GURU KASHI UNIVERSITY

Bachelors of Science with Research

(B.Sc. NM.)

Session : 2024-25

Department of Physics

GRADUATE ATTRIBUTES OF THE PROGRAMME: The Graduates will be t apply the knowledge of mathematics and science fundamentals, to the solution of complex physical problems; identify, formulate, research literature, and analyses complex problems reaching substantiated conclusions using first principles of mathematics, natural sciences; design solutions for complex science related problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations; create, select, and apply appropriate techniques, resources.

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

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

Course Structure of the B.Sc. Non-Medical

Semester –I						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNR112	Probability and Statistics	Compulsory Foundation	2	0	0	2
BNR102	Mechanics	Core	4	0	0	4
BNR103	Inorganic Chemistry	Core	4	0	0	4
BNR104	Matrix and Co-ordinate Geometry	Core	4	0	0	4
BNR105	Mechanics Lab	Skill Based	0	0	2	1
BNR106	Inorganic Chemistry Lab	Skill Based	0	0	2	1
BNR101	Communication Skills	Skill Based	1	0	0	1
BNR107	Communication Skills Lab	Skill Based	0	0	2	1
BNR113	Introduction To Data Science	Ability Enhancement	2	0	0	2
BNR114	ICT Skills in Education	MD	3	0	0	3
Discipline Elective (Any one of the following)						
BNR108	Condensed Matter Physics	Discipline Elective-I	3	0	0	3
BNR109	Waves & Oscillation					
BNR110	Medical Physics					
BNR111	Radiation Physics					
Total			**23**	**0**	**6**	**26**

Semester-II						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNR201	Electricity &Magnetism	Core	4	0	0	4
BNR202	Physical Chemistry	Core	4	0	0	4
BNR203	Real Analysis	Core	4	0	0	4
BNR204	Electricity & Magnetism Lab	Skill Based	0	0	2	1
BNR205	Physical Chemistry Lab	Skill Based	0	0	2	1
BNR215	Data Analysis	Skill Based	2	0	0	2
BNR216	Data Analysis Lab	Skill Based	0	0	2	1
Discipline Elective (Any one of the following)						
BNR207	Differential Equations	Discipline Elective-II	3	0	0	3
BNR208	Linear Algebra					
BNR217	Mathematical Methods					
BNR210	Number Theory					
Value Added Course (For other departments also)						
BNR218	Environmental Science and Sustainability	Value Added Course	2	0	0	2
BNR299	xxx	MOOC	0	0	0	2
Total			**19**	**0**	**6**	**24**

Semester-III						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNR301	Thermodynamics & Statistical Physics	Core	4	0	0	4
BNR302	Organic Chemistry	Core	4	0	0	4
BNR304	Thermodynamics & Statistical Physics Lab	Skill Based	0	0	2	1
BNR305	Organic Chemistry Lab	Skill Based	0	0	2	1
BNR313	MATLAB Programming	Skill Based	2	0	0	2
BNR314	MATLAB Programming Lab	Skill Based	0	0	2	1
BNR315	Instrumentation in Physics	Skill Based	2	0	0	2
BNR316	Instrumentation in Physics Lab	Skill Based	0	0	2	1
BNR317	Industrial Training in Physics (6 weeks)	Skill Based	0	0	0	3
Discipline Elective (Any one of the following)						
BNR306	Complex Analysis	Discipline Elective- III	3	0	0	3
BNR307	Linear Programming Problem					
BNR308	Riemann Integration & Series of Functions					
BNR314	Discrete Mathematics					
BNR399	XXX	MOOC	0	0	0	2
Open Elective						
XXX	XXX	IDC	2	0	0	2
Total			**17**	**0**	**8**	**26**

Open Elective (For other departments)						
OEC002	Basic Mathematics	IDC	2	0	0	2
OEC027	Physics for competitive exams					
OEC008	Chemistry in Everyday Life					

Semester-IV						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNR401	Nuclear and Particle Physics	Core	4	0	0	4
BNR403	Abstract Algebra	Core	4	0	0	4
BNR405	Nuclear and Particle Physics Lab	Skill Based	0	0	2	1
BNR412	Industrial Training in Chemistry (6 weeks)	Skill Based	0	0	0	3
BNR413	Seminar	Skill Based	0	0	4	2
BNR414	Digital Literacy	Elective Foundation	3	0	0	3
BNR415	Basics of Translation	MD	3	0	0	3
Discipline Elective (Any one of the following)						
BNR416	Pharmaceutical Chemistry	Discipline Elective- IV	3	0	0	3
BNR417	Conductance, Electrochemistry & Functional Group Organic Chemistry					
BNR418	Polymer Chemistry					
BNR419	Pesticide Chemistry					
Value Added Course (For other departments also)						
BNR411	Life Skills	Value Added Course	2	0	0	2
Total			**19**	**0**	**6**	**25**

Semester-V						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNR516	Modern Physics	Compulsory Foundation	2	0	0	2
BNR517	Spectroscopy	Core	4	0	0	4
BNR518	Calculus	Core	4	0	0	4
BNR506	Numerical Methods	Skill Based	2	0	0	2
BNR507	Numerical Methods Lab	Skill Based	0	0	2	1
BNR519	Spectroscopy Lab	Skill Based	0	0	2	1
BNR520	Modern Physics Lab	Skill Based	0	0	2	1
BNR521	Training in Mathematics (6 weeks)	Skill Based	0	0	0	3
Discipline Elective (Any one of the following)						
BNR512	General Organic Chemistry & Aliphatic Hydrocarbons	Discipline Elective-V	3	0	0	3
BNR513	Chemical Energetics, Equilibria & Functional Group Organic Chemistry					
BNR514	Analytical Methods in Chemistry					
BNR515	Chemistry of s- and p-block elements, States of matter and Chemical Kinetics					
BNR599	XXX	MOOC	0	0	0	2
Total			**15**	**0**	**6**	**23**

Semester-VI						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNR601	Fluid Mechanics	Core	4	0	0	4
BNR612	Organic Synthesis	Core	4	0	0	4
BNR613	Project in Physics/Chemistry/Mathematics	Skill Based	0	0	6	3
BNR606	IT Skills for Chemists	Skill Based	2	0	0	2
BNR607	IT Skills for Chemists Lab	Skill Based	0	0	2	1
BNR614	Organic Synthesis Lab	Skill Based	0	0	2	1
Discipline Elective (Any one of the following)						
BNR615	Analog Electronics	Discipline Elective-VI	3	0	0	3
BNR616	High Energy Physics					
BNR617	Physics of Nanomaterials					
BNR618	Atomic Spectroscopy					
Value Added Course (For other departments also)						
BNR623	Value Education	Value Added Course	2	0	0	2
BNR624	Human Rights and Duties	MD	3	0	0	3
Total			**18**	**0**	**13**	**23**

Semester-VII						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNR701	Research Methodology	Research Based Skill	4	0	0	4
BNR702	Research Proposal	Research Based Skill	0	0	8	4
BNR703	Ethics and IPR	Interdisciplinary	3	0	0	3
BNR704	Proficiency in Teaching	Skill Based	2	0	0	2
BNR707	MATLAB Programming	Skill Based	2	0	0	2
BNR708	MATLAB Programming Lab	Skill Based	0	0	4	2
BNR706	Service Learning	Community Linkage	0	0	4	2
BNR799	XXX	MOOC	0	0	0	2
Total			**11**	**0**	**16**	**21**

Semester VIII						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
BNR801	Dissertation	Research Based Skill	--	--	--	20
Total			**--**	**--**	**--**	**20**
Grand Total			**127**	**0**	**60**	**167**

Evaluation Criteria for Theory Courses

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

Evaluation Criteria for Practical Courses

The syllabus of subject is divided into five experiments, each experiment contain 20 marks (10 lab performance, 5 viva, 5 lab record) - Total marks 100

Semester -I

Course Title: Probability and Statistics
Course Code: BNR112

L	T	P	Credit
2	0	0	2

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

1. Describe the Probability and its distributions and basic laws of total probability and compound probability in statistics.
2. Categorize appropriate sampling processes and testing of hypothesis based on them.
3. Recall the methods of classifying and analyzing data relative to single variable and multiple variables.
4. Distinguish between the practical purposes of a large and a small sample.

Course Content

UNIT I **8 hours**

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

UNIT II **7 hours**

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

UNIT III **8 hours**

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

UNIT IV **7 hours**

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

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

Suggested Readings:-

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

Course Title: Mechanics
Course Code: BNR102

L	T	P	Credit
4	0	0	4

Total Hours: 60

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

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

Course Content

UNIT -I **15 Hours**

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

UNIT -II **15 Hours**

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

UNIT -III **15 Hours**

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

UNIT -IV **15 Hours**

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

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

SUGGESTED READINGS:-

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

Course Name: Inorganic Chemistry

Course Code: BNR103

L	T	P	Credit
4	0	0	4

Total Hours: 60

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

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

Course Content

UNIT-I **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, Atomic radii, Ionic and crystal radii, covalent radii.

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

UNIT-II **15 Hours**

Chemistry of Noble gases: Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.
Chemical Bonding – I: Covalent Bond-Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. BeF_2 , BF_3, CH_4, PF_5, SF_6, IF_7, $Sncl_2$, BF_4, PF_6-, $SnCl_6$.

UNIT-III **15 Hours**

Chemical Bonding – II: Covalent Bond: Valence shell electron pair repulsion (VSEPR) theory to NH_3, H3O+, SF_4, CIF_3, ICI_2-,H_2O and ICI_2+, MO theory, homonuclear (elements and ions of 1st and 2nd row), diatomic molecules, multicenter bonding in electron deficient molecule (Boranes) percentage ionic character from dipole moment and eIectronegativity difference.

UNIT-IV **15 Hours**

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

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

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

SUGGESTED READINGS:-

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

Course Title: Matrices and Coordinate Geometry
Course Code: BNR104

L	T	P	Credit
4	0	0	4

Total Hours: 60

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

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

Course Content

UNIT I **18 hours**

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

UNIT II **15 hours**

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

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

UNIT III **15 hours**

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

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

UNIT IV **12 hours**

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

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

Suggested Readings:-

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

Course Title: Mechanics Lab
Course Code: BNR105

L	T	P	Credit
0	0	2	1

Total Hours: 15

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

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

Course Content

List of Practical's:

1. Measurements of length (or diameter) using Vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the motion of the spring and calculate (a) Spring constant and, (b) g.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine g and velocity for a freely falling body using Digital Timing Technique.
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille s method).

