Faculty of Science

Syllabus

For

B.Sc. Physical Science*

(Physics, Chemistry, Mathematics)

(Program Code: SC0142)

(2019-20)

(Approved by the Academic Council vide Resolution No. 34.26 dated 20.06.2019)

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1. Programme Educational Objectives (PEOs)

PEO1: The graduate will have successful carrier in various service domains like banking consultancy, teaching, government jobs, defense, industry and entrepreneurship pursuit.

PEO2: The graduate will have specialized knowledge and expertise to identify, formulate, investigate, analyze and implement on the problems in physical sciences.

PEO3: The graduate will have continuous learning attitude to adopt new skills and techniques to overcome the challenges related with new technologies.

2. Graduate Attributes (GAs)

The graduate attributes of B.Sc. Physical Science are the summation of the expected course learning outcomes mentioned at the end of each course. Some of them are stated below.

GA1: Discipline-specific Knowledge: Capability of demonstrating comprehensive knowledge of B.Sc. programme and understanding of one or more disciplines which form a part of an undergraduate programme of study.

GA2: Critical Thinking: Ability to employ critical thinking in understanding the concepts in every area of B.Sc. programme.

GA3: Analytical Reasoning: Ability to analyze the results and apply them in various problems appearing indifferent courses.

GA4: Research-related skills: Develop a sense of inquiry and capability for asking relevant and intelligent questions, problematizing, synthesizing and articulating; ability to recognize and establish cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyze, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation.

GA5: Problem Solving: Capability to solve problems by using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

GA6: Usage of Modern Tools (Information/digital literacy): Create, select, and apply appropriate techniques, resources, and modern science and IT tools including prediction and modeling to complex science activities with an understanding of the limitations.

GA7: Self-directed learning: Ability to work independently and do in-depth study of various notions of courses of B.Sc. Programme.

GA8: Communications skills:

i. Ability to communicate various concepts of B.Sc. programme effectively using examples and their geometrical visualizations.

ii. Ability to use courses as a precise language of communication in other branches of human knowledge.

iii. Ability to communicate long standing unsolved problems in Physics, Chemistry, Mathematics.

iv. Ability to show the importance of their courses of B.Sc.as precursor to various scientific developments since the beginning of the civilization.

GA9. Multicultural Competence: Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.

GA10. Leadership Readiness/Qualities: Capability for mapping out the tasks in a team or an organization, self-motivating and inspiring team members to engage with the team objectives/vision; and using management skills to follow the mapped path to the destination in a smooth and efficient way.

GA11: Lifelong learning: Ability to think, acquire knowledge and skills through logical reasoning and to inculcate the habit of self-learning.

GA12: Moral and ethical awareness/reasoning: Ability to identify unethical behavior such as fabrication, falsification or misrepresentation of data and adopting objective, unbiased and truthful actions in all aspects of their programme.

GA13: Employability Options: This programme will also help students to enhance their employability for jobs in different sectors.

3. Programme Outcomes (POs)

Students graduating with the B.Sc. Physical Science degree should be able to acquire

PO1: Capability of demonstrating comprehensive knowledge of B.Sc. programme.

PO2: Ability to employ critical thinking in understanding the concepts in every area of B.Sc. PCM programme.

PO3: Ability to analyze the results and apply them in various problems.

PO4: Develop a sense of research to predict cause-and-effect relationships.

PO5: Capability to solve problems by using research-based knowledge and research methods.

PO6: Create, select, and apply appropriate techniques, resources, and modern science and IT tools.

PO7: Ability to work independently and do in-depth study of various notions of courses.

PO8: Ability to communicate various concepts of B.Sc. programme effectively using examples and their geometrical visualizations.

PO9: Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.

PO10: Self-motivating and inspiring team members to engage with the team objectives by using management skills.

PO11: Ability to think, acquire knowledge and skills through logical reasoning and to inculcate the habit of self-learning.

PO12: Ability to identify unethical behavior and adopting objective, unbiased and truthful actions in all aspects of their programme.

PO13: This programme will also help students to enhance their employability for jobs in different sectors.

Mapping of Graduate Attributes (GAs) and Programme Learning Outcomes (POs):

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12	GA13
PO1	■												
PO2		■											
PO3			■										
PO4				■									
PO5					■								
PO6						■							
PO7							■						
PO8								■					
PO9									■				
PO10										■			
PO11											■		
PO12												■	
PO13													■

4. Programme Specific Outcomes (PSOs)

PSO1: Demonstrate the ability to use skills in science and its related areas of technology for formulating and tackling scientific problems and identifying and applying appropriate physical principles and methodologies to solve a wide range of problems.

PSO2: Apply the knowledge gained during the course of the program to identify, formulate and solve real life problems to meet the core competency with continuous up gradation.

PSO3: Graduates will acquire a comprehensive knowledge and sound understanding of Fundamentals of basic sciences.

5. Course-Wise Learning Objectives, Structures and Outcomes (CLOSOs)

Course learning outcomes of each course in B.Sc. Physical Science as a subject have been enshrined in the end of course contents of each course with their objectives those are in the beginning of the every course.

FIRST SEMESTER

THEORY PAPERS		**No. of Teaching Hours**			**Marks Allocation**			
Code	**Subject/Paper**	**L**	**T**	**P**	**IA**	**EA**	**Total**	**Credits**
BSC101	English	3	-	-	30	70	100	3
BSC102	Mechanics	5	-	-	30	70	100	5
BSC103	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic hydrocarbons	5	-	-	30	70	100	5
BSC104	Differential Calculus	6	-	-	30	70	100	6
PRACTICALS/VIVA-VOCE		**No. of Teaching Hours**			**Sessional**	**Practical**	**Total**	**Credits**
BSC105	Mechanics Lab	-	-	4	30	20	50	2
BSC106	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic hydrocarbons Lab	-	-	4	30	20	50	2
TOTAL		**19**	**-**	**8**	**180**	**320**	**500**	**23**

SECOND SEMESTER

THEORY PAPERS		**No. of Teaching Hours**			**Marks Allocation**			
Code	**Subject/Paper**	**L**	**T**	**P**	**IA**	**EA**	**Total**	**Credits**
BSC201	Environmental Science	3	-	-	30	70	100	3
BSC202	Electricity, Magnetism and EMT	5	-	-	30	70	100	5
BSC203	Chemical energetic, Equilibria & Functional Group Organic Chemistry-I	5	-	-	30	70	100	5
BSC204	Differential Equations	6	-	-	30	70	100	6
PRACTICALS/VIVA-VOCE		**No. of Teaching Hours**			**Sessional**	**Practical**	**Total**	**Credits**
BSC205	Electricity, Magnetism and EMT Lab	-	-	4	30	20	50	2
BSC206	Chemical energetic , Equilibria & Functional Group Organic Chemistry-I Lab	-	-	4	30	20	50	2
TOTAL		**19**		**8**	**180**	**320**	**500**	**23**

THIRD SEMESTER

THEORY PAPERS		**No. of Teaching Hours**			**Marks Allocation**			
Code	**Subject/Paper**	**L**	**T**	**P**	**IA**	**EA**	**Total**	**Credits**
BSC301	Thermal Physics and Statistical Mechanics	5	-	-	30	70	100	5
BSC302	Solutions, Phase equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II	5	-	-	30	70	100	5
BSC303	Real Analysis	6	-	-	30	70	100	6
BSC304	**SEC-1 (Choose any one)**	3	-	-	30	70	100	3
BSC304A	Analytical Geometry							
BSC304B	Integral Calculus and Applied Mathematics							
BSC304C	Physics workshop skills							
BSC304D	Computational physics skills							
BSC304E	Pharmaceutical Chemistry							
BSC304F	Basic Analytical Chemistry)							
PRACTICALS/VIVA-VOCE		**No. of Teaching Hours**			**Sessional**	**Practical**	**Total**	**Credits**
BSC305	Thermal Physics and Statistical Mechanics Lab	-	-	4	30	20	50	2
BSC306	Solutions, Phase equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II Lab	-	-	4	30	20	50	2
TOTAL		**19**	**-**	**8**	**180**	**320**	**500**	**23**

FOURTH SEMESTER

THEORY PAPERS		**No. of Teaching Hours**			**Marks Allocation**			
Code	**Subject/Paper**	**L**	**T**	**P**	**IA**	**EA**	**Total**	**Credits**
BSC401	Waves and optics	5	-	-	30	70	100	5
BSC402	Transition Metal & Coordination Chemistry, states and matter Chemical kinetics	5	-	-	30	70	100	5
BSC403	Algebra	6	-	-	30	70	100	6
BSC404	**SEC-2 (Choose any one)**	3	-	-	30	70	100	3
BSC404A	Vector Calculus							
BSC404B	Theory of Equations							
BSC404C	Electrical circuit & net work skills							
BSC404D	Technical drawing							
BSC404E	Analytical Clinical Biochemistry							
BSC404F	Green Methods in Chemistry							
PRACTICALS/VIVA-VOCE		**No. of Teaching Hours**			**Sessional**	**Practical**	**Total**	**Credits**
BSC405	Waves and optics Lab	-	-	4	30	20	50	2
BSC406	Transition Metal & Coordination Chemistry Lab	-	-	4	30	20	50	2
TOTAL		**19**	**-**	**8**	**180**	**320**	**500**	**23**

FIFTH SEMESTER

THEORY PAPERS		No. of Teaching Hours			Marks Allocation			
Code	**Subject/Paper**	**L**	**T**	**P**	**IA**	**EA**	**Total**	**Credits**
BSC501	**SEC-3 (Choose any one)**	3	-	-	30	70	100	3
BSC501A	Probability and Statistics							
BSC501B	Mathematical Modelling							
BSC501C	Radiology & safety							
BSC501D	Weather forecasting							
BSC501E	Chemistry of Cosmetics & Perfumes							
BSC501F	Pesticide Chemistry							
BSC502	**DSE-1A (Choose any one)**	6	-	-	30	70	100	6
BSC502A	Matrices							
BSC502B	Mechanics							
BSC502C	Linear Algebra							
BSC503	**DSE-2A (Choose any one)**	5	-	-	30	70	100	5
BSC503A	Analytical Methods in Chemistry							
BSC503B	Novel Inorganic Solids							
BSC503C	Organometallics, Bioinorganic chemistry , Polynuclear hydrocarbons and UV ,IR Spectroscopy							
BSC503D	Chemistry of Main Group Elements, Theories of Acids and Bases							
BSC504	**DSE-3A (Choose any one)**	5	-	-	30	70	100	5
BSC504A	Digital, Analog and Instrumentation							
BSC504B	Elements of Modern Physics							
BSC504C	Mathematical Physics							
BSC504D	Solid State Physics							
PRACTICALS/VIVA-VOCE		**No. of Teaching**			**Sessional**	**Practical**	**Total**	**Credits**

		Hours						
BSC505	**DSE-2A (Choose any one)**	-	-	4	30	20	50	2
BSC505A	Analytical Methods in Chemistry Lab							
BSC505B	Novel Inorganic Solids Lab							
BSC505C	Organometallics, Bioinorganic chemistry ,Polynuclear hydrocarbons and UV ,IR Spectroscopy Lab							
BSC505D	Chemistry of Main Group Elements, Theories of Acids and Bases Lab							
BSC506	**DSE-3A (Choose any one)**	-	-	4	30	20	50	2
BSC506A	Digital, Analog and Instrumentation Lab							
BSC506B	Elements of Modern Physics Lab							
BSC506C	Mathematical Physics Lab							
BSC506D	Solid State Physics Lab							
TOTAL		**19**	**-**	**8**	**180**	**320**	**500**	**23**

SIXTH SEMESTER

THEORY PAPERS		No. of Teaching Hours			Marks Allocation			
Code	**Subject/Paper**	**L**	**T**	**P**	**IA**	**EA**	**Total**	**Credits**
BSC601	**SEC-4 (Choose any one)**	3	-	-	30	70	100	3
BSC601A	Transportation and Game Theory							
BSC601B	Graph Theory							
BSC601C	Applied optics							
BSC601D	Basic instrumentation skills							
BSC601E	Chemical Technology & Society							
BSC601F	Fuel Chemistry							
BSC602	DSE-1B **(Choose any one)**	6	-	-	30	70	100	6
BSC602A	Numerical Methods							
BSC602B	Complex Analysis							
BSC602C	Linear Programming)							
BSC603	DSE-2B **(Choose any one)**	5	-	-	30	70	100	5
BSC603A	Polymer Chemistry							
BSC603B	Green Chemistry							
BSC603C	Instrumental Methods of Analysis							
BSC603D	Quantum Chemistry, Spectroscopy & Photochemistry							
BSC604	DSE-3B **(Choose any one)**	5	2*	-	30	70	100	5 (+2*)
BSC604A	Quantum Mechanics							
BSC604B	Embedded System: Introduction to microcontroller							
BSC604C	Nuclear and Particle Physics (Theory + Tutorials 2*)							
BSC604D	Medical Physics							
PRACTICALS/VIVA-VOCE		**No. of Teaching**			**Sessional**	**Practical**	**Total**	**Credits**

		Hours						
BSC605	DSE-2B **(Choose any one)**	-	-	4	30	20	50	2
BSC605A	Polymer Chemistry Lab							
BSC605B	Green Chemistry Lab							
BSC605C	Instrumental Methods of Analysis Lab							
BSC605D	Quantum Chemistry, Spectroscopy & Photochemistry Lab							
BSC606	DSE-3B **(Choose any one)**	-	-	4	30	20	50	2
BSC606A	Quantum Mechanics Lab							
BSC606B	Embedded System: Introduction to microcontroller Lab							
BSC606C	Nuclear and Particle Physics Lab							
BSC606D	Medical Physics Lab							
TOTAL		**19**	**-**	**8**	**180**	**320**	**500**	**23**

FIRST SEMESTER

THEORY PAPERS		**No. of Teaching Hours**			**Marks Allocation**			
Code	**Subject/Paper**	**L**	**T**	**P**	**IA**	**EA**	**Total**	**Credits**
BSC101	English	3	-	-	30	70	100	3
BSC102	Mechanics	5	-	-	30	70	100	5
BSC103	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic hydrocarbons	5	-	-	30	70	100	5
BSC104	Differential Calculus	6	-	-	30	70	100	6
PRACTICALS/VIVA-VOCE		**No. of Teaching Hours**			**Sessional**	**Practical**	**Total**	**Credits**
BSC105	Mechanics Lab	-	-	4	30	20	50	2
BSC106	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic hydrocarbons Lab	-	-	4	30	20	50	2
TOTAL		**19**	**-**	**8**	**180**	**320**	**500**	**23**

BSC101: ENGLISH

Credits: 03, Max. Marks: 100, Exam Hours: 3 hours

Course Objectives:

- To use English effectively for study purpose across the curriculum.
- To develop interest in and appreciation of Literature.
- To develop their own creativity. Enhance their writing skills
- To develop and integrate the use of the four language skills i.e. Reading, Listening, Speaking and Writing.
- The ability to read English with understanding.
- Pronounce English correctly and intelligibly.
- Write paragraphs, letters. (Personal and official) simple, narrative pieces, reports, notices, messages, C.V. etc.
- To use correct grammatical items.
- To enable the learner to communicate effectively and appropriately in real life situation.
- During the course, the student should be enabled to write an original, dialogue, storyone-act play, poems etc.

