atomic Spectroscopy
Course Code: BNM414

L	T	P	Credits
3	0	0	3

Total Hours:45

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

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

Course Contents

UNIT I **10 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 **13 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 **10 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:

1. Arthur Beiser(1995), *Concepts of Modern Physics*, McGraw Hill Pub.Co., Delhi, 9th ed.

2. S.H. Patil(1998), *Elements of Modern Physics*, McGraw Hill.

3. E. Merzbacher(2000), *Quantum Mechanics*, John Wiley, 2nd ed.

4. C.N. Banwell(2001), *Fundamental of Molecular Spectroscopy*, Tata McGraw Hill Pub. Co., Delhi.

5. H.G. Kuhn (1969), *Atomic Spectra*, Longmans, 2nd ed., 1969.

Semester: 5th

Course Name:Organic Chemistry

Course Code: -BNM501

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1. interpret the concept of aromaticity and the main properties of aromatic compounds.
2. Evaluates the importance of carbonyl function in organic chemistry.
3. prepare alkane, alkene and alkynes using different methods.

4. write side chain reactions of aromatic compounds.

UNIT-I **15 Hours**

Arcncs and Aromaticity : Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: molecular formula vandKekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture.

Aromaticity: theHuckel rule, Aromatic electrophilic substitution-general pattern of the mechanism, role of σ and π complexes. Mechanism or nitration, halogenation, sulphonation, Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Methods of formation and chemical reaction of alkylbenzenes

UNIT-II **15 Hours**

Alkcnes : Nomenclature of alkenes-methods of formation, mechanisms and dehydration of alcohols and dehydrohalogenation of alkyl halides regioselectivity in alcohol dehydration. The Saytzeffrule, Hofmanr elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes-mechanisms involved in hydrogenation, electrophilic and free radical additions Markownikoff's rule, hydroboration-oxidation, oxymercuration reduction.

UNIT-III **15 Hours**

Dienes And Alkynes : Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions-I,2 and l,4 additions, Diels-Alder reaction.

Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidityn of alkynes. Mechanism of electrophilic and nucleophilic metal-ammonia reductions, oxidation and polymerization.

UNIT-IV **15 Hours**

Alkyl and aryl halides Nomenclature and classes of alkyl halides, methods of formation chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides, SN2and SN1 reactions with energy profile diagrams. Methods of formation of aryl halides, nuclear and side chain reactions. The addition elimination and the elimination-additional mechanisms of nucleophilic aromatic substitution reactions.
Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides.

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. Organic Chemistry. Morrison and Boyd, Prentice Hall.
   Organic Chemistry. L.G. Wade lr.Prentice Hall.
   Fundamentals of Organic Chemistry. Solomons, John

Wiley.
2. Organic Chemistry. Vol. I, II & III. S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International)
3. Organic Chemistry. F.A. Aarey, McGraw Hill India.
4. Introduction to Organic Chemistry. Stretwieser, Heathcock and Kosover, Machmilan

Course Name:Nuclear and Particle Physics
Course Code:- BNM502

L	T	P	Credits
4	0	0	4

Total Hours:60

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

1. Analyze the ideas of basics of nucleus, Constituents of nucleus and their intrinsic properties, Qualitative facts about size, mass, density, and energy.
2. Explain about the general properties of nuclei, nuclear forces and detectors, radioactive decay and nuclear reactions.
3. Examine the liquid drop model. Semi-empirical mass formula, Conditions of nuclear stability, Fermi gas model. Nuclear shell modelto explain the nucleus structure
4. Categorize the different types of the radioactive decay and kinetics of nuclear reactions, Evidence of existence of neutrino, Qualitative discussion of alpha and beta decay theories, Nuclear reactions. Reaction cross section, Conservation laws. Kinematics of nuclear reaction, Q-value and its physical significance.

Course Content

UNIT-I **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. Experimental evidence of magic numbers and its explanation.

UNIT-II **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.

UNIT-III **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.