8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater s Pendulum.

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

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

SUGGESTED READINGS:-

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

Course Title: Inorganic Chemistry Lab

Course Code: BNR106

L	T	P	Credits
0	0	2	1

Total Hours: 15

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

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

Course Content

List of Practical's:

(A) Titrimetric Analysis

(i) Calibration and use of apparatus

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

(B) Acid-Base Titrations

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

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

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

(C) Oxidation-Reduction Titrimetry

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

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with K2Cr2O7 using internal (diphenylamine, anthranilic acid) and external indicator.

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

SUGGESTED READINGS:-

- *Vogel, A.I. (2018) A Textbook of Quantitative Inorganic Analysis, ELBS.*
- *Marr. G and Rocket, B. W. (1999) B. W. Practical Inorganic Chemistry, University Science Books. Lee, J.D. Concise (1991).Inorganic Chemistry, ELBS.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

L	T	P	Credit
1	0	0	1

Course Title: Communication Skills
Course Code: BNR101

Total Hours: 15

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, and refine ability to write academic papers, essays and summaries.

Course Content

UNIT I **5 Hour**

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 **5 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 **3 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.

UNIT -IV **2 Hours**

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

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

SUGGESTED READINGS:-

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

Course Title: Communication Skill Lab
Course Code: BNR107

L	T	P	Credit
0	0	2	1

Total Hours: 15

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

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

Course Content

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

SUGGESTED READINGS :

- *Butterfield Jeff, Soft Skills of Everyone. Cengage Learning: New Delhi.*

Course Title: Introduction to Data Science
Course Code: BNR113

L	T	P	Credit
2	0	0	2

Total Hours: 30

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

1. Understand the basic principles and processes involved in data science.
2. Gain proficiency in programming languages commonly used in data science, such as Python and R.
3. Learn essential statistical concepts and methods for analyzing data.
4. Explore machine learning algorithms and their applications in data analysis and prediction.

Course Content

UNIT I **8 Hours**

Introduction to Data Science : Definition and scope of data science, The data science workflow: data collection, cleaning, analysis, and visualization, Applications of data science in various domains.

UNIT II **7 Hours**

Understanding data: Introduction – Types of Data: Numeric – Categorical – Graphical – High Dimensional Data – Classification of digital Data: Structured, Semi-Structured and Un- Structured - Example Applications. Sources of Data: Time Series – Transactional Data – Biological Data – Spatial Data – Social Network Data – Data Evolution.

UNIT III **7 Hours**

Ethics in Data Science : Introduction and need of ethical consideration, privacy and confidentiality of data, Data governance framework, case studies and ethical dilemmas.

UNIT IV **8 Hours**

Introduction to Machine Learning : Overview of supervised and unsupervised learning. Basic concepts: training and testing data, model evaluation, Regression and classification algorithms.

SUGGESTED READINGS :

- *Cathy O'Neil, Rachel Schutt(2013), Doing Data Science, Straight Talk from The Frontline.*
- *Davy Cielen (2016), Introducing Data Science,, Arno D. B. Meysman, Mohamed Ali, Manning Publications Co.*

- *D J Patil, Ethics and Data Science, O'Reilly Media*

- *Interact English Lab Manual for Undergraduate Students,. Orient BlackSwan.*
- *Raman, Meenakshi and Sangeetha Sharma. Professional Communication. Oxford University Press: Oxford.*
- *S. Hariharanetal. Soft Skills. MJP Publishers.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Course Title: ICT Skills in Education
Course Code: BNR114

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

1. Appreciate the scope of ICT for improving the personal productivity and professional competencies
2. Develop skills of interaction in the classroom and electronic teaching portfolio.
3 use internet efficiently to access remote information, communicate and collaborate with others.
4. Describe social, economic, security and ethical issues associated with the use of ICT.

Course Content

UNIT I **12 Hours**

Educational Technology: Concept & Objectives, Forms of Educational Technology, Multisensory Instruction, Challenges for Educational Technology. Concept of Communication and Class Interaction, Elements, Process & Types of Communication.

UNIT II **11 Hours**

ICT in Education: Importance and need of ICT in Education, scope of ICT, Teaching Learning Process, Publication Evaluation, Research and administration, Challenges in Integrating ICT in School Education.

UNIT III **11 Hours**

ICT Integration in Teaching Learning Process: Approaches to Integrating ICT in Teaching Learning Process, Project Based Learning (PBL), Co-Operative Learning, Collaborative Learning, ICT and Constructivism: A Pedagogical Dimension.

UNIT IV **11 Hours**

ICT for Professional Development: Electronic Teaching Portfolio, Assistive Technology for Children with Special Needs, ICT for Personal & Professional Development: Tools & Opportunities, Open Education Resources: Concept & Significance.

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

SUGGESTED READINGS:-

- *Agarwal J.P. (2013), Modern Educational Technology. Black Prints, Delhi.*
- *Barton,R.(2004), Teaching Secondary Science with ICT. McGraw Hill International.*
- *Bhaskar Rao (2013), Samachara Prasara Sankethika vidya Shastramu, Masterminds, Guntur.*
- *Cambridge, D. (2010), E-Portfolios for Lifelong Learning and Assessment. John Wiley and Sons.*
- *Costantino, P.M et al. (2006), Developing a professional teaching portfolio: a guide for success. Pearson Publishers.*
- *Denis, Kim, Sen and Morin (2000), Information Technology – The breaking Wave. Tata McGraw-Hill Publishing Company Limited.*

Course Title: Condensed Matter Physics
Course Code: BNR108

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

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

Course Content

UNIT I **12 Hours**

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

UNIT II **11 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 **11 Hours**

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

UNIT IV **11 Hours**

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

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

SUGGESTED READINGS:-

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

Course Title: Waves & Oscillations
Course Code: BNR109

L	T	P	Credit
3	0	0	3

Total Hours 45

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

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

Course Content

UNIT I **12 Hours**

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

UNIT II **11 Hours**

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

UNIT III **11 Hours**

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

UNIT IV **11 Hours**

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

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

SUGGESTED READINGS:-

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

Course Title: Medical Physics
Course Code: BNR110

L	T	P	Credit
3	0	0	3

Total Hours 45

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

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

UNIT I **11 Hours**

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

UNIT II **11 Hours**

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

UNIT III **11 Hours**

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

UNIT IV **12 Hours**

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

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

SUGGESTED READINGS:

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

Course Title: Radiation Physics
Course Code: BNR111

L	T	P	Credit
3	0	0	3

Total Hours 45

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 **12 Hours**

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

UNIT II **11 Hours**

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

UNIT III **11 Hours**

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

UNIT IV **11 Hours**

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

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

SUGGESTED READING:

- *Knoll G.F, Radiation Detection and Measurements, Wiley Publishers.*
- *Herman Cember, Introduction to Health Physics, Pergamon Press*
- *Attix F H et al,Radiation Dosimetry, Academic Press.*
- *Ronald L. Kathren, Radiation Protection, Adam Hilger Ltd. International PublishersServices*
- *Merril Eisenbud, Environmental Radioactivity, Academic Press, Orlando.*
- *James E Turner, Atoms, Radiation & Radiation Protection, Pergamon Press, 1986.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Semester –II

Course Title: Electricity and Magnetism
Course Code: BNR201

L	T	P	Credit
4	0	0	4

Total Hours 60

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

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

Course Content

UNIT I **15 Hours**

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

UNIT II **15 Hours**

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

UNIT III **15 Hours**

Electric Potential: Potential as line integral of field, potential difference, Gradient of a scalar function, Derivation of the field from the potential, potential of a charge distribution, uniformly charged disc. Force on a surface charge, energy associated

with an electric field, Gauss's theorem and differential form of Gauss's law, Laplacian and Laplace's equation, Poisson's equation.

UNIT IV **15 Hours**

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

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

SUGGESTED READINGS:-

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

Course Title: Physical Chemistry
Course Code: BNR202

L	T	P	Credit
4	0	0	4

Total Hours: 60

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

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

Course Content

UNIT-I **15 Hours**

Gaseous state: Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

UNIT II **15 Hours**

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

UNIT III **16 Hours**

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

UNIT IV **14 Hours**

Solid state: Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

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

SUGGESTED READINGS:-

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

Course Title: Real Analysis
Course Code: BNR203

L	T	P	Credit
4	0	0	4

Total Hours: 60

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

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

Course Content

UNIT I **15 hours**

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

UNIT II **15 hours**

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

UNIT III **15 hours**

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

UNIT IV **15 hours**

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

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

Suggested Readings:-

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

Course Title: Electricity and Magnetism Lab
Course Code: BNR204

L	T	P	Credit
0	0	2	1

Total Hours: 15

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

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

Course Content

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

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

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

SUGGESTED READINGS:

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

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

Course Title: Physical Chemistry Lab-II

Course Code: BNR205

L	T	P	Credits
0	0	2	1

Total Hours: 15

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

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

Course Content

List of Practical's:

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

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:-

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

Course Title: Data Analysis
Course Code: BNR215

L	T	P	Credit
2	0	0	2

Total Hours: 30 hours

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

1. Understand the importance of data analysis in scientific research.
2. Learn how to collect and clean data from various sources
3. Gain proficiency in basic statistical methods for analyzing data.
4. Develop skills in data visualization techniques.

Course Content

UNIT I **7 hours**

Introduction to Data Analysis: Overview of data analysis process, Types of data and measurement scales, Introduction to statistical software, Ethics and best practices in data analysis.

UNIT II **8 hours**

Data Collection: Importance and benefits of data collection, various data collection methods: surveys, experiments, observational studies. Ethical guidelines and principles for data collection and new technologies and trends in data collection.

UNIT III **8 hours**

Data Cleaning : Significance of data cleaning, Difference between data cleaning and data transformation, various steps to clean data, data cleaning and preprocessing techniques, handling missing data and outliers, latest softwares for data cleaning

UNIT IV **7 hours**

Data Visualization: Importance and benefits of data visualization, Principles of effective data visualization, Graph types and when to use them, Hands-on practice with data visualization tools (e.g., ggplot2, matplotlib), Choropleth maps , Bubble maps and Proportional symbol maps.