UNIT	CONTENT	CONTACT HOURS
I	**Grammar and Usage** 1. Tense. 2. Modals. 3. Active & Passive voice. 4. Direct & Indirect Speech.	10
II	**Elements of Communication** 1. Communication: Meaning, Importance and Process 2. Verbal and Non- Verbal Communication 3. Barriers to Communication**.** 4. Qualities of good Communication	10

III	**Comprehension(Poetry)**	5
	1. Stopping by Woods on a Snowy Evening: Robert Frost	
	2. Song of Youth by Dr. A. P. J. Abdul Kalam	
	3. Where the Mind is Without Fear : Rabindra Nath Tagore	
	4. Abou Ben Adhem by Leigh Hunt	
IV	**Comprehension (Prose)**	5
	1. An Astrologer's Day: R. K. Narayan	
	2. The Gift of Magi : O. Henry	
	3. Of Studies: Francis Bacon	
	4. On the Rule of the Road: A.G. Gardiner	
V	**Composition**	10
	1. Letter Writing: Formal and Informal	
	2. C.V. Writing.	
	3. E-Mails	
	4. Paragraph Writing	
	TOTAL	40

Reference Books:

1. English for Competitive Examinations, Prof. R. P. Bhatnagar, Macmillan Publications.
2. "Current English Grammar and Usage with Composition" by R.P. Sinha, Oxford University Press (New Delhi).
3. Communication Skills by Sanjay Kumar & Pushp Lata. Oxford University Press (New Delhi)
4. Judith Leigh: C.Vs and Job Application. OUP. 2004.

Course Outcomes:

At the end of the course, a student will be able to understand

CO1: The ability to understand English when it is spoken and to understand basic grammar principles. Be able to transform sentences.

CO2: Speak intelligibly while making statements, asking question, giving instructions and

commands, reporting events. Put ideas in a proper sequence. Show an understanding of opportunities in the field of communication. Use current technology related to the communication field.

CO3: Recognize poetry from a variety of cultures, languages and historic periods. Understand and appreciate poetry as a literary art form. Analyze the various elements of poetry, such as diction, tone, form, genre, imagery, figures of speech, symbolism, theme, etc.

CO4: It is to develop the language ability of the students. It is the intensive study of a language. The language ability helps the learners to use English language without any problem.

CO5: To express ideas in an organized and systematic way. Develop the skills of writing. Learn to use appropriate vocabulary in writing various forms of composition & to develop communicative competence.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	H	M	M	-	H	-	-	H	-	H	H	-	L
CO2	H	H	M	-	M	-	-	H	-	H	H	-	L
CO3	H	M	-	L	-	-	M	H	-	M	H	-	L
CO4	H	H	-	L	M	-	M	H	-	H	H	-	L
CO5	H	M	-	-	M	-	1	H	-	M	H	-	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC102: MECHANICS

Course Objectives:

- This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts.
- It begins with Newton's Laws of Motion and ends with the Fictitious Forces and Special Theory of Relativity.
- Students will also appreciate the Rotational Motion, Gravitation and Oscillations.
- The students will be able to apply the concepts learnt to several real world problems.

UNIT	CONTENTS	CONTACT HOURS
I	**Vectors:** Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.	**4**
	Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.	**6**
II	**Laws of Motion:** Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.	**10**
	Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.	**6**
	Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum.	**5**
III	**Gravitation:** Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).	**8**
	Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped Oscillations.	**6**
IV	**Elasticity:** Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants – Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum-Determination of Rigidity modulus and moment of inertia - q, η and ρ by Searles method.	**8**
V	**Special Theory of Relativity:** Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.	**7**
	TOTAL	**60**

Reference Books:

1. F. W. Sears, M. W. Zemansky and H. D., Young "University Physics" 13/e Addison-Wesley, 1986
2. Charles Kittel, et. Al. "Mechanics Berkeley Physics course, v.1" Tata McGraw-Hill, 2007
3. Resnick, Halliday & Walker "Physics" 9/e, Wiley, 2010
4. Basudeb Bhattacharya "Engineering Mechanics" 2nd edn. Oxford University Press, 2015
5. Ronald Lane Reese "University Physics" Thomson Brooks/Cole., 2003

Course outcomes:

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

CO1: Understand the role of vectors and coordinate systems in Physics.

CO2: Learn the concept of inertial reference frames their transformations.

CO3: Explain the phenomena of simple harmonic motion and the properties of systems executing such motions.

CO4: Describe how fictitious forces arise in a non-inertial frame.

CO5: Describe special relativistic effects and their effects on the mass and energy of a moving object.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	H	M	H	L	L	L	L	L	-	M	H	H	L	M	L
CO2	L1	M	L	-	M	L	M	M	M	M	M	M	H	L	M	M	M
CO3	L4	L	L	L	H	M	M	-	H	H	H	M	L	-	M	L	M
CO4	L4	M	H	H	H	L	M	M	M	M	M	M	H	M	M	L	M
CO5	L4	-	L	M	M	L	M	L	L	L	L	L	M	L	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC103: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Course Objectives:

- The course aims at making the students understand the atomic structure and behavior, interactions between matter and energy at both the atomic and molecular level.
- The students are taught to chemical bonding and molecular structure.
- To impart the knowledge of Stereochemistry
- To expose students to fundamentals of organic chemistry.
- Students are also expected to learn the physical and chemical properties of Aliphatic Hydrocarbons.

UNIT	CONTENTS	CONTACT HOURS
I	***Section A: Inorganic Chemistry-1***	12
	Atomic Structure:	
	Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.	
	Quantum Mechanics:	
	What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and $\psi 2$, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1*s* and 2*s* atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers *ml* and *ms*.Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number (*ms*). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.	
II	**Chemical Bonding and Molecular Structure:**	11
	Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.	
	Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bi pyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds.	

III	*MO Approach:* Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches. ***Section B: Organic Chemistry-1*** **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).	12
IV	**Fundamentals of Organic Chemistry:** Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.	8
V	**Aliphatic Hydrocarbons:** Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. **Alkanes:** (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation. **Alkenes:** (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cisaddition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation. **Alkynes**: (Upto 5 Carbons) *Preparation:* Acetylene from CaC2 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 KMnO4, ozonolysis and oxidation with hot alk. KMnO4.	17
	TOTAL	60

Reference Books:

1 Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.

2 Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.

3 Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.

4 Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry:Principles of Structure and Reactivity*, Pearson Education India, 2006.

5 Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. *Organic Chemistry,* John Wiley & Sons (2014).

6 Mc Murry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.

7 Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, New Delhi (1988).

8 Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.

9 Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.

10 Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.

11 Bahl, A. &Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.

Course Outcome:

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

CO1:	Understand atomic structure and behaviour, interactions between matter and energy at both the atomic and molecular level.
CO2:	Understand chemical bonding and molecular structure.
CO3:	Learn Stereochemistry
CO4:	Understand fundamentals of organic chemistry.
CO5:	Understand the physical and chemical properties of Aliphatic Hydrocarbons.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	POS1	PSO2	PSO3
CO1	L2	H	M	H	-	L	-	-	M	-	-	H	-	-	L	L	L
CO2	L2	H	L	H	-	L	-	-	M	-	-	H	-	-	H	M	M
CO3	L2	H	M	H	-	L	-	-	M	-	-	H	-	-	M	H	H
CO4	L2	H	M	H	-	-	-	-	M	-	-	H	-	L	H	H	H
CO5	L2	M	M	M	-	L	-	L	M	-	-	M	-	L	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC104: DIFFERENTIAL CALCULUS

Course Objectives: The objective of this course is to expose student to understand the basic concepts of differential calculus like limit, continuity, differentiability of functions, Curvature, Asymptotes and tracing of curves, mean value theorems, partial differentiation of multi variable functions.

UNIT	CONTENTS	CONTACT HOURS
I	Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem,	12
II	Tangents and Normals, Curvature, Asymptotes, Singular points,	10
III	Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.	13
IV	Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of sin x, cos x, e^x, log(l+x), (l+x)m,	15
V	Partial differentiation, Euler's theorem on homogeneous functions. Maxima and Minima with several variables, Indeterminate forms.	10
	TOTAL	60

Reference Books:

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

Course Outcomes: This course will enable the students to:

CO1:	To Calculate the limit and examine the continuity and differentiablity of a function at a point.
CO2:	To find tangents, normals and asymptotes of a curve and to calculate curvature
CO3:	To trace the curves
CO4	To Understand the consequences of various mean value theorems for differentiableFunctions
CO5	To Apply tests in optimization value of a function appearing in physical sciences, life sciences.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO 1	PSO 2	PSO 3
CO 1	L2	H	H	H	-	H	-	H	M	H	H	H	H	H	H	M	M
CO 2	L3	H	H	H	-	H	L	H	M	H	H	H	H	H	H	H	H
CO 3	L3	H	H	H	-	H	L	H	M	H	H	H	H	M	H	H	M
CO 4	L3	H	H	H	-	H	L	H	M	H	H	H	H	M	H	H	M
CO 5	L3	H	H	H	-	H	L	H	M	H	H	H	H	M	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC105: MECHANICS LAB

Course Objective:

- This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts experimentally.
- To understand use of basic measuring instruments such as using vernier caliper, screw gauge and travelling microscope.
- Students will also appreciate the concept of Moment of Inertia.
- The students will be able to apply the concepts learnt to several real world problems.

S. No.	Experiment
1	Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2	To determine the Height of a Building using a Sextant.
3	To determine the Moment of Inertia of a Flywheel.
4	To determine the Young's Modulus of a Wire by Optical Lever Method.
5	To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6	To determine the Elastic Constants of a Wire by Searle's method.
7	To determine g by Bar Pendulum.
8	To determine g by Kater's Pendulum.
9	To determine gand velocity for a freely falling body using Digital Timing Technique
10	To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g

Reference Books:

1 B. L. Flint and H. T. Worsnop "Advanced Practical Physics for students", Asia. 1971

2 Michael Nelson and Jon M. Ogborn "Advanced level Physics Practicals" 4th Edition, reprinted, Heinemann Educational Publishers. 1985

3 S. Panigrahi & B.Mallick "Engineering Practical Physics" Cengage Learning India Pvt. Ltd. 2015

4 Indu Prakash and Ramakrishna "A Text Book of Practical Physics" 11th Edition, Kitab Mahal, New Delhi. 2011

Course outcomes:

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

COs	Statements
CO1:	Understand the use of vernier calliper, screw gauge and travelling microscope.
CO2:	Learn the concept of Moment of Inertia.
CO3:	Understand use of Pendulums.
CO4:	Understand the physical meaning of 'g'.
CO5:	Knowledge of how to handle measuring instruments.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L3	M	L	M	L	H	M	H	M	H	H	H	M	H	L	M	L
CO2	L2	H	H	M	H	H	-	M	M	M	L	L	H	H	M	M	M
CO3	L2	L	L	H	M	H	L	H	L	H	H	H	M	M	H	L	M
CO4	L2	-	L	H	L	H	H	H	M	M	M	L	H	M	M	L	M
CO5	L4	H	H	H	L	-	L	H	M	-	H	H	H	M	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC106: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS LAB

Course Objectives:

- To experimental practice of quantitative volumetric analysis.
- To understand the separation techniques.

S.No.	Experiments
1	***Section A: Inorganic Chemistry - Volumetric Analysis*** Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2	Estimation of oxalic acid by titrating it with KMnO4.
3	Estimation of water of crystallization in Mohr's salt by titrating with KMnO4.
4	Estimation of Fe (II) ions by titrating it with K2Cr2O7 using internal indicator.
5	Estimation of Cu (II) ions iodometrically using Na2S2O3.
6	***Section B: Organic Chemistry*** Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
7	Separation of mixtures by Chromatography: Measure the R_f value in each case (combination of two compounds to be given)
7a	(a) Identify and separate the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
7b	(b) Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books:

1 Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.

2 Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.

3 Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

4 Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

Course Outcomes:

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

CO1:	Understand and apply the quantitative volumetric analysis.
CO2:	Understand and analyze the separation techniques.
CO3:	Identify and separate different molecules from the mixture

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO 1	PSO 2	PSO 3
CO 1	L3	H	H	H	L	L	L	M	H	-	-	H	-	-	L	M	H
CO 2	L4	H	H	H	L	L	L	M	H	-	-	H	-	L	L	M	H
CO 3	L4	H	H	H	M	L	-	L	H	-	-	H	-	L	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

SECOND SEMESTER

THEORY PAPERS		**No. of Teaching Hours**			**Marks Allocation**			
Code	**Subject/Paper**	**L**	**T**	**P**	**IA**	**EA**	**Total**	**Credits**
BSC201	Environmental Science	3	-	-	30	70	100	3
BSC202	Electricity, Magnetism and EMT	5	-	-	30	70	100	5
BSC203	Chemical energetic, Equilibria & Functional Group Organic Chemistry-I	5	-	-	30	70	100	5
BSC204	Differential Equations	6	-	-	30	70	100	6
PRACTICALS/VIVA-VOCE		**No. of Teaching Hours**			**Sessional**	**Practical**	**Total**	**Credits**
BSC205	Electricity, Magnetism and EMT Lab	-	-	4	30	20	50	2
BSC206	Chemical energetic , Equilibria & Functional Group Organic Chemistry-I Lab	-	-	4	30	20	50	2
TOTAL		**19**		**8**	**180**	**320**	**500**	**23**

BSC201: ENVIRONMENTAL SCIENCE

Course Objective:

The Environmental Science major prepares students for careers as leaders in understanding and addressing complex environmental issues from a problem-oriented, interdisciplinary perspective and Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.