UNIT-IV **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:-

1. M.R. Bhiday and V.A. Joshi(2002) , *An Introduction to Nuclear Physics*, Orient Longman

2.D.C. Tayal (2001), *Introductory Nuclear Physics*, Himalaya Pub.

3.I. Kaplan(2003), *Nuclear Physics*, Addision-Wiley Pub. Co. Inc.

4.Bucham(1965), *Nuclear Physics*, Indian Ed.

Course Title: Statistical Physics & Thermodynamics
Course Code: BNM503

L	T	P	Credits
4	0	0	4

Total Hours:60

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

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

Course Content

UNIT I **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 : Derivation of Maxwell's thermo dynamical relations, Cooling produced by adiabatic stretching, Adiabatic compression, Change of internal energy with volume, specific heat at constant pressure and constant volume, Expression for Cp -Cv , Kinetic Theory of Gases : Change of state and Clayperon equation, Thermodynamical treatment of Joule-Thomson effect, Use of Joule-Thomson effect.

UNIT III **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. Maxwell Boltzmann (MB) statistics applied to an ideal gas in equilibrium. Experimental verification of Maxwell Boltzman law of distribution of molecular speeds.

UNIT IV **15 Hours**

Quantum Statistics: Need for quantum statistics-Bose-Einstein (B.E.) statistics, Derivation of Planck's law of radiation, Deduction of Wien's displacement law and Stefan's law from Planck's law, Fermi-Dirac (F.D.) statistics, Comparison of M.B., B.E. and F.D. 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 :

1. V.S. Bhatia,(2018)*Statistical Physics and Thermodynamics*, SohanLal, Nagin Chand, Jalandhar
2. A.K. Sikri, (2017*)Statistical Physics and Thermodynamics*, Pardeep Publication, Jalandhar
3.M.N. Saha&N. Srivastava (1965), *A Treatise on Heat*, The Indian Press Pvt.Ltd., Allahabad.
4. Bhattacharjee J. K(2000) ,*Statistical Mechanics* : An Introductory Text, Allied Pub., Delhi

Course Title: Real Analysis
Course Code: BNM504

L	T	P	Credits
4	0	0	4

Total Hours:60

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

1. Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.

2. Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence, comparison test, Cauchy's root Test, ratio Test, Rabbe's of an infinite series of real numbers.

3. Equipped with the knowledge of improper integrals, and their convergences, convergence and uniform convergence of sequences and series of functions for further applications in the relevant fields.

4. Utilize the analytic and technical skills necessarily at practical field and analyse the real analysis for further higher studies.

Course Content

UNIT I **14 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 **16 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 **16 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 **14 Hours**

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

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

SUGGESTED READINGS:-

1. Walter Rudin, (1976), *Principle of Mathematical Analysis* (3rd edition) McGraw-Hill Kogakusha, International Student Edition.
2. Bartle, Robert G., &Sherbert, Donald R. (2015). *Introduction to Real Analysis* (4th ed.). Wiley India Edition. New Delhi.
3. T. M. Apostol, (1985), *Mathematical Analysis*, Narosa Publishing House, New Delhi.
4. S. C. Malik and Savita Arora, (2012), *Mathematical Analysis* , New Age International Pvt. (Ltd).
5. 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.
6. Denlinger, Charles G. (2011). *Elements of Real Analysis*. Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.
7. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Course Name- Chemistry Lab-V
Course Code: BNM505

L	T	P	Credits
0	0	4	2

Total Hours:30

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

1. Perform Name reaction essential for synthesis of Organic Compounds.
2. Gain knowledge to purify organic compounds.
3. Detect unknown compounds through Spectral studies.
4. Perform solvent extraction essential for Organic Synthesis.

Course Contents

List of Practical's:

a) Preparation of sodium trioxalatoferrate(III), $Na_3[Fe(C_2O_4)_3]$ and determination of its composition by permagnometry.
(b) Preparation of Ni-DMG complex, $[Ni(DMG)_2]^{2+}$
(c) Preparation of copper tetra-ammine complex. $[Cu(NH_3)_4]SO_4$.
(d) Preparation of cis-and trans-bis(oxalato)diaquachromate(III) ion.