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

SUGGESTED READINGS:

- *Dunn, P. F., & Davis, M. P. (2017). Measurement and data analysis for engineering and science. CRC press.*
- *Brandt, S. (1970). Statistical and computational methods in data analysis.*
- *Robinson, E. L. (2017). Data analysis for scientists and engineers. In Data Analysis for Scientists and Engineers. Princeton University Press.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Data Analysis Lab
Course Code: BNR216

L	T	P	Credit
0	0	2	1

Total Hours: 15

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

1. Understand the importance of data analysis in scientific research.
2. Learn how to collect and clean data from various sources
3. Gain proficiency in basic statistical methods for analyzing data.
4. Develop skills in data visualization techniques.

Course Content

1. Choose a dataset from a public repository (e.g., UCI Machine Learning Repository, Kaggle) and perform EDA.
2. Explore the distribution of variables, identify outliers, and visualize relationships between variables.
3. Collecting data by conducting experiments in a controlled environment or simulated setting.
4. Take a messy dataset with missing values, duplicate records, and inconsistent formatting. Identifying and resolving these issues using data cleaning techniques in a spreadsheet software (e.g., Excel).
5.Data Transformation and Normalization: Provide a dataset with numerical features that need scaling and normalization. Task students with applying different data transformation techniques. Compare and contrast the effects of each technique on the dataset and subsequent analyses.
6. Dealing with Outliers:Present a dataset with evident outliers in some of the numerical features. Have them decide on and apply strategies to handle outliers, such as capping, flooring, or removal, and discuss the impact on the analysis.
7. Text Data Cleaning: Provide a dataset with raw text data (e.g., social media posts, customer reviews).Task students with cleaning the text data by removing stop words, punctuation, numbers, and performing stemming or lemmatization.
8. Addressing Duplicates: Give students a dataset with duplicate records. Teach them techniques to identify and remove duplicate entries.

9. Data Type Conversion: Provide a dataset with columns that have incorrect data types (e.g., dates stored as strings, numerical values stored as text).Have students convert these columns to the correct data types using appropriate methods in a spreadsheet or programming environment.
10. Use a public dataset like the Iris dataset or Titanic dataset and create histograms, scatter plots, and pair plots to explore relationships between features.

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

SUGGESTED READINGS:

- *Dunn, P. F., & Davis, M. P. (2017). Measurement and data analysis for engineering and science. CRC press.*
- *Brandt, S. (1970). Statistical and computational methods in data analysis.*
- *Robinson, E. L. (2017). Data analysis for scientists and engineers. In Data Analysis for Scientists and Engineers. Princeton University Press.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Differential Equations

Course Code: BNR207

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

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

UNIT I **10 hours**

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

UNIT II **12hours**

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

UNIT III **11 hours**

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

UNIT IV **12 hours**

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

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

SUGGESTED READINGS:-

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

Course Title: Linear Algebra

Course Code: BNR208

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

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

Course Content

UNIT I **10 hours**

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

UNIT II **12 hours**

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

UNIT III **11 hours**

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

UNIT IV **12 hours**

Rings, Various types of rings, Rings with unity, Rings without zero divisors, Properties of rings, Sub rings. Ideals, Quotient rings, Principal ideals, Maximal ideals, Prime ideals, Principal ideal domains, Characteristic of a ring.

Integral domain, Field, Skew field etc., Field of quotients of an integral domain, Embedding of an integral domain in a field, Factorization in an integral domain, Divisibility, Units, Associates, Prime and irreducible elements, Unique Factorization Domain, Euclidean rings.

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

Suggested Readings:-

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

Course Title:-Mathematical Methods

Course Code: BNR217

L	T	P	Credit
3	0	0	3

Total Hours: 45

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-Vlue 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 **12 Hours**

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

UNIT II **12 Hours**

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

UNIT III **11 Hours**

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

UNIT IV **10 Hours**

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

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

Suggested Readings:-

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

Course Title: Number Theory

Course Code: BNR210

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

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

Course Contents

UNIT I **11 hours**

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

UNIT II **12 hours**

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

UNIT III **10 hours**

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

UNIT IV **12 hours**

Quadratic Reciprocity, Quadratic Residues, The Legendre Symbol and its properties, Lemma of Gauss, The Gaussian Reciprocity Law, The Jacobi symbol. Arithmetic functions $\mu(n)$, $d(n)$, $\sqrt{(n)}$, $\sigma\alpha(n)$, Mobious inversion formula.

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

Suggested Readings:-

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

Course Title: Environmental Science and Sustainability
Course Code: BNR218

L	T	P	Credit
2	0	0	2

Total Hours: 30

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

1. Understand the various environmental challenges faced by world.
2. Create a sense of how to be more responsible towards the environment.
3. Analyze fundamental knowledge of environmental science and its importance in the present day context.
4. Develop strategies for the development of environmental degradation.

Course Content

UNIT I **8 Hours**

Environmental Science: Nature, Scope and importance of environmental Science. Climate change, causes, societal impacts, adaptation. Sustainable development and living.

UNIT II **7 Hours**

Environmental Degradation: Causes and consequences of land degradation. Exploitation of surface and ground water. Air pollution: anthropogenic causes, impact on health, agriculture, climate, hydrology.

UNIT-III **8 Hours**

Sustainability And Management: Definition and concepts of Sustainable development, Integration of: a. Economic, Social and Environmental sustainability, b. Biodiversity and c. Availability of natural resources in development. Critical review of drawbacks in traditional (based on economics) evaluation development, Cost benefit analysis.

UNIT-IV **8 Hours**

Sustainable Practices: Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles : Carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio economic and technological change.

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

Suggested Readings:-

- *Rieuwerts, J, (2015), the Elements of Environmental Pollution, Routledge Taylor & Francis Group.*
- *Hill, MK. (2010) Understanding Environmental Pollution, Cambridge University Press.*
- *Tyler Miller, G. Jr (2010), Advantage Series: Sustaining the Earth - An Integrated Approach 10th Edition. Thomson/Brooks Cole.*
- *Mary Ann Curran (2010), Environmental life cycle assessment. McGraw – Hill, New York.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Semester III

Course Title: Thermodynamics and Statistical Mechanics
Course Code: BNR301

L	T	P	Credit
4	0	0	4

Total Hours: 60

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

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

Course Content

UNIT I **15 Hours**

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

UNIT II **15 Hours**

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

UNIT III **15 Hours**

Kinetic Theory of Gases Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean,

RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. Molecular Collisions. Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

UNIT IV **15 Hours**

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

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

SUGGESTED READINGS:

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

L	T	P	Credit
4	0	0	4

Course Title: Organic Chemistry
Course Code: BNR302

Total Hours: 60

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 **15 Hours**

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

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

Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes

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

UNIT II **15 Hours**

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

UNIT III **15 Hours**

Chemistry of Aliphatic Hydrocarbons

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

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

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

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

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

UNIT IV **15 Hours**

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

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

SUGGESTED READINGS:-

- *Morrison, R. N. & Boyd, R. N.(2010)Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
- *Finar, I. L.(2005)Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
- *Finar, I. L. Organic Chemistry(2009) (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*

- *Eliel, E. L. &Wilen, S. H. (2008)Stereochemistry of Organic Compounds; Wiley: London, 1994.*
- *Kalsi, P. S. (2016)Stereochemistry Conformation and Mechanism; New Age International, 2005.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Course Title: Thermodynamics and Statistical Mechanics Lab
Course Code: BNR304

L	T	P	Credit
0	0	2	1

Total Hours: 15

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

1. Understand the depth knowledge of Thermodynamics and Statistical Mechanics.
2. Demonstrate skills and competencies to conduct wide range of scientific experiments.

3. How to apply the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases,
4. Heat engines and Make connections between applications of general statistical theory in various branches of physics.

Course Content

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using Null Method.
8. Computational analysis of the behavior (any three) of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
    a. Study of local number density in the equilibrium state (i) average; (ii) fluctuations.
    b. Study of transient behavior of the system (approach to equilibrium)
    c. Relationship of large N and the arrow of time.
    d. Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution
9. Single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:
    a. Volume Cv, depend upon the temperature, total number of particles N and the spectrum of single particle states.
    b. Ratios of occupation numbers of various states for the systems considered above.
    c. Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.
10. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.
11. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.

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

SUGGESTED READINGS:

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

Course Name: Organic Chemistry Lab

Course Code: BNR305

L	T	P	Credits
0	0	2	1

Total Hours:15

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

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

Course Contents

List of Practical's:

A. Laboratory Techniques

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

6. Estimation of ferrous and ferric by dichromatemethod.
7. Estimation of copper using sodium thiosulphate.

B. Thin Layer Chromatography

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

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

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

4. Separation of a mixture of dyes

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

SUGGESTED READINGS:-

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

Course Title: MATLAB Programming
Course Code: BNR313

L	T	P	Credit
2	0	0	2

Total Hours: 30

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

1. Implement loops, branching, control instruction and functions in MATLAB programming environment.
2. Program curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve electrical engineering problems.
3. Understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB.
4. Simulate MATLAB Simulink examples.

Course Content

UNIT I **8 Hours**
Introduction to MATLAB: Overview of MATLAB and its applications, MATLAB environment: Command Window, Workspace, Editor, and Help, Basic arithmetic operations and variables.

UNIT II **7 Hours**
MATLAB arrays: vectors, matrices, and multidimensional arrays: Array operations: indexing, slicing, and reshaping, Generating arrays: linspace, logspace, and meshgrid.

UNIT III **8 Hours**
MATLAB Programming Basics: MATLAB scripts and functions, Control flow statements: if-else, for loops, and while loops, Writing and debugging MATLAB code.

UNIT IV **7 Hours**
Plotting and Visualization: Introduction to plotting: plot, scatter, and bar, Customizing plots: labels, titles, colors, and markers, Plotting multiple data sets and subplots.