UNIT	CONTENTS	CONTACT HOURS
I	**Ecosystem: concepts and functions** Ecosystem- Definition and Introduction of Ecosystem- Abiotic and Biotic components, types of Ecosystems, Structure and functions of Ecosystem- Food chain, Food web, Ecological pyramids, Energy flow in Ecosystem. Biodiversity- Definition, Type and levels of Biodiversity, Values, Threats of biodiversity Conservation of biodiversity- In-situ and Ex-situ.	9
II	**Natural Resources** Definition and classification of natural resources, Types and uses of renewable and non-renewable resources in India, potentials of resources in India.	4
III	**Environmental Pollution and Control measures** Causes, Effects and Control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, and Nuclear Hazards. **Disaster management:** Floods, earthquake, cyclone and landslides.	3
IV	**Solid Waste Management** Introduction, Classification of solid waste, Composition and characteristics of solid waste, collection, conveyance and disposal methods of solid waste, Reuse, Recycle and Recovery of waste.	6
V	**Social Issues and Environment** Sustainable development, urban problems related to energy, Water conservation, Rain water harvesting water shed management, Resettlement and rehabilitation Public awareness and Environmental Education. Environment Protection Act- 1986, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest conservation Act.	8
	TOTAL	30

Reference Books:

1. Brunner R.C., Hazardous Waste Incineration, McGraw Hill Inc. 1989.

2. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB).

3.Cunningham, W.P, Cooper, T.H. Gorhani, E & Hepworth, M.T. , Environmental Encyclopedia, Jaico Publishing House, Mumbai, 2001.

4. De. A.K., Environmental Chemistry, Wiley Eastern Ltd.

5. Agarwal, K.C. 2001 Environmental Biology, Nidhi Publ. Ltd. Bikaner.

6. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut.

7. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p.

Course outcomes:

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

CO1:	Appreciate concepts and methods from ecological and physical sciences and their application in environmental problem solving. Ecosystem Links between environmental components and their role, types, values and conservation of biodiversity.
CO2:	Concept of non-Conventional energy resources, types and various applications of renewable resources and current potentials of energy resources.
CO3:	Basic Structure of atmosphere and their functions Current problems related issues Students will apply knowledge of the sciences within an interdisciplinary context in solving environmental issues such as environmental health, food and agriculture, energy, waste and pollution, climate change, disaster management.
CO4:	Composition of solid waste, sources of generation, collection and disposal methods of solid waste, recycling, reuse of wastes.
CO5:	Sustainable development, urban problems related to energy, Water conservation, and Rain water harvesting water shed management, Resettlement and rehabilitation, Public awareness and Environmental Education, various environmental Acts.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Bloom's Level	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PS O1	PS O2	PS O3
CO 1	L2	L	M	H	-	L	L	-	M	H	H	H	M	H	L	H	H
CO 2	L1	H	M	M	L	M	-	-	M	H	H	H	M	H	H	L	L
CO 3	L2	H	M	M	M	1	M	M	-	H	H	H	H	M	L	L	H
CO 4	L2	H	M	M	M	M	-	L	M	H	L	L	H	M	H	M	H
CO 5	L3	H	M	M	H	H	M	H	M	H	H	M	H	M	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC202: ELECTRICITY, MAGNETISM AND EMT

Course Objective:

- This course reviews the concepts of electromagnetism learnt at school from a more advanced perspective and goes on to build new concepts.
- The course covers static and dynamic electric and magnetic fields, and the principles of electromagnetic induction.
- It also includes analysis of electrical circuits and introduction of network theorems.
- The students will be able to apply the concepts learnt to several real world problems.

UNIT	CONTENTS	CONTAT HOURS
I	**Vector Analysis**: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).	12
II	**Electrostatics-I:** Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, Calculation of electric field from potential.	11
III	**Electrostatics-II:** Uniformly charged spherical shell and solid sphere. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.	11
IV	**Magnetism:** Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferro-magnetic materials.	10
V	**Electromagnetic Induction:** Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.	06
	Maxwell`s equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.	10
	TOTAL	**60**

Reference Books:

1	Edward M. Purcell "Electricity and Magnetism" McGraw-Hill Education.	1986
2	J.H. Fewkes& J. Yarwood "Electricity and Magnetism" Vol. I, Oxford Univ.Press.	1991
3	D. C. Tayal "Electricity and Magnetism" Himalaya Publishing House.	1988
4	Ronald Lane Reese "University Physics" Thomson Brooks/Cole.	2003
5	D.J. Griffiths "Introduction to Electrodynamics" 3rd Edn, Benjamin Cummings.	1998

Course Outcomes:

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

CO1:	Explain and differentiate the vector and scalar formalisms of electrostatics.
CO2:	Apply Gauss's law of electrostatics to solve a variety of problems.
CO3:	Describe how magnetism is produced and list examples where its effects are observed.
CO4:	Describe the magnetic field produced by magnetic dipoles and electric currents.
CO5:	Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L4	H	H	M	-	L	H	L	H	L	L	M	L	L	M	M	L
CO2	L2	M	L	H	M	L	M	M	L	M	M	M	H	M	M	M	M
CO3	L3	L	L	H	H	M	-	-	M	H	L	M	L	L	M	L	L
CO4	L3	M	H	H	H	-	M	H	H	M	M	M	H	L	M	L	M
CO5	L4	-	L	M	L	L	M	L	H	L	H	L	L	H	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC203: CHEMICAL ENERGETIC, EQUILIBRIA & FUNCTIONAL GROUP ORGANIC CHEMISTRY-I

Course Objectives:

- To impart the basic knowledge of chemical energetics and chemical equilibrium.
- To learn about ionic equilibria.
- Students are also expected to learn the synthesis, physical and chemical properties of aromatic hydrocarbons.
- To develop understand about synthesis, physical and chemical properties of alcohols, phenols and ethers.
- To learn the synthesis, physical and chemical properties of aldehydes and ketones.

UNIT	CONTENTS	CONTACT HOURS
I	***Section A: Physical Chemistry-1*** **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. **Chemical Equilibrium:** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle. Relationships between *Kp, Kc* and *Kx* for reactions involving ideal gases.	12
II	**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.	10
III	***Section B: Organic Chemistry-2*** 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	13

	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 (SN_1, SN_2 and SN_i) reactions. *Preparation:* from alkenes *and* alcohols. *Reactions:* hydrolysis, nitrite & nitro formation, nitrile &isonitrile formation. Williamson's ether synthesis: Elimination v/s substitution. **Aryl Halides:** *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. *Reactions (Chlorobenzene):* Aromatic nucleophilic substitution (replacement by –OH group) 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.	
IV	**Alcohols, Phenols and Ethers** (Upto 5 Carbons) **Alcohols:** *Preparation:* Preparation of 1o, 2o and 3o 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. KMnO4, acidic dichromate, conc. HNO3). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement. **Phenols:** (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts. *Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction. **Ethers (aliphatic and aromatic):** Cleavage of ethers with HI.	15
V	**Aldehydes and ketones (aliphatic and aromatic):** (Formaldehye, acetaldehyde, acetone and benzaldehyde) *Preparation:* from acid chlorides and from nitriles. *Reactions* – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.	10
	TOTAL	60

Reference Books:

1 Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. *Organic Chemistry,* John Wiley & Sons (2014).

2 McMurry, J.E. *Fundamentals of Organic Chemistry*, 7thEd. Cengage Learning India Edition, 2013.

3 Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, New Delhi (1988).

4 Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.

5 Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.

6 Bahl, A. &Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.

7 Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).

8 Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).

9 Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).

10 Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).

11 Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

Course Outcomes:

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

CO1:	Understand the chemical energetics and chemical equilibrium.
CO2:	Understand ionic equilibria.
CO3:	Understand the synthesis of aromatic hydrocarbons with their physical and chemical properties.
CO4:	Understand the synthesis, physical and chemical properties of alcohols, phenols and ethers.
CO5:	Understand the synthesis, physical and chemical properties of aldehydes & ketones.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Bloom Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	M	M	L	-	-	-	-	M	-	-	L	-	-	L	M	M
CO2	L2	M	M	L	-	-	-	-	M	-	-	L	-	-	H	L	M
CO3	L2	L	M	M	L	L	-	L	L	-	-	M	-	L	M	H	M
CO4	L2	M	M	M	L	L	-	L	M	-	-	M	-	L	H	M	H
CO5	L2	M	M	M	L	L	-	L	M	-	-	M	-	L	L	M	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC204: DIFFERENTIAL EQUATIONS

Course Objectives: The objective of this course is to expose student to understand the basic concepts and solution methodologies of differential Equations and partial differential equations of various orders and degrees, classification of differential equations and partial differential equations and their applications in the field of science and engineering and technology.

UNIT	CONTENTS	CONTACT HOURS
I	First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p.	12
II	Methods for solving, higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order.	10
III	Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.	13
IV	Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method.	15
V	Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.	10
	TOTAL	**60**

Reference Books:

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984. 117

2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

Course Outcomes: The course will enable the students to

CO:1	Understand the genesis of ordinary differential equations.
CO2:	Learn various techniques of getting exact solutions of solvable first order differentialequations and linear differential equations of higher order.
CO3:	Know Charpit's method to find the solutions of Partial differential equations
CO4:	Grasp the concept of a general solution of a linear differential equation of an arbitraryorder and also learn a few methods to obtain the general solution of such

	equations.
CO5:	Formulate mathematical models in the form of ordinary and partial differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PO13	PSO 1	PSO2	PSO 3
CO1	L2	H	H	H	L	H	-	H	M	H	H	H	H	H	M	H	M
CO2	L3	H	H	H	M	H	-	H	M	H	H	H	H	H	H	H	H
CO3	L2	H	H	H	M	H	-	H	M	H	H	H	H	H	M	M	M
CO4	L3	H	H	H	M	H	-	H	M	H	H	H	H	H	H	H	H
CO5	L3	H	H	H	M	H	-	H	M	H	H	H	H	H	M	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC205: ELECTRICITY, MAGNETISM AND EMTLAB

Course Objective:

- This course reviews the concepts of electromagnetism learnt at school from a more advanced perspective and goes on to build new concepts practically.
- To understand the concept of electrical devices.
- It also includes analysis of electrical circuits.
- Introduction of network theorems.
- The students will be able to apply the concepts learnt to several real world problems.

S. No.	Experiment
1	To use a Multi meter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2	Ballistic Galvanometer: (i) Measurement of charge and current sensitivity (ii) Measurement of CDR (iii) Determine a high resistance by Leakage Method (iv) To determine Self Inductance of a Coil by Rayleigh's Method.
3	To compare capacitances using De' Sauty s bridge.
4	Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
5	To study the Characteristics of a Series RC Circuit.
6	To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
7	To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q
8	To determine a Low Resistance by Carey Foster's Bridge.
9	To verify the Thevenin and Norton theorem
10	To verify the Superposition, and Maximum Power Transfer Theorem

Reference Books:

1 B. L. Flint and H. T. Worsnop "Advanced Practical Physics for students", Asia Publishing House. 1971

2 Michael Nelson and Jon M. Ogborn "Advanced level Physics Practicals" 4th Edition, reprinted, Heinemann Educational Publishers. 1985

3 S. Panigrahi &B. Mallick "Engineering Practical Physics" Cengage Learning India Pvt. Ltd. 2015

4 Indu Prakash and Ramakrishna "A Text Book of Practical Physics" 11th Edition, Kitab Mahal, New Delhi. 2011

Course Outcomes:

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

COs	Statements
CO1:	Explain the working of Galvanometer.
CO2:	Apply Gauss's law of electrostatics to solve a variety of problems.
CO3:	Describe how magnetism is produced and list examples where its effects are observed.
CO4:	Describe the magnetic field produced by magnetic dipoles and electric currents.
CO5:	The student will get an opportunity to verify all theorems elaborated above.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L4	L	L	H	L	H	M	H	M	M	-	-	M	L	H	M	L
CO2	L3	L	-	M	H	-	L	M	M	M	L	L	H	L	M	M	M
CO3	L3	L	L	-	M	H	L	H	L	L	H	H	L	M	M	L	L
CO4	L4	H	L	H	L	-	H	L	M	M	M	L	H	L	L	H	M
CO5	L4	H	H	H	L	H	L	H	M	H	H	H	H	M	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC206: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I LAB

Course Objective

- To understand the experiments related to thermochemistry so that students can learn through experiments.
- To understand the experiments related to Ionic equilibria.
- To get the skills of purification and synthesis of some chemical compounds.

S. No.	Experiments
1	***Section A: Physical Chemistry*** **Thermo-chemistry** Determination of heat capacity of calorimeter for different volumes. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. 3. Determination of enthalpy of ionization of acetic acid. 4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl). 5. Determination of enthalpy of hydration of copper sulphate. 6. Study of the solubility of benzoic acid in water and determination of ΔH.
2	**Ionic equilibria** pH measurements a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter. b) Preparation of buffer solutions: (i) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide Measurement of the pH of buffer solutions and comparison of the values with theoretical values.
3	***Section B: Organic Chemistry*** 1Purification of organic compounds by crystallization (from water and alcohol) and distillation. 2. Criteria of Purity: Determination of melting and boiling points. 3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done. (a) Bromination of Phenol/Aniline (b) Benzoylation of amines/phenols

Reference Books:

1 Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.

2 Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

3 Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

Course Outcomes:

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

CO1:	Understand and apply the concepts of thermo-chemistry by experiments.
CO2:	Understand and apply the concepts of Ionic equilibria.
CO3:	Get the skills of purification and synthesis of some chemical compounds.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L3	H	M	M	L	L	-	L	M	-	-	M	-	-	M	M	M
CO2	L3	H	M	M	L	L	L	L	M	-	-	M	-	-	H	H	M
CO3	L5	M	M	M	L	L	-	L	M	-	-	M	-	M	H	M	M

H- High, M- Moderate, L- Low, '-' for No correlation

THIRD SEMESTER

THEORY PAPERS		**No. of Teaching Hours**			**Marks Allocation**			
Code	**Subject/Paper**	**L**	**T**	**P**	**IA**	**EA**	**Total**	**Credits**
BSC301	Thermal Physics and Statistical Mechanics	5	-	-	30	70	100	5
BSC302	Solutions, Phase equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II	5	-	-	30	70	100	5
BSC303	Real Analysis	6	-	-	30	70	100	6
BSC304	**SEC-1 (Choose any one)**	3	-	-	30	70	100	3
BSC304A	Analytical Geometry							
BSC304B	Integral Calculus and Applied Mathematics							
BSC304C	Physics workshop skills							
BSC304D	Computational physics skills							
BSC304E	Pharmaceutical Chemistry							
BSC304F	Basic Analytical Chemistry)							
PRACTICALS/VIVA-VOCE		**No. of Teaching Hours**			**Sessional**	**Practical**	**Total**	**Credits**
BSC305	Thermal Physics and Statistical Mechanics Lab	-	-	4	30	20	50	2
BSC306	Solutions, Phase equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II Lab	-	-	4	30	20	50	2
TOTAL		**19**	**-**	**8**	**180**	**320**	**500**	**23**

BSC301: THERMAL PHYSICS AND STATISTICAL MECHANICS

Course Objective

- This course will introduce Thermodynamics, Kinetic theory of gases and Statistical Mechanics to the students.
- The primary goal is to understand the fundamental laws of thermodynamics and its applications to various thermo-dynamical systems and processes.
- This coursework will also enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behavior of atoms and molecules through Statistical mechanics.