Synthesis or Organic Compounds
(a) Iodoform from ethanol and acetone
(b) Aromatic electrophlic substitution

1. m-dinitrobenzene
2. p-nitroacetanilide
3. p-bromoacetanilide
   2,4,6-tribromophenol
   Diazotization/Coupling
4. Preparation of methyl orange and methyl red
5. Preparation of benzoic acid from toluene
6. Reduction
   Preparation of aniline from nitrobenzene
   Preparation of m-nitroaniline from m-dinitrobenzene

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

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

Course Title: Physics Lab-V

Course Code: BNM506

L	T	P	Credits
0	0	4	2

Total Hours: 30

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

1. Acquire the appropriate data accurately and keep systematic record of laboratory activities.
2. Interpret findings using the correct physical scientific framework and tools.
3. Prepare professional quality textual and graphical presentations of laboratory data and computational Result.
4. Describe the physical and electronic properties of inorganic compounds such as metals, ionic solids, coordination compounds and nonmaterial.

Course Content

List of Practical's:

1. Measurement of reverse saturation current in p-n junction diode at various temperatures and to find the approximate value of energy gap.

2. To draw forward and reverse bias characteristics of a p-n junction diode and draw a load line.

3. To study the response of RC circuit to various input voltages (square, sine and triangular).

4. To measure the efficiency and ripple factors for (a) Half-wave (b) full wave and (c) bridge rectifier circuits

5. To study the reduction in the ripples in the rectified output with RC. LC and filters.

6. To draw the characteristics of a Zener diode.

7. To study the stabilization of output voltage of a power supply with Zener diode.

8. To plot Common Emitter Characteristics of a transistor (pnp or npn)

9. To plot Common Base Characteristics and determine h-parameters of a given transistor.

10. To draw the plateau of a GM counter and find its dead time.

11. To study the statistical fluctuations and end point energy of beta particles using GM counter.

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

SUGGESTED READINGS:-

1. C.L. Arora ,(2010), *Practical Physics,* S. Chand &Co.

2. R.S. Sirohi,(2012), *Practical Physics*, , Wiley Eastern.

Course Title: MATLAB programming Lab-II
Course Code:BNM507

L	T	P	Credits
0	0	4	2

Total Hours: 30

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

1. Plot various types of curves in MATLAB with proper labeling.
2. Plot various exponential, logarithmic and trigonometric curves.
3. Obtain various types of matrix operations by programming in MATLAB.
4. Numerical solutions to algebraic and transcendental equations-MATLAB programs - Bi-section method-Newton Raphson method-Regula falsi method.

List of Programs

1. Plotting of different curves along with styles, width etc.

2. Plotting of different surfaces along with styles, width etc.

3. Plotting of graphs of function basic functions like $e^{(ax+b)}$, log (ax+b), sin (ax+b) , cos (ax+b), 1/(ax+b), |ax+b| and to illustrate the effect of a and b on the graph.

4. Matrix Operations: Addition, Multiplication, Inverse, Transpose, Determinant, Rank, Eigenvectors, Eigen values, Characteristic equation and verification of the Cayley-Hamilton theorem, Solving the systems of linear equations.

5. Complex numbers and their representations, Operations like addition, Multiplication, Division, Modulus. Graphical representation of polar form.

6. Computation of limit, Differentiation, Integration and sketching of vector-valued
functions.

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. Rudra Pratab(2005)*Getting Started with MATLAB*, Oxford Univ. press, Seventh Edition.
2. K.Srinivasa Rao(2015)*Introduction to MATLAB*, IMRF International Publications
3. P.Nagarajan, K.Srinivasa Rao, (2004) *Numerical Methods with Programs in MATLAB*, University Press, SCSVMV

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Course Title: Green Chemistry

Course Code: BNM508

L	T	P	Credits
3	0	0	3

Total Hours:45

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

1. Understand the basic principal of green chemistry and their contemporary importance.

2. Design and develop less hazardous and environmental friendly chemicals.

3. Cope with the less eco-friendly discharge from chemical reactions.

4. Achieve a deep insight into the mechanism of solvent fewer reactions.

Course Content

UNIT-I **10 Hours**

Introduction to Green Chemistry : What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.

Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

UNIT-II **15 Hours**

Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples and special

Emphasis on the following:

- Designing a Green Synthesis using these principles; Prevention of Waste/ byproductsmaximum incorporation of the materials used in the process into the final products,Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.
- Prevention/ minimization of hazardous/ toxic products reducing toxicity.
- Risk = (function) hazard × exposure; waste or pollution prevention hierarchy.
- Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solvent less processes, immobilized solvents and how to compare greenness of solvents.
- Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.
- Selection of starting materials; avoidance of unnecessary derivatization – careful use
  Of blocking/protecting groups.
- Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents;
  Catalysis and green chemistry, comparison of heterogeneous and homogeneous
  Catalysis, biocatalysts, asymmetric catalysis and photocatalysis.
- Prevention of chemical accidents designing greener processes, inherent safer design,
  Principle of ISD “What you don’t have cannot harm you”, greener alternative to

- Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer
  Route to cyclohexane) subdivision of ISD, minimization, simplification, substitution,
  Moderation and limitation.
- Strengthening/ development of analytical techniques to prevent and minimize the
  Generation of hazardous substances in chemical processes.

UNIT-III **10 Hours**

Examples of Green Synthesis/ Reactions and some real world cases

- Green Synthesis of the following compounds: Adipic acid, catechol, disodium
  Iminodiacetate (alternative to Stracke synthesis)
- Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic
- acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents
- Diels-Alder reaction and Decarboxylation reaction
- Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic
  Alternative to Iodine)
- Surfactants for carbon dioxide – replacing smog producing and ozone depleting
  Solvents with CO2 for precision cleaning and dry cleaning of garments.
- Designing of Environmentally safe marine antifoulant.
- Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic
  Pigments.
- An efficient, green synthesis of a compostable and widely applicable plastic (poly
  Lactic acid) made from corn.
  Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for
  Production of no Trans-Fats and Oils
- Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

UNIT-IV **10 Hours**

Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green

Chemistry; Proliferation of solvent less reactions; co crystal controlled solid state synthesis

(C2S3); Green chemistry in sustainable development.

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. Ahluwalia, V.K. &Kidwai, M.R.(2015).New Trends in Green Chemistry, Anamalaya
Publishers

2. Matlack, A.S.(2011)Introduction to Green Chemistry, Marcel Dekker.
3. Cann, M.C. &Connely, M.E. (2012).Real-World cases in Green Chemistry, American
Chemical Society, Washington.

4. Ryan, M.A. &Tinnesand, M.(2015)Introduction to Green Chemistry, American ChemicalSociety, Washington

Course Title: Applications of Computers in Chemistry

Course Code: BNM509

L	T	P	Credits
3	0	0	3

Total Hours: 45

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

1. Make innovative contribution to science and technology.
2. Be an example of high professional ethics.
3. Interpret the results obtained from experiments into graphical representation.
4. Learn the importance of computers in chemistry.

Course Content

UNIT-I **10 Hours**

Computer organization: Hardware, Software, Programming languages with special reference to BASIC, Fortran and C.

Binary representation : Binary numbers, Conversion of decimal to binary and binary to decimal, Idea of Octal and hexa-decimal numbers.

Problem solving: Problem analysis, Algorithm development, Program Coding,

Program Compilation and execution

UNIT-II **15 Hours**

Introduction to C : Historical development of C, The C character set, Constants, variables and keywords, Types of C constants and variables, C keywords.

C instructions : Type declaration instruction, Arithmetic instructions, Integer and float conversion, Type conversion in assignment, Hierarchy of operations, Writing of a first program in C, Control Instructions in C. Simple problems with sequential structure.

UNIT-III **10 Hours**

Decision and control structure : The if statement, The if-else statement, The nested if-else statement, Use and hierarchy of logical operators, Conditional operators.