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

SUGGESTED READINGS:

- *Brian R. Hunt et al.(2006), A Guide to MATLAB - for Beginners and Experienced Users", 2nd Ed., Cambridge University Press.*
- *Stephen J. Chapman(2009), Essentials of MATLAB Programming, Cengage Learning.*
- *David McMahon(2007), MATLAB Demystified", The McGraw-Hill Companies.*
- *Holly Moore(2012), MATLAB for Engineers, Pearson Education.*

Course Title: MATLAB Programming Lab
Course Code: BNR314

L	T	P	Credit
0	0	2	1

Total Hours: 30

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

1. Implement loops, branching, control instruction and functions in MATLAB programming environment.
2. Program curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve electrical engineering problems.
3. Understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB.
4. Simulate MATLAB Simulink examples.

Course Content

1. Basic Operations: Perform arithmetic operations like addition, subtraction, multiplication, and division on scalar, vector, and matrix inputs.
2. Plotting: Plot simple graphs like straight lines, parabolas, and circles using the plot() function.
3. Matrix Manipulation: Learn basic matrix manipulation techniques like transposition, matrix multiplication, and inversion.
4. Function Writing: Write your own MATLAB functions to perform specific tasks, such as calculating the factorial of a number or finding the roots of a quadratic equation.
5. Data Visualization: Import data from a file (e.g., CSV) and visualize it using different types of plots like histograms, scatter plots, and bar charts.
6. Numerical Integration: Use MATLAB's built-in functions for numerical integration to approximate definite integrals.
7. Differential Equations: Solve ordinary differential equations (ODEs) using MATLAB's ODE solvers and visualize the solutions.
8. Signal Processing: Explore basic signal processing techniques like filtering, Fourier transforms, and convolution.
9. Image Processing: Perform simple image processing tasks like resizing, rotating, and applying filters to images using MATLAB's Image Processing Toolbox.

10. GUI Development: Create simple graphical user interfaces (GUIs) using MATLAB's App Designer to interact with your MATLAB code more intuitively.

SUGGESTED READINGS:

- *Brian R. Hunt et al.(2006), A Guide to MATLAB - for Beginners and Experienced Users", 2nd Ed., Cambridge University Press.*
- *Stephen J. Chapman(2009), Essentials of MATLAB Programming, Cengage Learning.*
- *David McMahon(2007), MATLAB Demystified", The McGraw-Hill Companies.*
- *Holly Moore(2012), MATLAB for Engineers, Pearson Education.*

Course Title: Instrumentation in Physics

Course Code: BNR315

L	T	P	Credit
2	0	0	2

Total Hours: 30

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

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

UNIT I **8 Hours**

Multimeter and Voltmeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and

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

UNIT II **7 Hours**

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

UNIT III **7 Hours**

Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis. Impedance Bridges & Q-Meters: Block diagram of bridge. working principles of basic(balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

UNIT IV **8 Hours**

Digital meters : Characteristics of a digital meter. Working principles of digital voltmeter. Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter.

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

SUGGESTED READINGS :

- *B L Theraja ,A text book in Electrical Technology , S Chand and Co.*
- *S. Salivahanan , Electronic Devices and circuits.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Course Title: Instrumentation in Physics Lab
Course Code: BNR316

L	T	P	Credit
0	0	2	1

Total Hours :15

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

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

Course Content

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

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

SUGGESTED READINGS:

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

L	T	P	Credit
0	0	0	3

Course Title: Industrial training in Physics
Course Code: BNR317

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

1. Gain hands-on experience with laboratory equipment, techniques, and safety protocols.
2. Analyze experimental data using statistical methods, software tools, and data visualization techniques to draw meaningful conclusions.
3. Collaborate effectively with other interns, researchers, and faculty members on projects, fostering teamwork and interpersonal skills.
4. Acquire proficiency in using specialized software, instrumentation, and computational tools relevant to physics research.

General Instructions for students

The internship is an 3-credit course. It requires the student to complete 6 weeks within the internship organization. The student is required to work under the supervision of a Mentor. She is expected to observe the work week and hours of the agency/organization. The general rules and regulations that the agency/organization applies to its regular staff, will have to be adhered to by the intern.

The student is expected to develop at least five learning objectives that are measurable and realistic and she would like to and strive to achieve during her internship. These objectives should be finalized in consultation with the Supervisor/Mentor and Faculty Coordinator and signed by all three stakeholders.

The student is required to develop a work plan that will help her achieve objectives i.e. help her to practice and develop competencies that will help her in her chosen career path. She is required to complete tasks and assignments, projects given by the Supervisor/Mentor as well as reports and presentations regarding the internship experience and issues related to professional development. She may be required to attend seminars/conferences/meetings during the internship upon approval by the Supervisor/Mentor and the Faculty Coordinator.

She is required to submit to the Faculty Coordinator a summary of the week's experience and the weekly log of hours that she has worked. At the culmination of the internship, the intern will submit a written report of her experience. She should not only describe the work done but also write how it has contributed towards her professional development and career goals. The report should be read and certified by the Supervisor/Mentor.

Evaluation/ Assessment of the Internship Seminar-

After completion of internship, student is required to make a presentation about her experience. This will be evaluated by the Coordinator, the Supervisor/Mentor and the Head of Department. The duration of the presentation should not exceed 20 minutes.

Course Title: Complex Analysis
Course Code: BNR306

L	T	P	Credit
0	0	0	3

Total Hours: 45

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 **10 Hours**

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

UNIT III **12 Hours**

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

UNIT IV **11 Hours**

Series and Residues: Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples, Absolute and uniform convergence of power series, Uniqueness of series representations of power series, Isolated singular points, Residues, Cauchy's residue theorem, residue at infinity; Types of isolated singular points, Residues at poles and its examples.

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

Suggested Readings:-

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

Course Title: Linear Programming Problem
Course Code: BNR307

L	T	P	Credit
0	0	0	3

Total Hours: 45

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 **12 Hours**

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

UNIT II **12 Hours**

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

UNIT III **11 Hours**

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

UNIT IV **10 Hours**

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

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

Suggested Readings:-

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

Course Title:-Riemann Integration & Series of Functions

Course Code: BNR308

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

1. Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Fundamental theorems of integration.
2. Know about improper integrals including, beta and gamma functions.
3. Learn about Cauchy criterion for uniform convergence and Weierstrass M-test for uniform convergence.
4. Approximate transcendental functions in terms of power series as well as, differentiation and integration of power series.

Course Content

UNIT I **12 Hours**

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

UNIT II **10 Hours**

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

UNIT III **13 Hours**

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

Unit IV **10 Hours**

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

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

Suggested Readings:-

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

Course Title:-Discrete Mathematics

Course Code: BNR314

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

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

Course Content

UNIT I **12 hours**

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

UNIT II **11 hours**

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

UNIT III **11 hours**

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

UNIT IV **11 hours**

Graph terminology, types of graphs, subgraphs, isomorphic graphs, Adjacency and incidence matrices, Paths, Cycles, and connectivity, Eulerian and Hamiltonian paths, Planar graphs. Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

Suggested Readings:-

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

Course Title: Basic Mathematics

Course Code: OEC002

L	T	P	Credit
2	0	0	2

Total Hours: 30

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

1. Define sets and functions with related concepts.
2. Define the concept of functions and relations.
3. Express an argument using logical notation and determine if the argument is or is not valid
4. Prove basic set equalities Demonstrate the ability to write and evaluate a proof.
5. Relate the concept of Arithmetic progression and Geometric progression and their sum.
6. Explain the description of algebraic properties of complex numbers.
7. Explore the theory of Matrices and Determinants.

Course Content

UNIT I **8 Hours**

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

UNIT II **7 Hours**

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

UNIT III **8 Hours**

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

UNIT IV **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- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

Suggested Readings:-

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

Course Title: Physics for Competitive Exams
Course Code: OEC027

L	T	P	Credit
2	0	0	2

Total Hours: 30

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:

- *How Things Work: The Physics of Everyday Life, 3rd edition, by Louis A. Bloomfield, Wiley, 2006.*
- *B.B. Laud (2002), Lasers and Non-linear Optics, New Age Pub.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Chemistry in Everyday Life
Course Code: OEC008

L	T	P	Credit
2	0	0	2

Total Hours: 30

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

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

Course Content

UNIT I **7 Hours**

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

UNIT II **8 Hours**

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

UNIT III **7 Hours**

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

UNIT IV **8 Hours**

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

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

SUGGESTED READINGS:-

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

Semester -IV

Course Title: Nuclear and Particle Physics
Course Code: BNR401

L	T	P	Credit
4	0	0	4

Total Hours: 60

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

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

Course Content

UNIT I **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. 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:-

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

Course Title: Abstract Algebra
Course Code: BNR403

L	T	P	Credit
4	0	0	4

Total Hours: 60

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

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

UNIT I **15 Hours**

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

UNIT II **15 Hours**

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

UNIT III **15 Hours**

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

UNIT IV **15 Hours**

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

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

Suggested Readings:-

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

Course Title: Nuclear and Particle Physics Lab
Course Code: BNR405

L	T	P	Credit
0	0	2	1

Total Hours: 15

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

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

Course Content

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

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

SUGGESTED READINGS:

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

Course Title: Industrial training in Chemistry
Course Code: BNR412

L	T	P	Credit
0	0	0	3

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

1. Gain hands-on experience with laboratory equipment, techniques, and safety protocols.
2. Analyze experimental data using statistical methods, software tools, and data visualization techniques to draw meaningful conclusions.
3. Collaborate effectively with other interns, researchers, and faculty members on projects, fostering teamwork and interpersonal skills.
4. Acquire proficiency in using specialized software, instrumentation, and computational tools relevant to physics research.

General Instructions for students

The internship is a 3-credit course. It requires the student to complete 6 weeks within the internship organization. The student is required to work under the supervision of a Mentor. She is expected to observe the work week and hours of the agency/organization. The general rules and regulations that the agency/organization applies to its regular staff, will have to be adhered to by the intern.

The student is expected to develop at least five learning objectives that are measurable and realistic and she would like to and strive to achieve during her internship. These objectives should be finalized in consultation with the Supervisor/Mentor and Faculty Coordinator and signed by all three stakeholders.

The student is required to develop a work plan that will help her achieve objectives i.e. help her to practice and develop competencies that will help her in her chosen career path. She is required to complete tasks and assignments, projects given by the Supervisor/Mentor as well as reports and presentations regarding the internship experience and issues related to professional development. She may be required to attend seminars/conferences/meetings during the internship upon approval by the Supervisor/Mentor and the Faculty Coordinator.