UNIT	CONTENTS	CONTACHOURS
I	**Laws of Thermodynamics:** Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_P&C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem.	**16**
II	**Entropy:** Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability ofabsolute zero.	**06**
	Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for ($C_P - C_V$), C_P/C_V, TdS equations	**10**
III	**Kinetic Theory of Gases:**Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.	**10**
IV	**Theory of Radiation:** Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.	**06**
V	**Statistical Mechanics:** Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.	**12**

	TOTAL	**60**

Reference Books:

1. S. Garg, R. Bansal and C. Ghosh "Thermal Physics" Tata McGraw-Hill. 1993
2. Meghnad Saha, and B.N. Srivastava "A Treatise on Heat" Indian Press. 1969
3. Enrico Fermi "Thermodynamics" Courier Dover Publications. 1956
4. M. W. Zemasky and R. Dittman "Heat and Thermodynamics" McGrawHill. 1981
5. F.W.Sears&G.L.Salinger "Thermodynamics, Kinetic theory & Statistical thermodynamics," Narosa. 1988
6. Ronald Lane Reese "University Physics" Thomson Brooks/Cole. 2003
7. A. Kumar and S.P. Taneja "Thermal Physics" S. Chand Publications. 2014

Course outcomes:

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

CO1:	Learn the basic concepts of thermodynamics and concept of entropy.
CO2:	Learn the basic concepts of the thermodynamic potentials and their physical interpretations.
CO3:	Knowledge of the real gas equations, Vander Waal equation of state, the Joule-Thompson effect.
CO4:	Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
CO5:	Learn the quantum statistical distributions, viz., B-E statistics and F-D statistics.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	-	M	M	L	L	M	M	L	M	L	M	L	H	H	L	L
CO2	L2	M	M	H	H	L	L	-	L	L	L	-	M	L	L	L	M
CO3	L2	M	H	L	M	L	L	M	L	L	-	M	H	M	H	M	H
CO4	L2	H	L	M	L	-	H	L	L	L	H	H	M	L	M	L	M
CO5	L2	M	M	L	M	L	M	H	L	L	M	L	H	L	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC302: SOLUTIONS, PHASE EQUILIBRIA, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II

Course Objective

- To impart an insight into the basic principles of solution, phase equilibrium and properties of ideal and non-ideal solutions.
- To understand the basic concepts of conductance and electrochemistry and their applications.
- To understand the synthesis, physical and chemical properties of carboxylic acid and their derivatives.
- To learn the synthesis, physical and chemical properties of amines and diazonium salts
- To learn the synthesis, physical and chemical properties of amino acids, peptides & proteins and serve the knowledge about carbohydrates.

UNIT	CONTENTS	CONTACT HOURS
I	***Section A: Physical Chemistry-2*** **Solutions:** Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction. **Phase Equilibrium:** Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).	12
II	**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). **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	12

	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).	
III	***Section B: Organic Chemistry-3*** Functional group approach for the following reactions (preparations & reactions) tobe studied in context to their structure.**Carboxylic acids and their derivatives** Carboxylic acids (aliphatic and aromatic) *Preparation:* Acidic and Alkaline hydrolysis of esters. *Reactions:* Hell – Vohlard - Zelinsky Reaction. **Carboxylic acid derivatives (aliphatic):** (Upto 5 carbons) *Preparation:* Acid chlorides, Anhydrides, Esters and Amides from acids and their inter conversion. *Reactions:* Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.	11
IV	**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.	10
V	**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 Cu2+ 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.	15
	TOTAL	60

Reference Books

1 Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).

2 Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).

3 Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).

4 Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa (1998).

5 Petrucci, R.H. *General Chemistry*, 5th Ed., Macmillan Publishing Co.: New York (1985).

6 Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

7 Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

8 Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

9 Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W. H. Freeman.

10 Berg, J.M., Tymoczko, J.L. &Stryer, L. *Biochemistry*, W.H. Freeman, 2002.

Course Outcomes:

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

CO1:	Acquire the knowledge of solution and phase equilibrium.
CO2:	Understand the basic concepts of conductance and electrochemistry and their applications.
CO3:	Understand the synthesis process of carboxylic acid with their physical and chemical properties.
CO4:	Become skilled at the synthesis of amines and diazonium salts with their physical and chemical properties.
CO5:	Learn the synthesis process of amino acids, peptides, proteins and carbohydrates with their physical and chemical properties.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	M	L	L	-	-	-	-	M	-	-	M	-	-	M	M	H
CO2	L2	M	M	M	-	-	M	-	M	-	-	M	-	-	M	M	M
CO3	L2	M	M	M	L	L	-	L	M	-	L	M	-	M	H	M	M
CO4	L2	M	M	M	L	L	-	L	M	-	L	M	-	M	L	L	L
CO5	L2	M	M	M	L	L	-	L	M	-	L	M	-	M	M	M	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC303: REAL ANALYSIS

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Real Analysis like countable and uncountable sets. Real line properties, bounds of set and functions, Convergence of sequence and series, Riemann integration, Uniform convergence of sequence and series of functions.

UNIT	CONTENTS	CONTACT HOURS
I	Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.	12
II	Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).	20
III	*Integration.* The Riemann Integral and its properties. Integrability of continuous and monotonic functions. Functions of bounded variation, their relation with monotonic functions, and integrability. The fundamental theorem of calculus. Mean value theorems of integral calculus. Convergence of improper integrals. Infinite series. Cauchy convergence criterion for series, positive term series, geometric series,	12
IV	comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence.	8
V	Sequences and series of functions, Pointwise and uniform convergence. Mn-test, M test,Statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence.	9
	TOTAL	60

Reference Books:

1. T. M. Apostol, Calculus (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R Sherbert, Introduction to Real Analysis, John Wiley and Sons(Asia) P. Ltd., 2000.
3. E. Fischer, Intermediate Real Analysis, Springer Verlag, 1983.
4. K.A. Ross, Elementary Analysis- The Theory of Calculus Series- Undergraduate Texts in Mathematics, Springer Verlag, 2003.

Course Outcomes:

This course will enable the students to:

CO1:	Understand many properties of the real line $\mathbb{R}$ and learn to define sequence in terms of functions from $\mathbb{R}$ to a subset of $\mathbb{R}$.
CO2:	Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
CO3:	Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.
CO4:	Learn some of the properties of Riemann integrable functions, and the applications ofthe fundamental theorems of integration.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	H	H	L	H	-	H	M	-	H	H	-	L	H	M	M
CO2	L3	H	H	H	M	H	-	H	M	-	H	H	-	M	M	H	M
CO3	L3	H	H	H	L	H	-	H	M	-	H	H	-	L	H	H	M
CO4	L3	H	H	H	M	H	-	H	M	-	H	H	-	M	H	M	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC304A: ANALYTICAL GEOMETRY

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Analytical Geometry of three dimensions in special reference to Line, Plane, Cone, Sphere, Cylinder and Classification of quadratic equations.

UNIT	CONTENTS	CONTACT HOURS
I	Analytical geometry of three dimensions. Direction cosines.	**8**
II	Straight line. Plane.	**8**
III	Sphere. Cone. Cylinder.	**5**
IV	Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola.	**5**
V	Classification of quadratic equations representing lines, parabola, ellipse and hyperbola. Spheres, Cylindrical surfaces. Illustrations of graphing standard quadric surfaces like cone, ellipsoid.	**4**
	TOTAL	**30**

Reference Books:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) Pvt. Ltd.,2002.
3. S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company,London.
4. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*,McMillan India Ltd., 1994.

Course Outcomes: This course will enable the students to:

CO1:	Explain the properties of three dimensional shapes.
CO2:	Knowledge of direction cosines
CO3:	Techniques for sketching parabola, ellipse and hyperbola
CO4:	Classification of quadratic equations representing lines, parabola, ellipse and hyperbola

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	H	H	M	H	M	H	L	M	H	H	M	H	H	H	H
CO2	L2	H	H	H	M	H	M	H	L	M	H	H	M	H	M	M	M
CO3	L2	H	H	H	M	H	M	H	L	M	H	H	M	H	H	H	H
CO4	L2	H	H	H	M	H	M	H	L	M	H	H	M	H	M	H	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC304B: INTEGRAL CALCULUS AND APPLIED MATHEMATICS

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Integral Calculus and Applied Mathematics like to find the length of the curve, area ,volume using double and triple integration, and give the knowledge of Interpolation techniques, Numerical methods to find the solution of algebraic and transcendental equations and to familiarize with the LPP .

UNIT	CONTENTS	CONTACT HOURS
I	Double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar).	9
II	Applications: areas and volumes by (double integration).Areas and lengths of curves in the plane, volumes and surfaces of solids of revolution.	4
III	Newton's forward and backward interpolation formula, central difference interpolation, Lagrange's interpolation formula, Numerical Differentiation and Integration.	3
IV	Solutions of algebraic and transcendental equations using bisection, Newton-Raphson and Regula-falsi methods. Solutions of ordinary differential equations.	6
V	Linear Programming, Simplex Methods , Two Phases of the simplex Method, Transportation Problem, Assignment Problem.	8
	TOTAL	**30**

Reference Books:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd.,2002.
3. Rao S.S., "Engineering Optimization- Theory and Optimization", New Age International Publishers.
4. P. C. Bishwal: Numerical Analysis; PHI, India.

Course Outcomes:

This course will enable the students to:

CO1:	Know to find the length of the curve, area ,volume using double and triple integration.
CO2:	Provide Numerical methods to find the solution of algebraic and transcendental equations
CO3:	give the knowledge of Interpolation techniques
CO4:	Analyze and solve linear programming models of real life situations. Provide graphical solutions of linear programming problems with two variables,

	Understand the theory of the simplex method.
CO5:	Know about the Transportation Problem, Assignment Problem.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L4	H	H	H	L	H	M	H	M	M	H	H	M	H	H	H	H
CO2	L3	H	H	H	M	H	M	H	M	M	H	H	M	H	M	H	M
CO3	L2	H	H	H	L	H	M	H	M	M	H	H	M	H	H	M	H
CO4	L3	H	H	H	M	H	M	H	M	M	H	H	M	H	M	H	H
CO5	L3	H	H	H	H	H	M	H	H	M	H	H	M	H	H	M	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC304C: PHYSICS WORKSHOP SKILLS

Course Objective:

- The aim of this course is to enable the students to be familiar and have experience of various mechanical and electrical tools through hands-on mode.
- This course enables students to understand working of various measuring devices and different type of errors encountered in the measurement process.
- This course also develops the mechanical skills of the students by direct exposure to different machines and tools by demonstration and experimental technique.

UNIT	CONTENTS	CONTAT HOURS
I	**Introduction:** Measuring units. Conversion to SI and CGS. Familiarization with meter scale, Vernier-calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc.	**04**
II	**Mechanical Skill-I**: Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood. Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines.	**05**
III	**Mechanical Skill-II**: Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothening of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet.	**05**
IV	**Electrical and Electronic Skill**: Use of Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, Electronic switch using transistor and relay.	**10**
V	**Introduction to prime movers**: Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, Lifting of heavy weight using lever. Braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment.	**06**
	TOTAL	**30**

Reference Books:

1	B L Theraja "A text book in Electrical Technology" S. Chand and Company.	2000
2	M.G. Say "Performance and design of AC machines –" ELBS Edn.	2002
3	K.C. John "Mechanical workshop practice" PHI Learning Pvt. Ltd.	2010
4	Bruce J Black "Workshop Processes, Practices and Materials" 3rd Edn., Editor Newness.	2005
5	Lawrence Smyth, Liam Hennessy "New Engineering Technology," The Educational Company of Ireland	1998

Course outcomes:

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

CO1:	Learn the use of measurement and dimensional analysis.
CO2:	Learn basic mechanical skills and use in daily life.
CO3:	Have knowledge of cutting the various metals.
CO4:	Learn about the electrical and electronic skills and use in daily life.
CO5:	Learn the concept of power generation systems.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	M	M	-	M	M	M	L	L	M	M	H	H	H	M	L	H
CO2	L2	H	-	M	M	L	L	H	-	L	-	L	L	H	L	M	M
CO3	L1	L	H	M	L	M	-	M	M	-	M	H	M	L	M	M	L
CO4	L2	H	L	M	H	M	M	L	M	M	M	M	M	M	L	L	M
CO5	L4	-	M	L	L	L	L	M	H	L	H	M	L	H	L	H	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC304D: COMPUTATIONAL PHYSICS SKILLS

Course Objectives

- This course is intended to give an insight into computers and their scientific applications.
- To familiarize students with the use of computer to solve physics problems.
- To teach a programming language namely FORTRAN and data visualization using Gnuplot.
- To teach them to prepare long formatted document using latex.