Loop control structure : The while loop, The for loop, Nesting of loops, The do-while loop, Break and continue statements.

UNIT-IV **10 Hours**

Case control studies : Decision using switch, The go to statement, Simple problems with Selective and repetitive structures.

Functions : What is function, why use functions, Passing values between a functions, Role of functions.

Advanced features of functions : Function declaration and prototypes, Call by values and call by reference, An introduction to pointer, Pointer notion.

Arryas : What are arrays, Initialization of arrays.

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

SUGGESTED READINGS

1. E. Balgurusamy(2004)Programming in ANSI , Tata McGraw-Hill Publishing Co. I.T., New Delhi.

2. Ran Kumar(2009)Programming with Fortran-77, Tata McGraw-Hill Publishing Co. I.T., New Delhi.

Course Title: Chemistry of Main Group Elements, Theories of Acids And Bases

L	T	P	Credits
3	0	0	3

Course Code: BNM510 **Total Hours: 45**

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

1. Examine the Gravimetric estimation of compounds performed.

2. Demonstrate the Iodometric estimation of compounds established experimentally.

3. Determine the DO in water.

4. Analyze that Amount of iodine, ascorbic acids essential for normal metabolic

Functioning determined.

UNIT- I **15 Hours**

Acids and Bases : Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.
General Principles of Metallurgy : Chief modes of occurrence of metals based on standard electrode potentials, Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agents.

Hydrometallurgy with reference to cyanide process for gold and silver. Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn, Au): electrolytic refining, zone refining, van Arkel-de Boer process, Parting Process, Mond's process and Kroll 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, electron gain enthalpy, electronegativity (Pauling scale).

General characteristics of s-block metals like density, melting and boiling points, flame colour and reducing nature.

Oxidation states of s- and p-block elements, inert-pair effect, diagonal relationships and anomalous behaviour of first member of each group. Allotropy in C, P and S.

Complex forming tendency of s block elements and a preliminary idea of crown ethers and cryptates, structures of basic beryllium acetate, salicylaldehyde/ acetylacetonato complexes of Group 1 metals.

Solutions of alkali metals in liquid ammonia and their properties.

Common features, such as ease of formation, solubility and stability of oxides, peroxides, superoxides, sulphates and carbonates of s-block metals.Structure, bonding and properties (acidic/ basic nature, oxidizing/ reducing nature and

hydrolysis of the following compounds and their applications in industrial and environmental chemistry wherever applicable:

Diborane and concept of multicentre bonding, hydrides of Groups 13 (EH3), 14, 15, 16 and 17.

UNIT- III **10 Hours**

Oxides of N and P, Oxoacids of P, S and Cl.

Halides and oxohalides of P and S (PCl3, PCl5, SOCl2 and SO2Cl2)

Interhalogen compounds.

A brief idea of pseudohalides

Noble gases

Rationalization of inertness of noble gases, clathrates, preparation and properties of XeF2, XeF4 and XeF6, bonding in these compounds using VBT and shapes of noble gas compounds using VSEPR Theory

UNIT- IV **5 Hours**

Inorganic Polymers : Types of inorganic polymers and comparison with organic polymers, structural features, classification and important applications of silicates. Synthesis, structural features and applications of silicones. Borazines and cyclophosphazenes – preparation, properties and reactions. Bonding in (NPCl2)3.

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. Lee, J.D.(1991)Concise Inorganic Chemistry, ELBS,.
- Cotton, F.A., Wilkinson, G. &Gaus, P.L.(1995)Basic Inorganic Chemistry, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J.(2012) Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
- Greenwood, N.N. &Earnshaw.(1997)Chemistry of the Elements, Butterworth-Heinemann.
- Rodger, G.E.(2004)Inorganic and Solid State Chemistry, Cengage Learning India Edition.
- Miessler, G. L. & Donald, A. Tarr.(2008)Inorganic Chemistry 4th Ed., Pearson.