She is required to submit to the Faculty Coordinator a summary of the week's experience and the weekly log of hours that she has worked. At the culmination of the internship, the intern will submit a written report of her experience. She should not only describe the work done but also write how it has contributed towards her professional development and career goals. The report should be read and certified by the Supervisor/Mentor.

Evaluation/ Assessment of the Internship Seminar-

After completion of internship, student is required to make a presentation about her experience. This will be evaluated by the Coordinator, the Supervisor/Mentor and the Head of Department. The duration of the presentation should not exceed 20 minutes.

Course Name: Seminar
Course Code: BNR413

L	T	P	Credit
0	0	4	2

Total Hours: 30

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

1. Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.
2. Identify a personally meaningful and academically relevant question to explore related to the course theme.
3. Reflect on the process including new insights and knowledge about the topic.
4. Substantiate and develop ideas through the analysis of evidence and critical use of sources in support of an argument that drives a clear and progressive structure.

General Instructions
Students will be given a topic related to recent trends in advance Physics, they will submit a report consisting of salient features about the topic. They will also prepare and submit PPT and deliver a seminar on the topic.

Course Name: Digital Literacy
Course Code: BNR414

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

1. Develop an understanding of the digital world and its impact on society.

2. Enhance skills for navigating digital technologies effectively and responsibly.
3. Learn to critically evaluate digital information for accuracy, credibility, and relevance.
4. Gain proficiency in digital communication tools and platforms.

Course Content

UNIT I **12 Hours**

Introduction to Digital Literacy: Defining digital literacy and its importance in the modern world. Historical overview of digital technologies and their evolution. Digital divide: understanding disparities in access to and use of technology. Navigating the Digital Landscape: Understanding the internet and its structure. Web browsers, search engines, and online resources. Evaluating website credibility and reliability.

UNIT II **12 Hours**

Information Literacy and Digital Communication: Strategies for effective online research and information retrieval. Assessing the credibility and bias of digital sources. Citation and plagiarism in the digital age. Email etiquette and effective communication in digital environments. Social media platforms and online networking. Digital storytelling and multimedia communication.

UNIT III **11 Hours**

Privacy and Data Protection: Best practices for creating strong passwords and protecting personal information. Recognizing common online threats, such as phishing and malware. Cybersecurity measures for safe internet browsing and data protection. Understanding digital footprints and online privacy risks. privacy settings and controls on social media and other online platforms.

UNIT IV **11 Hours**

Ethical Considerations in the Digital Age: Intellectual property rights and copyright laws. Ethical implications of digital surveillance and data mining. Digital activism and ethical uses of technology for social change. Critical Thinking in Digital Environments: Recognizing misinformation, fake news, and digital propaganda. Fact-checking strategies and tools for verifying information online. Analyzing bias and perspective in digital media.

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

SUGGESTED READINGS:

- *Paul Glister (1998), Digital Literacy: An Introduction to the World of Computers, John Wiley & Sons.*
- *John Parker (1998), Digital Literacy Unpacked, Facet Publishing House.*
- *Renne Hobbs (2011), Digital and Media Literacy: Connecting Culture and Classroom, Sage Publishers.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

L	T	P	Credit
3	0	0	3

Course Name: Basics of Translation
Course Code: BNR415

Total Hours: 45

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

1. Develop the skills of translation among the learners through practice in the translation of various types of texts
2. Develop the skills of practicing translators and enhance their competence.
3. Translate texts and speeches from English to Punjabi.
4. Appreciate the cultural and linguistic diversity of their environment.

Course Content

UNIT I **10 Hours**

Introduction: Meaning, Nature and Scope of Translation, Relevance of Translation in the age of Globalization, Literal Translation and trans-creation, Duties and Responsibilities of a Translator, Limitations of Translation.

UNIT II **11 Hours**

Phrase Structure in English and Punjabi: Understanding Sentence Structure in English and Punjabi, using Dictionaries and Thesaurus in Translation, Translation of Registers and Technical Terms, Translation of sample non-literary and technical passages and texts like scientific, sociological, political speeches and philosophical texts.

UNIT III **12 Hours**

Theories and Trends in Translation: Historical Theories of Translation in Past Classics and Canons, Modern Theories in Translation: Impact of Technology, Multiple Intelligence and Corporate world on modern theories of translation, Changing trends and ideas in translation. Difference in Theoretical and Pragmatic Translations: Difficulties and Solutions in Translation.

UNIT IV **11 Hours**

New Possibilities and Strategies in Translation: Significance of Synonyms and Accuracy levels in Translation. Translation in Social Media and Literature: A Comparative glance. Translation in Re-Scripting for different audience or readers: Purpose Oriented Translation in Children's Literature and Instructional Education. Importance of Translation as Original Writing: Significance of reaching out in Target Language and Departure from Source Language.

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

SUGGESTED READING:

- *Cronin, Michael. (2003). Translation and globalization. London: Routledge.*
- *Gouadee (2007), D. Translation as a Profession. John Benjamins Publishing*
- *Shastri, Pratima dave (2012), Fundamental Aspects of Translation. PHI Learning, New Delhi.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Name: Pharmaceutical chemistry
Course Code: BNR416

L	T	P	Credit
3	0	0	3

Total Hours: 45

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. Study the action and discovery, the structure activity and drug targets.
3. Differentiate 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, anti inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol)

UNIT-II **10 Hours**

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

UNIT-III **10 Hours**

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

UNIT-IV **10 Hours**

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

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

SUGGESTED READINGS:-

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

Course Name: Conductance, Electrochemistry and

Functional Group Organic Chemistry

Course Code: BNR417

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

1. Calculate conductance of strong and weak electrolyte.
2. Derive Nearnst equation for calculation of e.m.f of cell.
3. Recognize the importance of electrochemistry in various fields.
4. Predict the activity of various functional group in synthesis of oganic compounds and in various reactions .

Course Content

UNIT-I **12 Hours**

Conductance

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

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

UNIT-I **11 Hours**

Electrochemistry

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

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

UNIT-III **10 Hours**

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

Amines and Diazonium Salts

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

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

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

UNIT IV **12 Hours**

Amino Acids, Peptides and Proteins:

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

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

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of

monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

SUGGESTED READINGS:-

- *G. W. Castellan: Physical Chemistry 4th Ed. Narosa (2004).*
- *J. C. Kotz, P. M. Treichel, J. R. Townsend, General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).*
- *B. H. Mahan: University Chemistry, 3rd Edn. Narosa (1998).*
- *R. H. Petrucci, General Chemistry, 5th Edn., Macmillan Publishing Co.: New York (1985).*
- *Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
- *Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
- *Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
- *Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.*
- *Digital platform: NPTEL/SWAYAM/MOOCs*

Course Name: Polymer Chemistry
Course Code: BNR418

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

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

Course Content

UNIT-I **15 Hours**

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

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

Kinetics of Polymerization: Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

UNIT-II **10 Hours**

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

Nature and structure of polymers- Structure Property relationships

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

UNIT-III **11 Hours**

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

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

UNIT-IV **09 Hours**

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

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

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

SUGGESTED READINGS:-

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

Course Name: Pesticide Chemistry
Course Code: BNR419

L	T	P	Credit
3	0	0	3

Total Hours: 45

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:-

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

Course Title: Life Skills
Course Code: BNR411

L	T	P	Credit
2	0	0	2

Total Hours 30

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 **7 Hours**

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

UNIT II **8 Hours**

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

UNIT III **7 Hours**

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

UNIT IV **8 Hours**

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

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

SUGGESTED READINGS:-

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

Semester V

Course Title: Modern Physics
Course Code: BNR516

L	T	P	Credit
2	0	0	2

Total Hours: 30

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

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

Course Content

UNIT I **7 Hours**

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

UNIT II **8 Hours**

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

UNIT III **7 Hours**

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

UNIT IV **8 hours**

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wave-functions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d shells.

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

SUGGESTED READINGS:-

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

Course Name: Spectroscopy
Course Code: BNR517

L	T	P	Credit
4	0	0	4

Total Hours: 60

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

1. Differentiate different types of spectroscopic techniques.
2. Derive the laws of photochemistry.
3. Verify Lambert-Beer's law.

4. Separate the molecular energies into translational, rotational, vibration and electronic components.

Course Content

UNIT-I **15 Hours**

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

UNIT-II **16 Hours**

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

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

UNIT-III **16 Hours**

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

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

UNIT-IV **13 Hours**

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

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

SUGGESTED READINGS:-

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

Course Title: Calculus

Course Code: BNR518

L	T	P	Credit
4	0	0	4

Total Hours: 60

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

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

Course Content

UNIT I **15 hours**

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

UNIT II **15 hours**

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

UNIT III **15 hours**

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

UNIT IV **15 hours**

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

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

Suggested Readings:-

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

Course Title: Numerical Methods

Course Code: BNR506

L	T	P	Credit
2	0	0	2

Total Hours: 30

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 and Newton backward formula.
4. Calculate Simpson's 1/3, 3/8 rules using Trapezoidal rule and evaluate the summation of series finite difference techniques

Course Content

UNIT I **10 Hours**

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

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UNIT II **8 Hours**

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

UNIT III **6 Hours**

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

UNIT IV **6 Hours**

Numerical differentiation and Numerical integration by Newton cotes formulae, Trapezoidal rule, Simpson's rule, Romberg formula and their error estimation. Numerical solution of ordinary differential equations by Euler's method, Picard's method, Taylor series and Runge-Kutta methods.

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

Suggested Readings:-

- *B. Bradie, (2007). A Friendly Introduction to Numerical Analysis, Pearson Education, India,*
- *M. K. Jain, S. R. K. Iyengar and R. K. Jain, (2007). Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India, 5th edition,*
- *C. F. Gerald and P. O. (2008). Wheatley, Applied Numerical Analysis, Pearson Education, India, 7th edition.*

- *M. Pal (2007). Numerical Analysis for scientific and engineering computation, Narosa Publication*
- *N. Ahmad (2008). Fundamental Numerical Analysis with error estimation, Anamaya Publisher.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs*

Course Title: Numerical Methods Lab
Course Code: BNR507

L	T	P	Credit
0	0	2	1

Total Hours: 15

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.