UNIT	CONTENTS	CONTACTHOURS
I	**Introduction:** Importance of computers in Physics, paradigm for solving physics problems for solution**.** Usage of Linux as an Editor. **Algorithms and Flowcharts:** Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin (x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.	**04**
II	**Scientific Programming**: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.	**05**
III	**Control Statements:** Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical **IF**, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DOWHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems. **Programming:** 1. Exercises on syntax on usage of FORTRAN Usage of GUI Windows, Linux Commands, familiarity with DOS	06

	commands and working in an editor to write sources codes in FORTRAN. 3. To print out all natural even/ odd numbers between given limits. 4. To find maximum, minimum and range of a given set of numbers. **5.** Calculating Euler number using exp(x) series evaluated at x=1	
IV	**Scientific word processing: Introduction to LaTeX:** TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. **Equation representation:** Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.	06
V	**Visualization:** Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot **Hands on exercises:** 1. To compile a frequency distribution and evaluate mean, standard deviation etc. 2. To evaluate sum of finite series and the area under a curve. 3. To find the product of two matrices 4. To find a set of prime numbers and Fibonacci series. 5. To write program to open a file and generate data for plotting using Gnuplot. 6. Plotting trajectory of a projectile projected horizontally. 7. Plotting trajectory of a projectile projected making an angle with the horizontally. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file. 9. To find the roots of a quadratic equation. 10. Motion of a projectile using simulation and plot the output for visualization. 1. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization. 12. Motion of particle in a central force field and plot the output for visualization.	\ 09
	TOTAL	**30**

Reference Books:

1	S.S. Sastry "Introduction to Numerical Analysis" 5th Edn., PHI Learning Pvt. Ltd.	2012
2	Leslie Lamport "LaTeX–A Document Preparation System" Second Edition, Addison-Wesley.	1994
3	Philip K Janert "Gnuplot in action: understanding data with graphs" Manning.	2010
4	S. Lipsdutz and A Poe "Schaum's Outline of Theory and Problems of Programming with Fortran" Mc-Graw Hill Book Co.	1986
5	R. C. Verma, et al. "Computational Physics: An Introduction" New Age International Publishers, New Delhi.	1999
6	U.M. Ascher and C. Greif "A first course in Numerical Methods" PHI Learning.	2012
7	K.E. Atkinson "Elementary Numerical Analysis" 3rd Edn., Wiley India Edition.	2007

Course outcomes:

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

CO1:	Learn the importance of computers in solving problems in Physics.
CO2:	Learn how to plan for writing the algorithm for solving a problem by drawing the flowchart of simple problems.
CO3:	Learn "Scientific Word Processing", particularly, how to use the LaTeX software in writing articles and papers.
CO4:	To have hands-on experience on computational tools.
CO5:	Simulate the motion of a particle in a central force field and plot the output for visualization.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	-	M	H	M	L	L	H	-	M	L	M	L	M	M	L
CO2	L3	L	L	M	L	M	L	L	L	L	L	M	-	H	L	H	M
CO3	L4	-	L	M	L	M	M	M	-	M	H	-	M	H	M	L	M
CO4	L3	M	H	L	H	M	L	M	L	L	L	L	L	M	H	H	H
CO5	L4	H	L	M	H	L	-	L	M	H	M	M	M	L	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC304E: PHARMACEUTICAL CHEMISTRY

Course Objective:

- To understand the basic concepts of drugs & pharmaceuticals, synthesis of analgesics, antipyretic and anti-inflammatory agents
- To learn the synthesis of antibiotics, antibacterial, antifungal and antiviral agents.
- To get the knowledge of synthesis of central nervous system, cardiovascular, antilaprosy, HIV-AIDS related drugs.
- To understand the fermentation process.
- To understand the Production of lysine, glutamic acid and some vitamin.

UNIT	CONTENTS	CONTACT HOURS
I	**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).	10
II	Synthesis of the representative drugs of the following classes: antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir),	6
III	Synthesis of the representative drugs of the following classes: Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).	6
IV	**Fermentation** Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin,	5
V	Aerobic and anaerobic fermentation. Production of Lysine, Glutamic acid, Vitamin B_2, Vitamin B12 and Vitamin C.	3
	TOTAL	30

S. No.	Experiments
1	Preparation of Aspirin and its analysis.
2	2. Preparation of magnesium bisilicate (Antacid).

Reference Books:

1 G.L. Patrick: Introduction to *Medicinal Chemistry, Oxford University* Press, UK.

2 Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry,* Vallabh Prakashan, Pitampura, New Delhi.

3 William O. Foye, Thomas L., Lemke , David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.

Course Outcomes:

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

CO1:	Learn the basic concepts of drugs & pharmaceuticals and synthesis of analgesics, antipyretic and anti-inflammatory agents
CO2:	Competent to synthesis of antibiotics, antibacterial, antifungal and antiviral agents.
CO3:	Synthesize of central nervous system, cardiovascular, antilaprosy, HIV-AIDS related drugs.
CO4:	Understand the fermentation process.
CO5:	Understand the production of lysine, glutamic acid and some vitamin.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PS O1	PS O2	PS O3
CO 1	L4	M	M	M	M	M	-	L	M	M	L	M	-	H	H	M	M
CO 2	L4	M	M	M	M	M	-	L	M	M	L	M	-	H	M	M	L
CO 3	L3	M	M	M	M	M	-	L	M	M	L	M	-	H	H	L	M
CO 4	L2	M	M	-	L	L	-	L	M	M	-	M	-	L	M	M	M
CO 5	L2	M	M	-	L	L	-	L	M	M	-	M	-	L	L	L	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC304F: BASIC ANALYTICAL CHEMISTRY

Course Objective

- To understand the basic concepts of analytical chemistry
- To learn the different parameters of soil analysis.
- To get the knowledge of analysis of water and food products.
- To understand the chromatography techniques.
- To get the skills for analysis of cosmetics.

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction:** Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.	5
II	**Analysis of soil**: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.	5
III	**Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. a. Determination of pH, acidity and alkalinity of a water sample. b. Determination of dissolved oxygen (DO) of a water sample. **Analysis of food products:** Nutritional value of foods, idea about food processingand food preservations and adulteration. a. Identification of adulterants in some common food items like coffee powder,asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. b. Analysis of preservatives and colouring matter.	8
IV	**Chromatography:** Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}). b. To compare paint samples by TLC method. **Ion-exchange:** Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).	8
V	**Analysis of cosmetics:** Major and minor constituents and their function a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.	4
	TOTAL	**30**

S.No.	Experiments
1	**Suggested Applications (Any one)**: a. To study the use of phenolphthalein in traps cases.
2	To analyze arson accelerants.
3	c. To carry out analysis of gasoline.
4	**Suggested Instrumental demonstrations:** a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
5	Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
6	c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Reference Books:

1 Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. *Instrumental Methods of Analysis*. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.

2 Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.

3 Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.,* Saunders College Publishing, Fort Worth (1992).

4 Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.

5 Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.

6 Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.

7 Freifelder, D. *Physical Biochemistry 2nd Ed.,* W.H. Freeman and Co., N.Y. USA (1982).

8 Cooper, T.G. *The Tools of Biochemistry,* John Wiley and Sons, N.Y. USA. (1977).

9 Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.,* Prentice Hall.

10 Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.,* Prentice Hall.

11 Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.,* Marcel Dekker, Inc., New York (1995).

Course Outcome:

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

CO1:	Understand the basic concepts of analytical chemistry.
CO2:	Learn the different parameters of soil analysis.
CO3:	Understand and apply the analysis of water and food products.
CO4:	Understand the chromatography techniques.
CO5:	Achieve the skills for analysis of cosmetics.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO 1	L2	M	L	L	-	-	-	-	M	L	-	M	-	-	H	H	H
CO 2	L2	M	M	M	L	L	L	-	M	-	-	M	-	-	M	M	M
CO 3	L3	M	M	M	M	M	L	M	M	L	-	M	-	M	L	M	M
CO 4	L2	L	M	L	L	L	M	M	L	-	-	M	-	L	M	H	H
CO 5	L4	M	M	M	M	M	L	M	M	L	-	M	-	H	M	H	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC305: THERMAL PHYSICS AND STATISTICAL MECHANICSLAB

Course Objective:

- This course will introduce the concept of Heat.
- The primary goal is to understand the fundamental laws of thermodynamics
- To understand the Planck's constant and Stefan's Constant.
- This coursework will also enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behavior of atoms.

S. No.	Experiment
1	To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2	Measurement of Planck's constant using black body radiation.
3	To determine Stefan's Constant.
4	To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5	To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6	To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7	To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8	To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9	To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
10	To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge

Reference Books:

1 B. L. Flint and H. T. Worsnop "Advanced Practical Physics for students", AsiaPublishing House. 1971

2 Michael Nelson and Jon M. Ogborn "Advanced level Physics Practicals" 4th Edition, reprinted, Heinemann Educational Publishers 1985

3 S. Panigrahi & B.Mallick "Engineering Practical Physics" Cengage LearningIndia Pvt. Ltd. 2015

4 Indu Prakash and Ramakrishna "A Text Book of Practical Physics" 11th Edition, Kitab Mahal, New Delhi. 2011

Course outcomes:

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

COs	Statements
CO1:	Learn the basic concepts of thermodynamics.
CO2:	Learn the basic concepts of the Thermal Conductivity.
CO3:	Have a knowledge of the real gas equations, Van der Waal equation of state, the Joule-Thompson effect.
CO4:	Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
CO5:	The students are expected to perform the experiments related to heat transfer.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	L	L	H	L	H	M	H	M	M	H	-	M	-	M	M	L
CO2	L2	L	-	M	-	L	L	M	M	M	L	L	L	L	M	L	M
CO3	L2	L	L	M	M	M	L	-	L	L	-	H	L	M	M	M	L
CO4	L2	H	L	-	L	L	H	L	M	L	M	L	H	L	L	L	M
CO5	L4	-	H	H	L	H	L	H	M	H	H	H	H	M	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC306: SOLUTIONS, PHASE EQUILIBRIA, CONDUCTANCE, ELECTROCHEMISTRY & CHEMSITRY-II LAB

Course Objective

- To understand the concept of equilibrium.
- To know the conductance and affects of different acid-base strength.
- To learn the potentiometric titrations.
- To get the knowledge of systematic qualitative organic analysis of organic compounds and separation techniques.

S. No	Experiments
1	***Section A: Physical Chemistry*** **Distribution** Study of the equilibrium of one of the following reactions by the distribution method: $I_2(aq) + I^-(aq) \rightarrow I^{3-}(aq)$ $Cu^{2+}(aq) + xNH_2(aq) \rightarrow [Cu(NH_3)_x]^{2+}$
2	**Phase equilibria** a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves. b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it. c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.
3	**Conductance** I. Determination of cell constant II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid. III. Perform the following conductometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base
4	**Potentiometry** Perform the following potentiometric titrations: i. Strong acid vs. strong base, ii. Weak acid vs. strong base iii. Potassium dichromate vs. Mohr's salt
5	***Section B: Organic Chemistry*** **I** Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

	II 1. Separation of amino acids by paper chromatography 2. Determination of the concentration of glycine solution by formylation method. 3. Titration curve of glycine 4. Action of salivary amylase on starch 5. Effect of temperature on the action of salivary amylase on starch. 6. Differentiation between a reducing and a nonreducing sugar.

Reference Books:

1 Vogel, A. I., Tatchell, A. R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

2 Mann, F. G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

3 Khosla, B. D. Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

4 Ahluwalia, V. K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

Course Outcomes:

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

CO1:	Understand the concept of equilibrium.
CO2:	Explain the conductance and affects of different acid-base strength.
CO3:	Learn the potentiometric titrations.
CO4:	Understand and analyze of systematic qualitative organic analysis of organic compounds and separation techniques.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L3	M	L	L	L	L	-	L	M	-	-	M	-	L	M	M	H
CO2	L5	M	M	M	L	L	-	L	M	-	-	M	-	L	M	H	H
CO3	L3	M	M	M	L	L	M	L	M	-	-	M	-	L	M	M	M
CO4	L4	M	M	M	L	L	-	L	M	-	-	M	-	M	M	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

FOURTH SEMESTER

THEORY PAPERS		**No. of Teaching Hours**			**Marks Allocation**			
Code	**Subject/Paper**	**L**	**T**	**P**	**IA**	**EA**	**Total**	**Credits**
BSC401	Waves and optics	5	-	-	30	70	100	5
BSC402	Transition Metal & Coordination Chemistry, states and matter Chemical kinetics	5	-	-	30	70	100	5
BSC403	Algebra	6	-	-	30	70	100	6
BSC404	**SEC-2 (Choose any one)**							
BSC404A	Vector Calculus							
BSC404B	Theory of Equations							
BSC404C	Electrical circuit & net work skills	3	-	-	30	70	100	3
BSC404D	Technical drawing							
BSC404E	Analytical Clinical Biochemistry							
BSC404F	Green Methods in Chemistry							
PRACTICALS/VIVA-VOCE		**No. of Teaching Hours**			**Sessional**	**Practical**	**Total**	**Credits**
BSC405	Waves and optics Lab	-	-	4	30	20	50	2
BSC406	Transition Metal & Coordination Chemistry Lab	-	-	4	30	20	50	2
TOTAL		**19**	**-**	**8**	**180**	**320**	**500**	**23**

BSC401: WAVES AND OPTICS

Course Objective

- This course reviews the concepts of waves and optics learnt at school from a more advanced perspective and goes on to build new concepts.
- It begins with explaining ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves.
- The course also provides an in depth understanding of wave phenomena of light, namely, interference and diffraction with emphasis on practical applications of the same.

UNIT	CONTENTS	CONTACTHOURS
I	**Superposition of Two Collinear Harmonic oscillations**: Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).	04
	Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.	**02**
	Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.	**07**
II	**Fluids:** Surface Tension: Synclastic and anticlastic surface - Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method. Viscosity: Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of a liquid with temperature lubrication. Physics of low pressure - production and measurement of low pressure - Rotary pump - Diffusion pump - Molecular pump - Knudsen absolute gauge - penning and pirani gauge – Detection of leakage.	**06**
III	**Sound:** Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.	06
	Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.	03

IV	**Interference:** Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.	10
	Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index and Visibility of fringes.	03
V	**Diffraction:** Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.	14
	Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization.	05
	TOTAL	**60**

Reference Books:

1	F. A. Jenkins and H. E. White "Fundamentals of Optics" McGraw-Hill	1976
2	B. K. Mathur "Principles of Optics" Gopal Printing	1995
3	H. R. Gulati and D.R. Khanna "Fundamentals of Optics" S. Chand Publication	1991
4	F. W. Sears, M. W. Zemansky and H. D. Young "University Physics" 13/e, Addison-Wesley.	1986

Course outcomes:

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

CO1:	Apply basic knowledge of principles and theories about the behaviour of light and the physical environment to conduct experiments.
CO2:	Explain several phenomena in everyday life.
CO3:	Use the principles of wave motion and superposition to explain the Physics of polarisation, interference and diffraction.
CO4:	Understand the working of selected optical instruments like biprism, interferometer, diffraction grating, and holograms.
CO5:	Recognize and use a mathematical oscillator equation and wave equation, and derive these equations for certain systems.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L3	H	M	-	H	M	M	-	M	H	-	H	H	H	L	M	L
CO2	L3	L	-	M	L	L	M	L	M	L	L	L	L	L	M	H	M
CO3	L3	M	M	H	H	H	L	H	L	-	H	H	H	L	H	M	M
CO4	L3	M	M	L	M	-	M	M	L	M	M	M	L	H	M	L	M
CO5	L1	H	L	H	M	L	H	M	L	M	M	M	M	L	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC402: TRANSITION METAL & COORDINATION CHEMISTRY, STATES AND MATTER CHEMICAL KINETICS

Course Objective

- To learn about the behavior of transition and inner transition elements.
- To impart knowledge regarding coordination compounds.
- To get comprehensive knowledge of kinetic theory of gases.
- To get the knowledge about various states of matter.
- To understand the kinetics of chemical reactions.