Course Title: Molecules of Life

L	T	P	Credits
3	0	0	3

Course Code: BNM511

Total Hours:45

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

1. Demonstrate the Importance of biomolecules in living beings established.
2. Define the immense chemistry constituting carbohydrates.
3. Estimate the number and average molecular weight /masses of polymers.
4. Discuss the physical properties of organic molecules.

UNIT- I **10 Hours**

Carbohydrates : Classification of carbohydrates, reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof).

Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) andpolysacharrides (starch and cellulose) excluding their structure elucidation.

UNIT- II **10 Hours**

Amino Acids, Peptides and Proteins : Classification of Amino Acids, Zwitterion structure and Isoelectric point.Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and withcarboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protectiontbutyloxy carbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

UNIT- III **10 Hours**

Enzymes and correlation with drug action : Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity),Enzyme inhibitors and their importance, phenomenon of inhibition(Competitive and Noncompetitiveinhibition including allosteric inhibition). Drug action-receptor theory. Structure–activity relationships of drug molecules, binding role of –OH group,-NH2 group, doublebond and aromatic ring,

Nucleic Acids : Components of nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only),other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure ofpolynucleotide's; Structure of DNA (Watson-Crick model) and RNA (types of RNA),Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

UNIT- IV **10 Hours**

Lipids : Introduction to lipids, classification.

Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number.

Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Concept of Energy in Biosystems : Calorific value of food. Standard caloric content of carbohydrates, proteins and fats.

Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy,

ATP hydrolysis and free energy change.

Conversion of food into energy. Outline of catabolic pathways of Carbohydrate- Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of Fats and Proteins.

Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.in the metabolic pathways of Proteins, Fats and Carbohydrates.

Suggested Readings:

1. Morrison, R. T. & Boyd, R. N.(2005)Organic Chemistry, Dorling Kindersley (India) Pvt.Ltd. (Pearson Education).
2. Finar, I. L.(2016)Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).

3. Finar, I. L.(2000)Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
4. Nelson, D. L. & Cox, M. M.(1995) Lehninger'sPrinciples of Biochemistry 7th Ed., W. H.Freeman.
5. Berg, J.M., Tymoczko, J.L. &Stryer, L.(1999)Biochemistry, W.H. Freeman.

Course Title: Life skills

Course Code: BNM512

L	T	P	Credits
1	0	0	1

Total Hours: 15

Course Learning Outcomes: On completion of this course, the successful students 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. Use 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 **3 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 **3 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 **4 Hours**

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

UNIT-IV **5 Hours**

Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques.

Morals, Values and Ethics: Integrity, Civic Virtue, Respect for Others, Living Peacefully. Caring, Sharing, Honesty, Courage, Valuing Time, Time management, Cooperation, Commitment, Empathy, 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:-

1. Shiv Khera, (2003) *You Can Win* , Macmillan Books, New York.
2. Barun K. Mitra (2017) *Personality Development & Soft Skills*, Oxford Publishers, Third impression.
3. ICT Academy of Kerala(2016) *Life Skills for Engineers*, McGraw Hill Education (India) Private Ltd.
4. Caruso, D. R. and Salovey P(2004) *The Emotionally Intelligent Manager: How to Develop and Use the Four Key Emotional Skills of Leadership*, John Wiley & Sons.
5. Kalyana (2015) *Soft Skill for Managers,* First Edition; Wiley Publishing Ltd.
6. Larry James, (2016) *The First Book of Life Skills ,* First Edition, Embassy Books.

Course Title: Basic Mathematics

Course Code: BNM513

L	T	P	Credits
2	0	0	2

Total Hours: 30

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

7. Express an argument using logical notation and determine if the argument is or is not valid
8. Prove basic set equalities Demonstrate the ability to write and evaluate a proof.
9. Relate the concept of Arithmetic progression and Geometric progression and their sum.
10. Explain the description of algebraic properties of complex numbers.

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 **7 Hours**

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-singular, Matrices, Inverse of a Matrix, Eigenvalues and Eigenvectors, Cayley Hamilton theorem.