Course Content

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

Suggested Readings:-

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

Course Title: Spectroscopy Lab
Course Code: BNR519

L	T	P	Credit
0	0	2	1

Total Hours: 15

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

1. Perform experiments based on instrumentation.
2. Enhance their skills in interpreting the data.
3. Analyze the effect of structure on spectra of organic compounds.
4. Determine the concentration of Unknown in a mixture using Lambert-Beer's Law.

UV/Visible spectroscopy

I. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).
II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.
III. 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.

Colourimetry

I. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration.
II. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.
III. Determine the dissociation constant of an indicator (phenolphthalein).

SUGGESTED READINGS:-

- *Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.*
- *Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).*
- *Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).*
- *Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).*
- *Advance Practical Physical Chemistry by J.B. Yadav, Goel Publication, Meerut.*
- *Practical Physical Chemistry by B. Vishwanathan and P.S. Raghvan, Viva Books Pvt. Ltd.*

Course Title: Modern Physics Lab
Course Code: BNR520

L	T	P	Credit
0	0	2	1

Total Hours: 15

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

1. Develop proficiency in using laboratory equipment and instruments to conduct experiments accurately and safely.
2. Gain the ability to design and execute experiments, including formulating hypotheses, controlling variables, and collecting data systematically.
3. Acquire skills in analyzing experimental data using statistical methods and software tools, interpreting results, and identifying sources of error.
4. Understand and apply the scientific method, including developing hypotheses, conducting experiments, analyzing data, and drawing conclusions

Course Content

1. Study of black body spectra
2. Determination of Planck's constant and De Broglie wavelength of

   Electrons using photoelectric experiments.
3. Determination of Rydberg's constant from hydrogen spectrum
4. Determination of charge to mass ratio of electron – Thomson's method
5. Verification of Bohr's theory – Franck – Hertz Experiment.
6. Determination of charge of electron by Millikan's oil drop method.
7. Electron Spin Resonance- Determination of 'g' factor of an electron
8. Determination of Ferromagnetic Curie temperature of a given sample
9. Studying the Energy gap of semiconductors.
10. Measurement of Hall coefficient of a semiconductor.

Course Title: Training in Mathematical modeling
Course Code: BNR521

L	T	P	Credit
0	0	2	1

Total Hours: 15

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

1. Gain hands-on experience with laboratory equipment, techniques, and safety protocols.
2. Analyze experimental data using statistical methods, software tools, and data visualization techniques to draw meaningful conclusions.
3. Collaborate effectively with other interns, researchers, and faculty members on projects, fostering teamwork and interpersonal skills.
4. Acquire proficiency in using specialized software, instrumentation, and computational tools relevant to physics research.

General Instructions for students

The internship is an 3-credit course. It requires the student to complete 6 weeks within the internship organization. The student is required to work under the supervision of a Mentor. She is expected to observe the work week and hours of the agency/organization. The general rules and regulations that the agency/organization applies to its regular staff, will have to be adhered to by the intern.

The student is expected to develop at least five learning objectives that are measurable and realistic and she would like to and strive to achieve during her internship. These objectives should be finalized in consultation with the Supervisor/Mentor and Faculty Coordinator and signed by all three stakeholders.

The student is required to develop a work plan that will help her achieve objectives i.e. help her to practice and develop competencies that will help her in her chosen career path. She is required to complete tasks and assignments, projects given by the Supervisor/Mentor as well as reports and presentations regarding the internship experience and issues related to professional development. She may be required to attend seminars/conferences/meetings during the internship upon approval by the Supervisor/Mentor and the Faculty Coordinator.

She is required to submit to the Faculty Coordinator a summary of the week's experience and the weekly log of hours that she has worked. At the culmination of the internship, the intern will submit a written report of her experience. She should not only describe the work done but also write how it has contributed towards her professional development and career goals. The report should be read and certified by the Supervisor/Mentor.

Evaluation/ Assessment of the Internship Seminar-

After completion of internship, student is required to make a presentation about her experience. This will be evaluated by the Coordinator, the Supervisor/Mentor and the Head of Department. The duration of the presentation should not exceed 20 minutes.

Course Title: General Organic Chemistry and Aliphatic Hydrocarbons	**L**	**T**	**P**	**Credit**
Course Code: BNR512	**3**	**0**	**0**	**3**

Total Hours 45

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

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

Course Content

UNIT I **12 Hours**

Fundamentals of Organic Chemistry

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

UNIT II **13 Hours**

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis* - *trans* nomenclature; CIP

Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

UNIT III **10 Hours**

Aliphatic Hydrocarbons

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

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

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation

UNIT IV **10 Hours**

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

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

SUGGESTED READINGS:-

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

Course Title: Chemical Energetics, Equilibria and Functional Group Organic Chemistry
Course Code: BNR513

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes: On successful completion of this course, the successful students will be able to:
1. Acquire basic knowledge of the fundamental principles of thermo-chemistry.
2. Calculate the bond energy, bond dissociation energy and resonance energy from thermodynamic data.
3. Derive various laws of chemical equilibrium.
4. Evaluate the functional group chemistry for various reactions of organic molecules.

UNIT I **12Hours**

Chemical Energetics

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

UNIT II **13Hours**

Chemical Equilibrium:

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

Ionic Equilibria:

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

UNIT III **10 Hours**

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

Aromatic hydrocarbons

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

Alkyl and Aryl Halides

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

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

UNIT IV **10 Hours**

Alcohols and Phenols (Upto 5 Carbons)

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

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

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

SUGGESTED READINGS:-

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

Course Name: Analytical Methods in Chemistry

Course Code: BNR514

L	T	P	Credits
3	0	0	3

Total Hours: 45

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

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

Course Content

UNIT-I **08 Hours**

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

UNIT-II **12 Hours**

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

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

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

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

UNIT-III **10 Hours**

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

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

UNIT-IV **15 Hours**

Separation techniques:

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

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

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

SUGGESTED READINGS:-

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

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

L	T	P	Credits
3	0	0	3

Course Code: BNR515

Total Hours: 45

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

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

Course Content

UNITI **11Hours**

General Principles of Metallurgy

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

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

UNIT-II **10 Hours**

_s_- and _p_-Block Elements

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

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

UNIT-III **12Hours**

Compounds of _s_- and _p_-Block Elements

Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements.Concept of multicentre bonding (diborane).Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial, organic and environmental chemistry, Hydrides of nitrogen (NH_3, N_2H_4, N_3H, NH_2OH)Oxoacids of P, S and Cl, Halides and oxohalides: PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2

UNIT IV **12 Hours**

Chemical Kinetics

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

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

Suggested Books:-

- *G. W. Castellan, (2004): Physical Chemistry 4th Edn. Narosa.*

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

Semester VI

Course Title: Fluid Mechanics

Course Code: BNR601

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

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

Course Content

UNIT I **15 Hours**

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

UNIT II **15 Hours**

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

UNIT III **15 Hours**

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

UNIT IV **15 Hours**

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

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

Suggested Readings:-

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

Course Title: Organic Synthesis
Course Code: BNR612

L	T	P	Credit
4	0	0	4

Total Hours: 60

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

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

Course Content

UNITI **13 Hours**

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

UNIT II **14 Hours**

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

UNIT III **15 Hours**

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

UNIT IV **18 Hours**

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

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

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

SUGGESTED READINGS:-

- *Acheson, R. M., & Jones, B. J. (1970). Addition reactions of heterocyclic compounds. PartXLII the mechanism of the thermal rearrangement of tetraethyl 7, 9-dimethyl-9a H-quinolizine-1, 2, 3,4-tetracarboxylatetothe4H-isomer.JournaloftheChemicalSocietyC:Organic.*

- *Cotton,F.A.,Wilkinson,G.,Murillo,C.A.,Bochmann,M.,&Grimes,R.(2018). A dvanced inorganic chemistry(Vol. 6,p. 1455).New York:Wiley.*
- *Katritzky, A. R., & Rees, C. W. (1984). Comprehensive heterocyclic chemistry. Pergamum* Press.
- *Sainsbury, M. (Ed.). (1992). Aliphatic Compounds: Monocarboxylic Derivatives of Aliphatic Hydrocarbons,Their Analogues and Derivatives, Elsevier.*

Course Title: Project in Physics/Chemistry/Mathematics
Course Code: BNR613

L	T	P	Credit
0	0	12	6

Total Hours: 30

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

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

Guidelines for Dissertation:

The purpose of the dissertation in B.Sc NM 6th semester 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.

SUGGESTED READINGS:

- *Bell, Judith (2005), Doing your research project: A Guide for First-time Researchers in Education, Health and Social Sciences, Open University Press.*
- *Guthrie, G. (2010), Basic Research Methods: An Entry to Social Science Research. Sage Publications.*
- *Mukherjee, Neela (2002), Participatory Learning and Action with 100 Field Methods. New Delhi: Concept Publication.*
- *Thomas, G. (2009), How to do your Research Project, Los Angles: Sage Publication.*
- *Wolcott, H.(1995), The Art of Field work, Alta Mira Press, Walnut Creek, CA,*

Course Title: IT Skills for Chemists
Course Code: BNR606

L	T	P	Credit
2	0	0	2

Total Hours: 30

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

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

Course Content

UNIT I **8 Hours**

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

UNIT II **7 Hours**

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

UNIT III **7 Hours**

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

UNIT IV **8 Hours**

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

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

SUGGESTED READINGS:-

- *Yates, P. Chemical calculations. 2ndEd. CRC Press (2007).*
- *Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.*

- *Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001) 487 pages.*
- *Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co.(1985).*
- *Venit, S.M. Programming in BASIC: Problem solving with structure and style. Jaico Publishing House: Delhi (1996).*

Course Title: IT Skills for Chemists Lab
Course Code: BNR607

L	T	P	Credit
0	0	2	1

Total Hours: 15

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

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

Course Content

List of Practical's

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

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

SUGGESTED READINGS:-

- *Mortimer, R. Mathematics for Physical Chemistry. 3 rd Ed. Elsevier (2005).*
- *Yates, P. Chemical calculations. 2 nd Ed. CRC Press (2007).*

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

Course Title: Organic Synthesis Lab
Course Code: BNR614

L	T	P	Credit
0	0	2	1

Total Hours: 15

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

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

Course Content

List of Experiments:

1. Safety Practices in the Chemistry Laboratory
2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.
4. Determination of the void volume of a gel filtration column.
5. Determination of a Mixture of Cobalt and Nickel (UV/Vis spectroscopy)
6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7. Potentiometric Titration of a Chloride-Iodide Mixture
8. Verify Lambert-Beer's law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration
9. Study the 200-500 nm absorbance spectra of KMnO4 and K2Cr2O7 (in 0.1 M H2SO4) and determine the λmax values. Calculate the energies of the two transitions in different Units (J molecule-1 , kJ mol-1 , cm-1 , eV).

10. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K2Cr2O7.

SUGGESTED READINGS:-

- *Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).*
- *Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.*

Course Title: Analog Electronics
Course Code: BNR615

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

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

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

Course Content

UNIT I **11 Hours**

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

UNIT II **12 Hours**

Junction transistor and its biasing: Structure and working, relation between different currents in transistor, Sign conventions. Amplifying action, Different configurations of a transistor and their comparison. CB and CE characteristics, Transistor biasing and stabilization of operating point, Fixed bias, Collector to base bias, Bias circuit with emitter resistor, Voltage divider biasing circuit.

UNIT III **11 Hours**

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

UNIT IV **11 Hours**

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

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

SUGGESTED READINGS:

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

Course Title: High Energy Physics
Course Code: BNR616

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

1. Explain the need of standard model and its limitations and the properties of QCD.

2. Draw Feynman diagrams and to check if interactions are allowed or forbidden.
3. Use the quark model for understanding the properties of hadrons e.g. neutrons and protons.
4. Explain the symmetry in baryon decuplets and octets for JP states.

Course Content

UNIT I **12 Hours**

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

UNIT II **11 Hours**

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

UNIT III **11 Hours**

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

UNIT IV **11 Hours**

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

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

SUGGESTED READINGS :

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

- *Cheng & Li, Gauge Field Theory of Elementary Particle Physics -- Oxford University Press.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Physics of Nanomaterials
Course Code: BNR617

L	T	P	Credit
3	0	0	3

Total Hours : 45

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

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

Course Content

UNIT I **12 Hours**

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

UNIT II **11 Hours**

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

UNITIII **11 Hours**

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

UNIT IV **11 Hours**

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

SUGGESTED READINGS :

- *Bimerg, D., Grundmann, M., and Ledentsov, N.N., Quantum Dot Heterostructures, John Wiley Publications.*
- *Poole,C.P., Owens,F.J., Introduction to NanotechnologyJohn Wiley &Sons.*
- *Jain, K.P., Physics of Semiconductor Nanostructures, Narosa.*

- *Fendler, J.H., Nano particles and Nano-structured Films, John Wiley &Sons.*
- *Timp, G., Nanotechnology, Springer-Verlag.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Atomic Spectroscopy
Course Code: BNR618

L	T	P	Credit
3	0	0	3

Total Hours : 45

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

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

Course Content

UNIT I **11 Hours**

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

UNIT II **11 Hours**

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

UNIT III **12 Hours**

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

UNIT IV **11 Hours**

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

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

SUGGESTED READINGS:

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

Course Title: Value Education
Course Code: BNR623

L	T	P	Credit
2	0	0	2

Total Hours: 30

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

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

Course Content

UNIT I **8 Hours**

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

UNIT II **7 Hours**

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

UNIT III **8 Hours**

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

UNIT IV **7 Hours**

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

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

SUGGESTED READINGS:-

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

Course Title: Human Rights and Duties
Course Code: BNR624

L	T	P	Credit
3	0	0	3

Total Hours: 45

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

Course Content

UNIT I **12 Hours**

Definition of Human Rights: Nature, Content, Legitimacy and Priority – Theories on Human Rights – Historical Development of Human Rights. Human Rights Declarations – U.N. Human Rights Declarations – U.N. Human Rights Commissioner

UNIT II **11 Hours**

International Human Rights: prescription and Enforcement up to World War II – Human Rights and the U.N.O – Universal Declaration of Human Rights - International Covenant on Civil and Political Rights - International Covenant on Economic, Social and Cultural Rights and Optional Protocol

UNIT III **11 Hours**

Amnesty International: Human Rights and Helsinki Process – Regional Developments – European Human Rights System – African Human Rights System – International Human Rights in Domestic Courts.

UNIT III **11 Hours**

Contemporary Issues on Human Rights: Children's Rights – Women's Rights – Dalit' s Rights – Bonded Labor and Wages – Refugees – Capital Punishments. Fundamental Rights in the Indian Constitutions – Directive Principles of State Policy – Fundamental Duties – National Human Rights Commission.

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

SUGGESTED READINGS:

- *Manoj Kumar Sinha (2013), Implementation of Basic Human Rights, Lexis Nexis*
- *Vijay Chitnis et. al. (1997), Human Rights and the Law: National and Global Perspective, Snow White Publishers.*
- *Bhagyashree A. Deshpande (2017), Human rights- Law and Practice, CLP.*
- *H.O. Agarwal (2019), International Law and Human Rights, CLP.*
- *Justice D M Dharmadhikari (2016) , Human Values and Human Rights (Lexis Nexis, 2016)*

Semester- VII

Course Title: Research Methodology

Course Code: BNR701

L	T	P	Credit
4	0	0	4

Total Hours: 60

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

1. Develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.
2. Know the main approaches in legal methodology, have basic knowledge on qualitative research techniques
3. Have adequate knowledge of the key issues of disciplinary and interdisciplinary legal research.
4. Develop an adequate literature review and identify relevant references to formulate a theoretical framework in accordance with the research topic.

Course Content

UNIT I **15 Hours**

Research: its concept, nature, scope, need and Objectives of Research, Research types, Research methodology, Research process – Flow chart, description of various steps, Selection of research problem.

UNIT II **15 Hours**

Research Design: Meaning, Objectives and Strategies of research, different research designs, important experimental designs. Methods of Data Collection and Presentation: Types of data collection and classification, Observation method, Interview Method, Collection of data through Questionnaires, Schedules, data analysis and interpretation, editing, coding, content analysis and tabulation.

UNIT III **15 Hours**

Sampling Methods: Different methods of Sampling : Probability Sampling methods , Random Sampling, Systematic Sampling, Stratified Sampling, Cluster Sampling and Multistage Sampling. Non probability Sampling methods, Sample size.

UNIT IV **15 Hours**

Report writing and Presentation: Types of reports, Report Format – Cover page, Introductory page, Text, Bibliography, Appendices, Typing instructions, Oral Presentation

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

SUGGESTED READINGS:

- *Panneerselvam R, 'Research Methodology', PHI, New Delhi.*
- *Cooper, D.R.,Schindler, P.S., 'Business Research Methods,' Tata McGraw Hill .*
- *Gupta S P,' Statistical Methods', Sultan Chand & Sons, Delhi.*
- *Ronald E Walpole, 'Probability and Statistics for Engineers and Scientists' (International Edition), Pearson Education.*
- *Geode, Millian J. & Paul K. Hatl, "Methods in Research", McGraw Hills, NewDelhi.*
- *Kothari C.R., "Research Methodology", New Age Publisher.*
- *Nargundkar R, Marketing Research, Tata McGraw Hill, New Delhi, 2002.*
- *Sekran, Uma, "Business Research Method", Miley Education,Singapore.*
- *https://www.academia.edu/*
- *https://www.studeersnel.nl*
- *https://www.scribd.com*

Course Title: Research Proposal

Course Code: BNR702

L	T	P	Credits
0	0	8	4

Learning Outcomes

After completion of the course, the learner willbe able to

1. Get deep insights to collect, review and analyze the related literature.
2. To apply the knowledge to formulate hypothesis & design research process.
3. Find the research titles which are significant, applicable and researchable.
4. Interpret the findings to design statistical strategies & write references, bibliography and webliography.

Course Content

A research proposal contains all the key elements involved in the research process and proposes a detailed information to conduct the research.

The students are supposed to prepare the research proposal of any research area of their choice following these steps:

1. Selection of topic
2. Significance of the research area
3. Formulation of hypothesis/Research questions
4. Review of related literature
5. Method & Procedure (Includes sampling & design)
6. Data collection and proposed statistical analysis
7. Delimitations
8. Reference/Bibliography

Evaluation

The students will have to complete the writing process of each topic given above within one week, which will be evaluated at the end of every week. It will consist of 8 marks each. The final proposal shall be of 15 marks, Viva 16 marks and attendance 5 marks.

Transaction Mode

Collaborative learning, Group Discussion, E team Teaching, Activities, Assessments, Collaborative teaching, Peer Teaching, Video Based Teaching, Quiz, Open talk, E team Teaching, Case analysis, Flipped Teaching

L	T	P	Credits
3	0	0	3

Course Title: Ethics & IPR
Course Code: BNR703

Total Hours : 45

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

1. Explain different kind of ethics and values.
2. Apply professional ethics in research.
3. Explain the role of IPRs in professional life.
4. Elucidate the importance of patents and copyrights.

Course Content

UNIT I **13 Hours**

Ethics:definition, moral philosophy, nature of moral judgments and reactions, scope, Ethics with respect to science and research, Intellectual honesty and research integrity Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP) Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data, Publication ethics: definition, introduction and importance.

UNIT II **12 Hours**

Introduction to Intellectual Property rights: Concept & theories, Kinds of intellectual Property Rights, Advantages & Disadvantages of IPR, Development of IPR in India, Role & Liabilities of IPRs in India. Rights of trademark-kind of signs used as trademark-types, purpose & functions of a trademark, trademark protection, trademark registration, selecting and evaluating trade mark, trade mark registration process.

UNIT III **10 Hours**

Patents: Introduction to Patents, Object of Patent Law, Inventions not Patentable, Obtaining Patents, Rights and Obligations of a Patentee.

UNIT IV **10 Hours**

Databases and Research Metrics: Indexing databases, Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, Altmetrics, Google Scholar, Research Gate, Pub-med etc.

Course Title: PROFICENCY IN TEACHING

Course Code: BNR704

L	T	P	Credits
2	0	0	2

Total Hours: 30

Learning Outcomes

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

1. Design the learner-centered instructional plans and learning outcomes.
2. Apply innovative teaching strategies and technologies to engage learners.
3. Analyze the different assessment methods to evaluate student learning.
4. Reflect on teaching experiences and continuously improve teaching practices.
5. Develop effective communication and classroom management skills.