UNIT	CONTENTS	CONTACT HOURS
I	**Transition Elements (3d series):** General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).	8
II	**Coordination Chemistry:** Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature. **Crystal Field Theory:** Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for *Oh* and *Td* complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.	13
III	***Section B: Physical Chemistry-3*** **Kinetic Theory of Gases:** Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO_2. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).	15

IV	**Liquids:** Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only). **Solids:** Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.	12
V	**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 (both for equal and unequal concentrations of reactants). 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).	12
	TOTAL	60

Reference Books

1 Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).

2 Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).

3 Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).

4 Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).

5 Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

6 Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry,* Wiley.

7 Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.

8 Wulfsberg, G. *Inorganic Chemistry,* Viva Books Pvt. Ltd.

9 Rodgers, G.E. *Inorganic &Solid State Chemistry,* Cengage Learning India Ltd., 2008.

Course Outcomes:

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

CO1:	Interpret the behaviour of transition and inner transition elements.
CO2:	Summarize coordination compounds.
CO3:	Understand the kinetic theory of gases.
CO4:	Interpret the various states of matter.
CO5:	Understand the kinetics of chemical reactions.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	M	M	L	-	-	-	-	M	-	-	M	-	-	M	M	M
CO2	L2	M	M	M	-	-	-	-	M	-	-	M	-	-	M	M	H
CO3	L2	M	M	L	-	-	-	-	M	-	-	M	-	L	L	L	M
CO4	L2	M	M	L	-	-	-	-	M	-	-	M	-	L	H	M	M
CO5	L2	M	M	M	-	-	-	-	M	-	-	M	-	L	M	M	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC403: ALGEBRA

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Algebra like groups, sub groups, order of groups, cyclic group, Rings, Fields.

UNIT	CONTENTS	CONTACT HOURS
I	Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GLn (n,R), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group Sym (n), Group of quaternions.	**17**
II	Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group.	**11**
III	Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.	**12**
IV	Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions,	**8**
V	Rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Zp, Q, R, and C. Field of rational functions.	**12**
	TOTAL	**60**

Reference Books:

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa, 1999.
4. George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984.

Course Outcomes:

The course will enable the students to:

CO1:	Recognize the mathematical objects called groups.
CO2:	Link the fundamental concepts of groups and Subgroups.
CO3:	Explain the significance of the notions of cosets, normal subgroups, and factor groups.Analyze consequences of Lagrange's theorem
CO4:	Familiarize with the concept of Ring, Integral domain and Fields.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L3	H	H	H	H	H	H	H	H	L	H	L	H	M	M	M	L
CO2	L4	H	H	H	H	H	H	H	H	M	H	M	H	L	H	M	M
CO3	L4	H	H	H	H	H	H	H	H	L	H	L	H	M	H	H	M
CO4	L3	H	H	H	H	H	H	H	H	M	H	M	H	M	M	H	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC404A: VECTOR CALCULUS

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Vector Calculus like vector function, differentiation of vector function, divergence, gradient, curl, directional derivatives, Green's theorem, divergence theorem, Stocke's theorem.

UNIT	CONTENTS	CONTACT HOURS
I	Vector Algebra. Operations with vectors. Scalar and vector product of three vectors. Product of four vectors. Reciprocal vectors.	**8**
II	Vector Calculus. Scalar-valued functions over the plane and the space. Vector function of a scalar variable: Curves and Paths. Vector fields.	**8**
III	Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors. the tangent plane, total differential	**5**
IV	Gradient, divergence and curl. Vector integration: Path, line, surface, and volume integrals. Line integrals of linear differential forms, integration of total differentials, conservative fields, conditions for line integrals to depend only on the endpoints, the fundamental theorem on exact differentials. Serret-Frenet Formulas.	**5**
V	Theorems of Green, Gauss, Stokes, and problems based on these.	**4**
	TOTAL	**30**

Reference Books:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.
3. P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998.

Course Outcomes: This course will enable the students to:

CO1:	Learn the concept of vector functions and vector fields.
CO2:	Apply the concept of ordinary, partial and total derivatives of vector function in real life problems.
CO3:	Apply the concept of Gradient, divergence and curl of vector function fields
CO4:	Realize importance of Green, Gauss and Stokes' theorems in other branches of mathematics.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	H	H	H	H	L	H	H	M	H	H	L	L	M	M	M
CO2	L3	H	H	H	H	H	L	H	H	L	H	H	M	L	M	H	H
CO3	L3	H	H	H	H	H	M	H	H	M	H	H	L	M	H	H	M
CO4	L3	H	H	H	H	H	L	H	H	L	H	H	M	M	H	H	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC404B: THEORY OF EQUATIONS

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Theory of Equations like polynomials, Graphical representation of a polynomials, Descarte's rule of signs, Relation between the roots and the coefficients of equations. Algebraic solutions of the cubic and biquadratic.

UNIT	CONTENTS	CONTACT HOURS
I	General properties of polynomials, Graphical representation of a polynomials, maximum and minimum values of a polynomials,	**9**
II	General properties of equations, Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.	**4**
III	Symmetric functions, Applications symmetric function of the roots,	**3**
IV	Transformation of equations. Solutions of reciprocal and binomial equations.	**6**
V	Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.	**8**
	TOTAL	**30**

Books Recommended:

1. W.S. Burnside and A.W. Panton, The Theory of Equations, Dublin University Press, 1954.
2. C. C. Mac Duffee, Theory of Equations, John Wiley & Sons Inc., 1954.

Course Outcomes: This course will enable the students to:

CO1:	Find the roots/solutions of algebraic equations using the various techniques of Theory of Equations.
CO2:	Analysis and study the symmetric functions.
CO3:	Understand the concept of transformation of equations.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	H	H	H	H	M	H	M	H	M	M	M	M	H	H	H
CO2	L2	H	H	H	H	H	M	H	M	H	M	H	H	L	H	M	M
CO3	L2	H	H	H	H	H	M	H	M	H	H	H	M	M	H	M	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC404C: ELECTRICAL CIRCUIT & NETWORK SKILLS

Course Objective

- To develop an understanding of basic principles of electricity and its household applications.
- To impart basic knowledge of solid state devices and their applications, understanding of electrical wiring and installation.
- To review the concepts of electrical theory.

UNIT	CONTENTS	CONTACT HOURS
I	**Basic Electricity Principles**: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter.	**03**
II	**Understanding Electrical Circuits**: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.	**04**
III	**Electrical Drawing and Symbols**: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.	04
	Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.	03
	Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.	04
IV	**Solid-State Devices**: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources	03
	Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection Device)	04
V	**Electrical Wiring**: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board	05
	TOTAL	**30**

Reference Books:

1	B L Theraja "A text book in Electrical Technology " S Chand & Co.	2000
2	A K Theraja "A text book of Electrical Technology "	2005
3	M G Say "Performance and design of AC machines -" ELBS Edn.	1998

Course outcomes:

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

CO1:	Learn the importance of basic electrical equipment's such as ammeter, voltmeter, galvanometer etc. in daily life.
CO2:	Learn difference between AC and DC circuits.
CO3:	Learn electrical drawing and use of electrical components.
CO4:	To have hands-on experience on electrical tools.
CO5:	Know the information about electrical protection.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	H	-	-	L	H	-	M	H	-	H	L	L	M	H	L
CO2	L2	M	M	H	M	L	M	M	M	M	M	M	M	L	L	M	L
CO3	L2	L	L	L	L	M	M	L	M	L	L	L	H	H	H	L	M
CO4	L4	M	-	H	M	L	-	M	-	M	M	M	M	M	M	L	H
CO5	L1	-	H	M	H	L	M	H	L	H	H	H	L	L	L	L	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC404D: TECHNICAL DRAWING

Course Objective

- To introduce the students to modern visualization techniques and their applications in diverse areas including computer aided design.
- To offer hands-on experience of engineering drawing based on knowledge gained using computer aided designing software.
- To review the concepts of technical drawing.

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction**: Drafting Instruments and their uses. lettering: construction and uses of various scales: dimensioning as per I.S.I. 696-1972. Engineering Curves: Parabola: hyperbola: ellipse: cycloids, involute: spiral: helix and loci of points of simple moving mechanism.2D geometrical construction. Representation of 3D objects. Principles of projections.	**04**
II	**Projections**: Straight lines, planes and solids. Development of surfaces of right and oblique solids. Section of solids	**06**
	Object Projections: Orthographic projection. Interpenetration and intersection of solids. Isometric and oblique parallel projection of solids.	04
III	**CAD Drawing-I**: Introduction to CAD and Auto CAD, precision drawing and drawing aids, Geometric shapes, Demonstrating CAD-specific skills (graphical user interface. Create, retrieve, edit, and use symbol libraries. Use inquiry commands to extract drawing data). Control entity properties.	06
IV	**CAD Drawing-II**: Demonstrating basic skills to produce 2- D and 3-Ddrawings. 3D modeling with Auto CAD (surfaces and solids), 3D modeling with sketch up, annotating in Auto CAD with text and hatching, layers, templates & design center,	05
V	**CAD Drawing-III**: Advanced plotting (layouts, viewports), office standards, dimensioning, internet and collaboration, Blocks, Drafting symbols, attributes, extracting data. Basic printing, editing tools, Plot/Print drawing to appropriate scale.	05
	TOTAL	**30**

Reference Books:

1	K. Venugopal, and V. Raja Prabhu "Engineering Graphic" New Age International.	2000
2	AutoCAD 2014 & AutoCAD 2014/Donnie Gladfelter/Sybex/ISBN:978-1-118-57510-9.	2014
3	Architectural Design with Sketchup/Alexander Schreyer/John Wiley & Sons/ISBN:978-1-118-12309-6.	2002

Course outcomes:

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

CO1	Understanding the concept of a sectional view and learn proper technique for drawing an aligned sections.
CO2	Understanding use of spatial visualization by constructing an orthographic multi view drawing.
CO3	Expert in drawing simple curves, spiral, Orthographic projections of points, lines and of solids.
CO4	To have hands-on experience on technical writing on scientific studies.
CO5	Exposure to Computer Aided Design (CAD) and Auto CAD technique.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	-	H	H	H	L	M	M	H	L	-	-	H	L	H	L	H
CO2	L4	M	L	H	M	L	M	M	-	M	M	M	M	L	M	H	M
CO3	L2	L	L	H	L	M	L	M	L	H	L	L	L	H	L	L	H
CO4	L3	M	H-	H	M	L	-	M	M	M	M	M	M	L	M	M	M
CO5	L4	H	M	M	H	L	M	L	H	L	H	H	-	M	L	L	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC404E: ANALYTICAL CLINICAL BIOCHEMISTRY

Course Objective:

- To build up knowledge of carbohydrates.
- To impart the acquaintance of protein.
- To understand the role of different enzymes.
- To give basics of lipids and lipoproteins.
- To understand the analysis of urine and blood.

UNIT	CONTENTS	CONTACT HOURS
I	**Carbohydrates:** Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysachharides.	6
II	**Proteins:** Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.	5
III	**Enzymes:** Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry. Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.	6
IV	**Lipids:** Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. **Lipoproteins:** Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones. *Structure of DNA* (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.	8
V	**Biochemistry of disease: A diagnostic approach by blood/ urine analysis.** *Blood:* Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin. *Urine:* Collection and preservation of samples. 6. Formation of urine. Composition and estimation of constituents of normal and pathological urine.	5
	TOTAL	**30**

S. No.	Experiments
	Identification and estimation of the following:
1	Carbohydrates – qualitative and quantitative.
2	Lipids – qualitative.
3	Determination of the iodine number of oil.
4	Determination of the saponification number of oil.
5	Determination of cholesterol using Liebermann- Burchard reaction.
6	Proteins – qualitative.
7	Isolation of protein.
8	Determination of protein by the Biuret reaction.
9	Determination of nucleic acids

Reference Books:

1 T.G. Cooper: Tool of Biochemistry.

2 Keith Wilson and John Walker: Practical Biochemistry.

3 Alan H Gowenlock: Varley's Practical Clinical Biochemistry.

4 Thomas M. Devlin: Textbook of Biochemistry.

5 Berg, J.M., Tymoczko, J.L. &Stryer, L. *Biochemistry*, W.H. Freeman, 2002.

6 Talwar, G.P. & Srivastava, M. *Textbook of Biochemistry and Human Biology*, 3rd Ed. PHI Learning.

7 Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,*W. H. Freeman.

8 Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

Course Outcomes:

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

CO1:	Build up knowledge of carbohydrates.
CO2:	Understand the role of protein.
CO3:	Understand the role of different enzymes.
CO4:	Understand the basics of lipids and lipoproteins.
CO5:	Understand the analysis of urine and blood.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L3	M	H	L	-	-	-	L	M	L	-	M	-	-	M	M	H
CO2	L3	M	M	M	-	-	-	L	M	L	-	M	-	L	M	L	M
CO3	L3	M	M	M	-	-	-	L	M	L	--	M	-	L	M	M	H
CO4	L2	M	M	L	-	-	-	L	M	L	-	M	-	-	H	M	M
CO5	L4	M	M	H	-	-	-	M	M	L	--	M	-	M	M	M	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC404F: GREEN METHODS IN CHEMISTRY

Credits: 03, Max. Marks: 100, Exam Hours: 3 hours

Course Objective

- To collect the basics of green chemistry.
- To understand the alternative sources of energy and green solvents.
- To get the knowledge of alternative methods and solvents.
- To design the eco-friendly pigments.
- To green synthesis of plastic.

UNIT	CONTENTS	CONTACT HOURS
I	Introduction: Definitions of Green Chemistry. Brief introduction of twelve principles of Green Chemistry, with examples, special emphasis on atom economy, reducing toxicity.	10
II	Green solvents, Green Chemistry and catalysis and alternative sources of energy, Green energy and sustainability.	4
III	Real world Cases in Green Chemistry: Surfactants for carbon dioxide – Replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.	7
IV	Real world Cases in Green Chemistry: Designing of environmentally safe marine antifoulant. Right fit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments.	5
V	An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.	4
	TOTAL	30

S. No.	Experiments
1	Preparation and characterization of biodiesel from vegetable oil.
2	Extraction of D-limonene from orange peel using liquid CO2 prepared from dry ice.
3	Mechano chemical solvent free synthesis of azomethine.
4	Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).

Reference Books:

1 Anastas, P.T. & Warner, J.K. Green Chemistry- Theory and Practical, Oxford University Press (1998).

2 Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).