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. E. Kreyszig. (1990).*Advanced Engineering Mathematics*.9th edition, John Wiley & Sons.

2. E.Kreyszig. (2002).*Advanced Engineering Mathematics*. 9th edition, John Wiley & Sons.

3. G. B. Thomas and R. L. Finney. (2015). *Calculus and Analytic Geometry*. 11th edition, Pearson India.

4. R. K. Jainand S.R.K. Iyengar. (2002).*Advanced Engineering Mathematics*.8th Edition, Narosa Publications.

Course Title: Physics for competitive exams

Course Code: BNM514

L	T	P	Credits
2	0	0	2

Total Hours: 30

Course Learning Outcomes: On completion of this course, the successful students 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

UNIT-I **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, 3rdedition, 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: CHMO-701

L	T	P	Credit
2	0	0	2

Total Hours: 30

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

1. Understand the cleaning mechanism of soaps by exploring the concept of "like dissolving like".
2. Differentiate between different types of soaps based on properties like lather formation and cleaning effect.
3. Different techniques of polymerization of polymers.
4. 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.

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 :

1. Swaminathan and Goswamy(2006)*Handbook on Fertilizer Technology*, 6 th ed. 2001, FAI.
2.J. R. Fried(2007)*Polymer Science and Technology*, (Prentice Hall).
3. P. Atkins and J. de Paula (2003)*Physical Chemistry* –-7 th Ed. 2002, Oxford University Press

Semester 6th

Course Title: Research Methodology
Course Code: BNM601

L	T	P	Credits
4	0	0	4

Total Hours: 60

Course Learning Outcomes: On successful completion of this course, the students will be able to**:**
1. Explain the various terms like as objective, meaning of research, significance research etc. which is used in research.
2. Acquaintance with various sampling techniques and hypothesis techniques.
3. Understand data pattern and its application to interpret.
4. Review the basic concepts of the research writing problems.

Course Content

UNIT I **15 Hours**

Scientific Methods and Research: Concept, Definitions of research; Purpose, importance, steps levels and rigor of research; different paradigms of research.

Basic Types of Researches: Fundamental/Applied research, Descriptive/Analytical research, Quantitative /Qualitative research, Conceptual/Empirical research, Diagnostic/Hypothesis testing research, Conclusion oriented/Decision oriented research, Theoretical / Action research, Longitudinal /Cross sectional research

UNIT II **16 Hours**

Data: Introduction, primary and secondary data, methods of collecting primary data, merits and demerits of different methods of collecting primary data, designing a questionnaire, pretesting a questionnaire, editing of primary

data, technique of interview, collection of secondary data, scrutiny of secondary data, Data Processing: Introduction, editing of data, coding of data, classification of data, tables as data presentation devices, graphical presentation of data.

UNIT III **15 Hours**

Research Question: Introduction, types and identification; Research Problem: Definition, identification of problem, ways of understanding problem, criteria of a good problem, guidelines for selecting meaningful problem; Research Objective: Definition, broad and specific objectives, goals; Research Hypothesis: Meaning of research hypothesis, sources of hypothesis, qualities of workable hypothesis

UNIT IV **14 Hours**

Conventional Research Method: Principle and Importance conventional methods, Scientific methods as conventional. Experimental Research Method: Introduction, Types of experiments, steps in experimental research, Problems in experimentation. Survey Research Method: Introduction, and Importance of survey method, Comparison of survey method with other methods.

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

SUGGESTED READING:

1. Kothari, C.R (2009): Research Methodology: Methods and Techniques, 2nd Revised Ed. Reprint, New Age International Publishers.

2. Lilien, Gary L. and Philip Kotler, 1983. Marketing Decision Making; A Model Building Approach, Harper & Row, New York.

3. Shenoy, GVS, et al., (1983). Quantitative Techniques for Managerial Decision Making, Wiley Eastern.

Course Title: Innovative Research Project in Physics/Chemistry/Mathematics **Course Code: BNM602**	**L**	**T**	**P**	**Credits**
	0	**0**	**0**	**12**

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.