Course content

UNIT I **10 Hours**

Overview of the course and its objectives – Specify 1-2 theories or give overview of theories of learning for teaching - Understanding the role of the teacher and student in the learning process - Writing clear and measurable learning outcomes -

Meaning Nature, definition, scope, and importance Pedagogy, Andragogy, and Heutagogy – Skills-based approach to teaching (Teaching skills), Micro-teaching, Macro teaching. Methods and approaches of teaching - CAM, Structure-function approach, Synthetic and Analytic approach, Jurisprudential inquiry model

UNIT II **6 Hours**

Understanding the diverse needs and backgrounds of learners - Creating an inclusive and supportive learning environment - Facilitating active learning and student engagement strategies

Lectures, discussions, and demonstrations - Group work, collaborative learning, and cooperative learning - Problem-based learning, case studies, and simulations

UNIT III **7 Hours**

Integrating technology tools into instruction – Online, blended learning, flipped learning, and M-learning approaches - Using educational software and platforms effectively

Formative and summative assessment methods – Difference between Assessment, Evaluation and Measurement, E-assessment tools,

UNIT IV **7 Hours**

The importance of reflective practice in teaching - Self-assessment and evaluation of teaching effectiveness –Need for Professional development - Teaching in multicultural and international classrooms - Culturally responsive teaching practices

Meaning, Definition of teaching model - Assumptions, Importance, Role, and type of teaching models. Historical teaching model, Philosophical model of teaching

Transaction Mode

Discussions, Case Studies, Microteaching, Classroom Observations, Peer Teaching: Video Analysis, Role-Playing, Lecture-cum-demonstration, Classroom Simulations, Reflective Journals/Blogs, Teaching Portfolios and Technology Integration, Flipped Teaching

Suggested Readings

- *Ali, L. (2012). Teacher education. New Delhi: APH Publishing Corporation.*
- *Anandan, K. (2010). Instructional technology in teacher education. New Delhi: APH Publishing Corporation.*
- *Bruce R Joyce and Marsha Weil, Models of Teaching, Prentice Hall of India Pvt Ltd, 1985.*

- *Chalan, K. S. (2007). Introduction to educational planning and management. New Delhi: Anmol Publications Pvt. Ltd.*
- *Chand, T. (2008). Principles of teaching. New Delhi: Anmol Publications Pvt. Ltd.*
- *Chiniwar, P. S. (2014). The technology of teaching. New Delhi: Anmol Publications Pvt. Ltd.*
- *Curzon, L. B., & Tummons, J. (2004). Teaching in future education. U.S.A: Bloomsbury Academic Publications.*
- *Das, R.C. (1993): Educational Technology – A Basic Text, Sterling Publishers Pvt. Ltd.*
- *Evaut, M. The International Encyclopedia of Educational Technology.*
- *Gage N L, Handbook of Research on Teaching, Rand Mc Nally and Co., Chicago, 1968.*
- *Graeme, K. (1969): Blackboard to Computers: A Guide to Educational Aids, London, Ward Lock.*
- *Haas, K.B. and Packer, H.Q. (1990): Preparation and Use of Audio Visual Aids, 3rd Edition, Prentice Hall, Inc.*
- *Haseen Taj (2006):modern Educational Technology, Agra: H.P Bhargava Book House.*
- *Jarvis, M. (2015). Brilliant ideas for ICT in the classroom. New York: Routledge Publications.*

Course Title: MATLAB Programming

Course Code: BNR707

L	T	P	Credits
2	0	0	2

Total Hours: 30

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

1. Use MATLAB effectively to analyze and visualize data.
2. Apply numeric techniques and simulations to solve physics-related problems.
3. Be familiar with the computational tool MATLAB
4. Learn graphics and programming in MATLAB.

Course Content

Basic Operations of MATLAB: MATLAB Fundamentals, Introduction- MATLAB Features-Desktop Windows: Command, Workspace, Command History, Array Editor and Current Directory -MATLAB Help and Demos- MATLAB Functions, Characters, Operators and Commands.

Basic Arithmetic in MATLAB-Basic Operations with Scalars, Vectors and Arrays-Matrices and Matrix Operations-Complex Numbers- MATLAB Built-In Functions-Illustrative Examples.

MATLAB Programming : Control Flow Statements: if, else, else if, switch Statements-for, while Loop Structures-break Statement-Input/output Commands-Function m Files-Script m Files-Controlling Output MATLAB Graphics.

2D Plots : Planar Plots, Log Plots, Scatter Plots, Contour Plots-Multiple Figures, Graph of a Function, Titles, Labels, Text in a Graph- Line Types, Marker types, Colors-3D Graphics-Curve Plots-Mesh and Surface Plots-Illustrative Examples.

SUGGESTED READINGS:

- *Chapman, S., "MATLAB Programming for Engineers", 4th Edition, Cengage Learning, Engineering, 1120 Birchmount Rd, Toronto, ON, M1K5G4, Canada. 2008.*
- *Register, A.H., "A guide to MATLAB object-oriented programming", Boca Raton, FL: CRC Press, 2007.*
- *Brian Hunt, Ronald Lipsman, Jonathan Rosenberg, "Guide to MATLAB for Beginners & Experienced Users",Cambridge University Press.*

Course Title: MATLAB Programming Lab

Course Code: BNR708

L	T	P	Credits
0	0	4	2

Total Hours: 30

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

1. Use MATLAB effectively to analyze and visualize data.
2. Apply numeric techniques and simulations to solve physics-related problems.
3. Be familiar with the computational tool MATLAB
4. Learn graphics and programming in MATLAB.

Course Content

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.

SUGGESTED READINGS:

- *Chapman, S., "MATLAB Programming for Engineers", 4th Edition, Cengage Learning, Engineering, 1120 Birchmount Rd, Toronto, ON, M1K5G4, Canada. 2008.*
- *Register, A.H., "A guide to MATLAB object-oriented programming", Boca Raton, FL: CRC Press, 2007.*
- *Brian Hunt, Ronald Lipsman, Jonathan Rosenberg, "Guide to MATLAB for Beginners & Experienced Users",Cambridge University Press.*

Course Title: Service Learning

Course Code: BNR706

L	T	P	Cr.
0	0	4	2

Learning Outcomes

On the completion of the course, the students will be able to

1. Participate in community activities to establish connections and build relationships.
2. Evaluate community needs through conversations with community members.
3. Develop and implement initiatives that address community needs.
4. Reflect on personal growth, community impact and ethical considerations related to service activities.

Course Content

This course aims to engross students in meaningful service-learning activities that foster community linking. Students will actively participate in community-based projects, collaborate with community members and organizations and reflect on the impact of their service activities. Through this experiential learning approach, students will develop a deep understanding of community needs, build relationships with diverse stakeholders and contribute to community development.

In this course, students are expected to be present in the community throughout the semester and reflect on their experiences regularly

after working with them. The students will use experiential learning for providing service learning. They will be able to analyse and have understanding of the key theoretical, methodological and applied issues.

Select 10 community related activities which are to be performed in nearby villages. Students in groups of 8-10 shall work on one activity.

Evaluation Criteria

1. Every activity shall be evaluated on the same day out of 10 marks.
2. Total 10 activities out of 100 shall be evaluated and submitted to Examination branch.

Activity Evaluation

1. Type of activity- 2 marks
2. Participation of student- 2 marks
3. Engagement in the activity- 2 marks
4. Outcome of the activities- 2 marks
5. Attendance- 2 marks

Transaction Mode

Problem-solving learning, Blended learning, Gamification, Cooperative learning, Inquiry-based learning, Visualization, Group discussion, Experiential learning, Active participation.

Semester-VIII

Course Title: Dissertation

Course Code: BNR801

L	T	P	Credits
0	0	0	20

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

1. Gain in-depth knowledge and use adequate methods in the major subject/field of study.
2. Create, analyze and critically evaluate different technical/research solutions
3. Clearly present and discuss the conclusions as well as the knowledge and arguments that form the basis for these findings
4. Identify the issues that must be addressed within the framework of the specific dissertation in order to take into consideration

Course Content

The aim of dissertation in M.Sc. 4th semesters is to expose of the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data, etc. Dissertation can be in Experimental Physics or Theoretical Physics in the thrust as well as non-thrust research areas of the department.

A student opting for this course will be attached to one teacher of the department before the end of the 3rd semester. A report of about 30 pages about the work done in the project (typed on both the sides of the paper and properly bound) will be submitted by a date to be announced by the GKU.

Assessment of the work done under the project will be carried out by a committee on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and viva-voce/seminar, etc as per guidelines prepared by the GKU.

Credits for Final Dissertation Report & Viva Voce: 20

All the candidates of MCA final project are required to submit a project report based on the work done by him/her during the project period. A student will submit his/her project report in the prescribed format. A student has to submit: two hard copies of the project report, and a soft copy of project on CD/DVD in a thick envelope pasted inside of the back cover of the dissertation report.

Prescribed outline for the Dissertation Report

1. Title Page (format as in Anenxure-1)
2. Declaration (format as in Anenxure-1)
3. Certificate from the Project Guide on letter head of an organization (format as in Anenxure-1)
4. Acknowledgement
5. Abstract

6. Index
7. List of Figures
8. List of Tables
9. List of acronyms and abbreviations
10. Introduction to the project
11. Statement of the Problem
12. Theoretical Background / Literature review
13. Experimental details.
14. Results
15. Conclusions and Future Work
16. References
17. Annexure (optional)

Formatting Instructions:

Margins: Left margin-1.3 inch, Right margin-1 inch, Top margin: 1 inch, Bottom margin:1 inch Page numbers–All pages should be numbered at the bottom center of the pages.

Normal Body Text: Font Size: 12, Times New Roman, 1.5 Spacing, Justified. 6 point above and below paragraph spacing. Section Heading: Font Size: 14, Times New Roman, Underlined, Left Aligned. 12 point above & below spacing.

Chapter Heading: Font Size: 20, Times New Roman, Centre Aligned, 30 point above and below spacing.

Figure and Table Captions: Font Size: 12, Times New Roman, centred.

Coding Font: size : 10, Courier New, Normal Good quality white paper A4 size should be used for typing and duplication.

This load (equivalent to 2 Hours per week) will be counted towards the normal teaching load of the teacher.