3 Cann, M. C. & Connely, M.E. Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
4 Ryan, M. A. & Tinnesand, M. Introduction to Green Chemistry, American Chemical Society, Washington (2002).
5 Sharma, R. K.; Sidhwani, I. T. & Chaudhari, M. K. Green Chemistry Experiments: A monograph I.K. International Publishing House Pvt Ltd. New Delhi, Bangalore.
6 Lancaster, M. Green Chemistry: An introductory text RSC publishing, 2nd Edition.
7 Sidhwani, I.T., Saini, G., Chowdhury, S., Garg, D., Malovika, Garg, N. Wealth from waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated "A Social Awareness Project", Delhi University Journal of Undergraduate Research and Innovation, 1(1): 2015.

Course Outcomes:

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

CO1:	Develop the basics of green chemistry.
CO2:	Interpret the alternative sources of energy and green solvents.
CO3:	Choose alternative methods of synthesis and solvents.
CO4:	Design the eco-friendly pigments.
CO5:	Understand the green synthesis of plastic.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	M	M	M	-	-	-	-	M	M	-	M	H	-	M	H	H
CO2	L2	M	M	M	-	-	-	-	M	M	-	M	H	-	M	H	H
CO3	L3	M	M	M	-	-	-	-	M	M	-	M	H	-	M	L	M
CO4	L5	M	M	L	M	M	-	L	M	L	L	M	H	M	M	H	H
CO5	L2	M	M	M	M	M	-	L	M	L	L	M	H	M	M	M	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC405: WAVES AND OPTICS LAB

Course Objective

- This course reviews the concepts of waves and optics.
- It begins with explaining ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves.
- The course also provides an in depth understanding of wave phenomena of light, namely, interference and diffraction with emphasis on practical applications of the same.

S. No.	Experiment
1	To investigate the motion of coupled oscillators
2	To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ^2 – T Law.
3	To study Lissajous Figures
4	Familiarization with Schuster`s focussing; determination of angle of prism.
5	To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
6	To determine the Refractive Index of the Material of a given Prism using Sodium Light.
7	To determine Dispersive Power of the Material of a given Prism using Mercury Light
8	To determine the value of Cauchy Constants of a material of a prism.
9	To determine the value of Cauchy Constants of a material of a prism.
10	To determine wavelength of sodium light using Fresnel Biprism.
11	To determine wavelength of sodium light using Newton's Rings.
12	To determine the wavelength of Laser light using Diffraction of Single Slit.
13	To determine wavelength of (1) Sodium & (2) spectrum of Mercury light using plane diffraction Grating
14	To determine the Resolving Power of a Plane Diffraction Grating.
15	To measure the intensity using photo sensor and laser in diffraction patterns of single and double slits.

Reference Books:

1 B. L. Flint and H. T. Worsnop "Advanced Practical Physics for students", Asia Publishing House. 1971

2 Michael Nelson and Jon M. Ogborn "Advanced level Physics Practicals" 4th Edition, reprinted, Heinemann Educational Publishers. 1985

3	S. Panigrai & B. Mallick "Engineering Practical Physics" Cengage Learning India Pvt. Ltd.	2015
4	Indu Prakash and Ramakrishna "A Text Book of Practical Physics" 11th Edition, Kitab Mahal, New Delhi.	2011

Course outcomes:

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

COs	**Statements**
CO1:	Apply basic knowledge of principles and theories about the behavior of light and the physical environment to conduct experiments.
CO2:	Explain several phenomena in everyday life.
CO3:	Use the principles of wave motion and superposition to explain the Physics of polarisation, interference and diffraction.
CO4:	Understand the working of selected optical instruments like biprism, interferometer, diffraction grating, and holograms.
CO5:	In the laboratory course, student will gain hands-on experience of using various optical instruments.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L4	L	L	H	L	-	M	H	-	M	H	-	M	H	H	M	M
CO2	L4	L	H	M	H	L	L	M	M	M	L	L	L	L	M	H	L
CO3	L3	L	L	M	M	M	L	-	L	L	H	H	L	M	M	H	M
CO4	L2	-	L	-	L	L	H	L	M	L	M	L	H	L	M	L	L
CO5	L4	H	H	H	L	H	L	H	M	H	H	H	H	M	H	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC406: TRANSITION METAL & COORDINATION CHEMISTRY LAB

Course Objectives:

- To get the skills of identification from mixture of two anions and two cations including complexometric titrations.
- To understand the concept and measurement of surface tension, viscosity, chemical kinetics.
- To understand the process of saponification of ethyl acetate.

S. No.	Experiments
1	***Section A: Inorganic Chemistry*** Semi-micro qualitative analysis (using H2S or other methods) of mixtures - not more than four ionic species (two anions and two cations, excluding insoluble salts) out of the following: Cations: NH^{4+}, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^{+} Anions : CO_3^{2-} , S^{2-}, SO^{2-}, $S_2O_3^{2-}$, NO_3^{-}, CH_3COO^{-}, Cl^{-}, Br^{-}, I^{-}, NO_3^{-}, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^{-} (Spot tests should be carried out wherever feasible) 1. Estimate the amount of nickel present in a given solution as *bis* (dimethylglyoximato) nickel (II) or aluminium as oximate in a given solution gravimetrically. 2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA. 3. Estimation of total hardness of a given sample of water by complexometric titration.
2	***Section B: Physical Chemistry*** (I) Surface tension measurement (use of organic solvents excluded). a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer. b) Study of the variation of surface tension of a detergent solution with concentration. (II) Viscosity measurement (use of organic solvents excluded). a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer. b) Study of the variation of viscosity of an aqueous solution with concentration of solute. (III) Chemical Kinetics Study the kinetics of the following reactions. 1. Initial rate method: Iodide-persulphate reaction 2. Integrated rate method: a. Acid hydrolysis of methyl acetate with hydrochloric acid. b. Saponification of ethyl acetate. c. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

Reference Books:

1 Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.

2 Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.

3 Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

Course Outcomes:

CO1:	Get the skills of identification from mixture of two anions and two cations including complexometric titrations.
CO2:	Understand the concept and measurement of surface tension, viscosity and chemical kinetics.
CO3:	Understand the process of saponification of ethyl acetate.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L5	H	M	M	L	L	-	L	H	-	L	H	-	L	M	M	H
CO2	L5	H	M	M	L	L	M	L	H	-	L	H	-	L	M	M	H
CO3	L4	M	M	M	L	L	-	L	M	-	L	M	-	M	M	M	H

H- High, M- Moderate, L- Low, '-' for No correlation

FIFTH SEMESTER

THEORY PAPERS		No. of Teaching Hours			Marks Allocation			
Code	**Subject/Paper**	**L**	**T**	**P**	**IA**	**EA**	**Total**	**Credits**
BSC501	**SEC-3 (Choose any one)**	3	-	-	30	70	100	3
BSC501A	Probability and Statistics							
BSC501B	Mathematical Modelling							
BSC501C	Radiology & safety							
BSC501D	Weather forecasting							
BSC501E	Chemistry of Cosmetics & Perfumes							
BSC501F	Pesticide Chemistry							
BSC502	**DSE-1A (Choose any one)**	6	-	-	30	70	100	6
BSC502A	Matrices							
BSC502B	Mechanics							
BSC502C	Linear Algebra							
BSC503	**DSE-2A (Choose any one)**	5	-	-	30	70	100	5
BSC503A	Analytical Methods in Chemistry							
BSC503B	Novel Inorganic Solids							
BSC503C	Organometallics, Bioinorganic chemistry , Polynuclear hydrocarbons and UV ,IR Spectroscopy							
BSC503D	Chemistry of Main Group Elements, Theories of Acids and Bases							
BSC504	**DSE-3A (Choose any one)**	5	-	-	30	70	100	5
BSC504A	Digital, Analog and Instrumentation							
BSC504B	Elements of Modern Physics							
BSC504C	Mathematical Physics							
BSC504D	Solid State Physics							

PRACTICALS/VIVA-VOCE		No. of Teaching Hours			Sessional	Practical	Total	Credits
BSC505	**DSE-2A (Choose any one)**	-	-	4	30	20	50	2
BSC505A	Analytical Methods in Chemistry Lab							
BSC505B	Novel Inorganic Solids Lab							
BSC505C	Organometallics, Bioinorganic chemistry ,Polynuclear hydrocarbons and UV ,IR Spectroscopy Lab							
BSC505D	Chemistry of Main Group Elements, Theories of Acids and Bases Lab							
BSC506	**DSE-3A (Choose any one)**	-	-	4	30	20	50	2
BSC506A	Digital, Analog and Instrumentation Lab							
BSC506B	Elements of Modern Physics Lab							
BSC506C	Mathematical Physics Lab							
BSC506D	Solid State Physics Lab							
TOTAL		**19**	**-**	**8**	**180**	**320**	**500**	**23**

BSC501A: PROBABILITY AND STATISTICS

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Probability and Statistics like sample space, random variables, probability mass function and probability density functions, various probability distribution, Mathematical expectation, moments, and marginal and conditional distributions.

UNIT	CONTENTS	CONTACT HOURS
I	Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions,	**9**
II	Mathematical expectation, moments, moment generating function, characteristic function,	**4**
III	Discrete distributions: uniform, binomial, Poisson,	**3**
IV	Continuous distributions: uniform, normal, exponential.	**4**
V	Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables.	**10**
	TOTAL	**30**

Reference Books:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.

2. Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Application, 7th Ed., Pearson Education, Asia, 2006.

3. Sheldon Ross, Introduction to Probability Model, 9th Ed., Academic Press, Indian Reprint, 2007.

Course Outcomes: This course will enable the students to:

CO1:	Understand the basic concepts of probability.
CO2:	Appreciate the importance of probability distribution of random variables and to know the notion of central tendency.
CO3:	Establish the joint distribution of two random variables in terms their correlation and regression.
CO4:	Understand central limit theorem which shows that the empirical frequencies of so many natural populations exhibit normal distribution.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO 1	L2	H	H	-	-	H	H	H	H	H	H	H	H	H	H	M	M
CO 2	L3	H	H	-	-	H	H	H	H	H	H	H	H	H	H	M	H
CO 3	L3	H	H	-	-	H	H	H	H	H	H	H	H	H	H	H	H
CO 4	L3	H	H	-	-	H	H	H	H	H	H	H	H	H	H	H	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC501B: MATHEMATICAL MODELING

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Mathematical Modeling.

UNIT	CONTENTS	CONTACT HOURS
I	Introduction, basic steps of Mathematical Modeling, its needs, types of models, limitations.	**7**
II	Elementary ideas of dynamical systems, autonomous dynamical systems in the plane-linear theory. Equilibrium point, node, saddle point, focus, centre and limit-cycle ideas with simple illustrations and figures.	**9**
III	Applications of differential equations: the vibrations of a mass on a spring, mixture problem, free damped motion, forced motion, resonance phenomena, electric circuit problem,	**5**
IV	Mechanics of simultaneous differential equations. Applications to Traffic Flow. Vibrating string, vibrating membrane,	**5**
V	Conduction of heat in solids, gravitational potential, conservation laws.	**4**
	TOTAL	**30**

Reference Books:

1. Shepley L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, 1984.

2. I. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, International Edition, 1967.

Course Outcomes: This course will enable the students to:

CO1:	Understand the basic concepts of mathematical modelling.
CO2:	Build the mathematical models of real life problems.
CO3	Applications of differential equations in modelling

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	H	H	H	H	H	H	M	H	H	H	M	M	H	M	H
CO2	L3	H	H	H	H	H	H	H	M	H	H	H	M	H	H	H	H
CO3	L3	H	H	H	M	H	H	M	M	H	H	H	M	M	H	M	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC501C: RADIOLOGY & SAFETY

Course Objective

- This course focuses on the applications of nuclear techniques and radiation protection.
- It will not only enhance the skills towards the basic understanding of the radiation but will also provide the knowledge about the protective measures against the radiation exposure.
- It imparts all the skills required by a radiation safety officer or any job dealing with radiation such as X-ray operators, nuclear medicine dealing jobs: chemotherapists, PET MRI CT scan, gamma camera etc. operators etc.
- To review the concepts of radiation and safety.

UNIT	CONTENTS	CONTACTHOURS
I	**Basics of Atomic and Nuclear Physics:** Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half-life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission	**06**
II	**Interaction of Radiation with matter: Types of Radiation:** Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, **Interaction of Photons** – Photoelectric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, **Interaction of Charged Particles:** Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), **Interaction of Neutrons**- Collision, slowing down and Moderation	**07**
III	**Radiation detection and monitoring devices: Radiation Quantities and Units:** Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). **Radiation detection:** Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors **(**Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry.	07
IV	**Radiation safety management:** *Biological effects of ionizing radiation*, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for	05

	waste management.	
V	**Application of nuclear techniques:** Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. *Industrial Uses:* Tracing, Gauging, Material Modification, Sterization, Food preservation. **Experiments:** 1. Study the background radiation levels using Radiation meter **Characteristics of Geiger Muller (GM) Counter:** 2) Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source). 3) Study of counting statistics using background radiation using GM counter. 4) Study of radiation in various materials (e.g. KSO4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage. 5) Study of absorption of beta particles in Aluminum using GM counter. 6) Detection of α particles using reference source & determining its half-life using spark counter 7) Gamma spectrum of Gas Light mantle (Source of Thorium)	05
	TOTAL	**30**

Reference Books:

1	W. E. Burcham and M. Jobes "Nuclear and Particle Physics" Longman	1995
2	W. J. Meredith and J. B. Massey, "Fundamental Physics of Radiology". John Wright and Sons, UK	1989
3	J. R. Greening, "Fundamentals of Radiation Dosimetry", Medical Physics Hand	1981
4	Practical Applications of Radioactivity and Nuclear Radiations, G. C. Lowental	2001
5	A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York	1981
6	W. R. Hendee, "Medical Radiation Physics", Year Book – Medical Publishers	1981

Course outcomes:

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

CO1:	Understand the hazards of radiation and the safety measures to guard against these hazards.
CO2:	Knowledge about the nature of interaction of matter with radiations and radiation shielding by appropriate materials.
CO3:	Learn about the devices which apply radiations in medical sciences, such as MRI, PET.
CO4:	To have hands-on experience on radiation and safety.
CO5:	Learn the basic aspects of the atomic and nuclear Physics.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	-	H	H	M	H	L	-	H	-	M	H	L	H	M	L
CO2	L2	-	L	-	M	L	M	M	M	M	M	M	M	H	M	L	H
CO3	L2	L	L	H	L	L	M	-	L	L	L	M	L	M	M	L	M
CO4	L3	M	H	H	M	L	M	M	M	M	M	M	M	H	M	M	L
CO5	L2	L	L	M	-	L	M	L	H	-	H	L	H	L	L	H	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC501D: WEATHER FORECASTING

Course Objective

- The aim of this course is to impart theoretical knowledge to the students.
- To enable them to develop awareness and understanding of the causes and effects of different weather phenomena and basic forecasting techniques.
- To review the concepts of weather and climate.

UNIT	CONTENTS	CONTATHOURS
I	**Introduction to atmosphere:** Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics.	**09**
II	**Measuring the weather:** Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.	**04**
III	**Weather systems:** Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.	03
IV	**Climate and Climate Change:** Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.	06
V	**Basics of weather forecasting:** Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts. **Demonstrations and Experiments:** 1. Study of synoptic charts & weather reports, working principle of weather station. 2. Processing and analysis of weather data: (a) To calculate the sunniest time of the year. (b) To study the variation of rainfall amount and intensity by wind direction. (c) To observe the sunniest/driest day of the week. (d) To examine the maximum and minimum temperature throughout the year. (e) To evaluate the relative humidity of the day. (f) To examine the rainfall amount month wise. 3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis. 4. Formats and elements in different types of weather forecasts/ warning (both aviation and non-aviation)	08

	TOTAL	**30**

Reference Books:

1. Aviation Meteorology, I.C. Joshi, 3rd edition Himalayan Books 2014
2. The weather Observers Hand book, Stephen Burt, Cambridge University Press. 2012
3. Meteorology, S.R. Ghadekar, Agromet Publishers, Nagpur 2001
4. Text Book of Agrometeorology, S.R. Ghadekar, Agromet Publishers, Nagpur 2005
5. Why the weather, Charls Franklin Brooks, Chpraman & Hall, London 1924
6. Atmosphere and Ocean, John G. Harvey, The Artemis Press 1995

Course outcomes:

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

CO1:	Knowledge of the elements of the atmosphere, its composition at various heights.
CO2:	Learn basic techniques to measure temperature and its relation with cyclones and anti-cyclones.
CO3:	Knowledge of simple techniques to measure wind speed and its directions, humidity and rainfall.
CO4:	Knowledge of global wind systems, jet streams, local thunderstorms, tropical cyclones, tornadoes and hurricanes.
CO5:	Develop skills needed for weather forecasting, mathematical simulations, weather.

Table: Mapping of Course Outcomes with Program Learning Outcomes.

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	M	-	H	H	L	-	L	H	H	H	M	H	L	M	L	H
CO2	L2	M	L	-	M	L	M	M	H	M	-	M	M	H	H	M	L
CO3	L2	L	L	H	L	M	L	-	L	L	L	M	L	M	L	L	L
CO4	L2	-	H	-	M	L	M	M	M	M	M	M	M	H	M	H	M
CO5	L4	H	L	M	-	L	M	L	H	H	H	L	H	L	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC501E: CHEMISTRY OF COSMETICS & PERFUMES

Course Objective:

- To serve the knowledge of hair enrichment items.
- To make the students understand about face glowing objects.
- To understand preparation and uses of creams, antiperspirants and artificial flavours.
- To get the facts of essential oils and their importance in cosmetic industries.

UNIT	CONTENTS	CONTACT HOURS
I	A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions.	8
II	A general study including preparation and uses of the following: face powder, lipsticks, talcum powder, nail enamel.	8
III	A general study including preparation and uses of the following: creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours.	5
IV	Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandal wood oil,	5
V	Essential oils and their importance in cosmetic industries with reference to eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.	4
	TOTAL	30

S. No.	Experiments
1	Preparation of talcum powder.
2	Preparation of shampoo.
3	Preparation of enamels.
4	Preparation of hair remover.
5	Preparation of face cream.
6	Preparation of nail polish and nail polish remover.

Reference Books:

1 E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.

2 P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.

3 Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut (1996).

Course Outcomes:

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

CO1:	Summarize the hair enrichment items.
CO2:	Understand the face glowing objects.
CO3:	Understand the preparation and uses of creams, antiperspirants and artificial flavours.
CO4:	Understand the essential oils and their importance in cosmetic industries.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	H	M	-	-	-		H	L	-	H	-	L	H	M	H
CO2	L2	H	H	M	-	-	-		H	L	-	H	-	L	H	M	H
CO3	L3	H	H	M	M	M	-	L	H	L	-	H	-	H	H	M	H
CO4	L2	M	M	M	-	-	-		M	L	-	M	-	L	H	M	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC501F: PESTICIDE CHEMISTRY

Course Objective:

- To understand the basic knowledge of pesticides.
- To get the structure activity relationship.
- To learn the synthesis and uses of some important pesticides.

UNIT	CONTENTS	CONTACT HOURS
I	General introduction to pesticides (natural and synthetic), benefits and adverse effects.	5
II	Changing concepts of pesticides, structure activity relationship, synthesis	5
III	Technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion).	8
IV	Technical manufacture and uses of representative pesticides in the following classes: Carbamates (Carbofuran and carbaryl);	7
V	Technical manufacture and uses of representative pesticides in the following classes: Quinones (Chloranil), Anilides (Alachlor and Butachlor).	5
	TOTAL	30

S. No.	Experiments
1	To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
2	Preparation of simple organophosphates, phosphonates and thiophosphates

Reference Book:

1 Cremlyn, R. *Pesticides. Preparation and Modes of Action*, John Wiley & Sons, New York, 1978.

Course Outcomes:

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

CO1:	Understand the basic knowledge of pesticides.
CO2:	Determine the structure activity relationship of pesticides.
CO3:	Synthesize and uses of some important pesticides.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	L	L	L	-	L	-	-	L	M	-	L	-	H	H	H	H
CO2	L5	M	M	H	H	M	-	M	M	M	-	M	-	H	M	M	H
CO3	L5	M	M	M	M	L	-	L	M	-	-	M	-	H	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC502A: MATRICES

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Vector spaces, Subspaces, Basis, quotient spaces, Linear transformations, Matrix form of basic geometric transformations.

UNIT	CONTENTS	CONTACT HOURS
I	Vector spaces, Subspaces, algebra of subspaces, R, R2, R3 as vector spaces over R subspaces, linear combination of vectors, linear span, linear independence,	**12**
II	Basis, Standard basis for each of R, R2, R3 and dimension, dimension of subspaces.	**10**
III	quotient spaces , Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.	**13**
IV	Translation, Dilation, Rotation, Reflection in a point, line and plane. Matrix form of basic geometric transformations. Interpretation of eigen values and eigen vectors for such transformations and eigen spaces as invariant subspaces.	**15**
V	Rank of matrix. Solutions of a system of linear equations using matrices. Illustrative examples of above concepts from Geometry, Physics, Chemistry, Combinatorics and Statistics.	**10**
	TOTAL	**60**

Reference Books:

1. A. I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.
2. S. H. Friedberg, A. L. Insel and L. E. Spence, *Linear Algebra*, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill,1989.
4. Sarangi, K. C., Elements of Abstract Algebra, Ramesh Book Depot, 2005.

Course Outcomes:

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

CO1:	Understand the concepts of vector spaces, subspaces, bases, dimension and theirproperties.
CO2:	Relate matrices and linear transformations; compute eigen values and eigen vectors of linear transformations.
CO3:	Realise importance of a Translation, Dilation, Rotation, Reflection in a point, line and plane.
CO4:	Applications of matrices in physical and life sciences

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	H	H	M	H	H	H	H	H	H	H	H	M	H	H	M
CO2	L3	H	H	H	M	H	H	H	H	H	H	H	H	M	H	H	H
CO3	L3	H	H	H	M	H	H	H	H	H	H	H	H	M	M	H	M
CO4	L3	H	H	H	M	H	H	H	H	H	H	H	H	H	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC502B: MECHANICS

Course Objectives: The objective of this course is to expose student to understand the basic concepts of coplanar forces, Laws of friction, Work and potential energy, Motion of a particle in three dimensions, Simple harmonic motion and Projectile Motion.

UNIT	CONTENTS	CONTACT HOURS
I	Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body, Laws of friction, Problems of equilibrium under forces including friction, Centre of gravity, Work and potential energy.	**15**
II	Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), tangential and normal components (space curve),	**13**
III	Motion of a particle in three dimensions. Motion on a smooth sphere, cone, and on any surface of revolution.	**12**
IV	Newton's Laws of motion, Simple harmonic motion, Simple Pendulum,	**10**
V	Projectile Motion. Motion of a projectile in a resisting medium. Motion of a particle in a plane under different laws of resistance	**10**
	TOTAL	**60**

Reference Books:

1. A. S. Ramsay, *Statics*, CBS Publishers and Distributors (Indian Reprint), 1998.120

2. A. P. Roberts, *Statics and Dynamics with Background in Mathematics*, Cambridge University Press, 2003.

Course Outcomes: This course will enable the students to:

CO1:	Familiarize with subject matter, which has been the single centre, to which were drawn mathematicians, physicists, astronomers, and engineers together.
CO2:	Understand necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.
CO3:	Determine the centre of gravity of some materialistic systems.
CO4:	Deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.
CO5:	Learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO 3
CO1	L2	H	H	H	M	H	M	H	H	M	H	H	M	H	H	H	H
CO2	L3	H	H	H	L	H	L	H	H	L	H	H	L	H	H	H	M
CO3	L3	H	H	H	M	H	M	H	H	M	H	H	M	H	M	H	M
CO4	L3	H	H	H	L	H	L	H	H	L	H	H	L	H	M	M	H
CO5	L3	H	H	H	L	H	L	H	H	L	H	H	L	H	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC502C: LINEAR ALGEBRA

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Vector spaces, Subspaces, Basis, quotient spaces, Linear transformations, Matrix form of basic geometric transformations.

UNIT	CONTENTS	CONTACT HOURS
I	Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence,	14
II	basis and dimension, dimension of subspaces.	11
III	Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.	12
IV	Dual Space, Dual Basis, Double Dual, Eigen values and Eigen vectors, Characteristic Polynomial.	11
V	Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.	12
	TOTAL	60

Reference Books:

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.

2. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

3. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.

4. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.

Course Outcomes: This course will enable the students to:

CO1:	Understand the concepts of vector spaces, subspaces, bases, dimension and their properties.
CO2:	Relate matrices and linear transformations, compute eigen values and eigen vectors of linear transformations.
CO3:	Learn properties of inner product spaces and determine orthogonality in inner product spaces.
CO4:	Realise importance of adjoint of a linear transformation and its canonical form.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	H	H	M	H	H	H	H	H	H	H	H	H	H	H	M
CO2	L3	H	H	H	M	H	H	H	H	H	H	H	H	H	H	H	M
CO3	L3	H	H	H	M	H	H	H	H	H	H	H	H	H	H	H	M
CO4	L3	H	H	H	M	H	H	H	H	H	H	H	H	H	H	H	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC503A: ANALYTICAL METHODS IN CHEMISTRY

Course Objective:

- To impart the knowledge of analysis and spectrometry.
- To understand the flame atomic absorption and emission spectrometry.
- To learn the thermal and electroanalytical methods of analysis.
- To get the comprehension about different separation techniques.

UNIT	CONTENTS	CONTACT HOURS
I	**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. **Optical methods of analysis I:** 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. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. *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.	15
II	**Optical methods of analysis II:** *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.	8
III	**Thermal methods of analysis:** Theory of thermogravimetry (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.	10
IV	**Separation techniques I:**	15

	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.	
V	**Separation techniques II:** Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis.	12
	TOTAL	60

Reference Books:

1 Jeffery, G. H., Bassett, J., Mendham, J. & Denney, R. C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons, 1989.

2 Willard, H. H., Merritt, L. L., Dean, J. & Settoe, F. A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

3 Christian, G. D; *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.

4 Harris, D. C. *Exploring Chemical Analysis*, Ed. New York, W.H. Freeman, 2001.

5 Khopkar, S. M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher, 2009.

6 Skoog, D.A. Holler F. J. & Nieman, T. A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.

7 Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

8 Ditts, R. V. *Analytical Chemistry; Methods of Separation*, van Nostrand, 1974.

Course Outcomes:

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

CO1:	Interpret qualitative and quantitative analysis of data and spectrometry.
CO2:	Understand the instrumentation and working of flame atomic absorption and emission spectrometry with their uses.
CO3:	Learn the thermal and electro-analytical methods of analysis.
CO4:	Evaluate different separation techniques.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L3	M	M	H	M	M	M	M	M	M	-	M	-	M	M	M	M
CO2	L3	H	M	H	M	M	M	M	H	M	-	H	-	H	M	L	M
CO3	L3	M	M	H	M	M	M	M	M	M	-	M	-	M	M	M	M
CO4	L5	H	M	H	M	M	M	M	H	M	-	M	-	M	M	L	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC503B: NOVEL INORGANIC SOLIDS

Course Objective:

- To explain the mechanism of solid-state synthesis and different characterization techniques and their principle.
- To get the knowledge of concept of nanomaterials, their synthesis and properties.
- To impart the knowledge of engineering materials for mechanical construction.
- To obtain the information of composite materials.
- To give the basics of speciality polymers.

UNIT	CONTENTS	CONTACT HOURS
I	**Synthesis and modification of inorganic solids:** Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods. **Inorganic solids of technological importance:** Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments. Molecular material and full rides, molecular materials & chemistry – one dimensional metals, molecular magnets, inorganic liquid crystals.	15
II	**Nanomaterials:** Overview of nanostructures and nanomaterials: classification. Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires. Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisical nanomaterials, bionano composites.	13
III	**Introduction to engineering materials for mechanical construction:** Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminium and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.	11
IV	**Composite materials:** Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.	10
V	**Speciality polymers:** Conducting polymers - Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrrole, applications of conducting polymers, Ionexchange resins and their applications. Ceramic & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications.	11
	TOTAL	60

Reference Books:

1 Shriver & Atkins. *Inorganic Chemistry*, Peter Alkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)

2 Adam, D.M. *Inorganic Solids: An introduction to concepts in solid-state structural chemistry*. John Wiley & Sons, 1974.

3 Poole, C. P. & Owens, F.J. *Introduction to Nanotechnology* John Wiley & Sons, 2003.

4 Rodger, G. E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.

Course Outcomes:

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

CO1:	Understand the mechanism of solid-state synthesis and different characterization techniques and their principle.
CO2:	Explain the concept of nanomaterials, their synthesis and properties.
CO3:	Gain knowledge of engineering materials for mechanical construction.
CO4:	Learn the information of composite materials.
CO5:	Explain basics of speciality polymers.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L3	M	M	H	-	M	-	L	M	-	-	M	-	H	M	H	H
CO2	L5	M	M	M	M	M	-	L	M	L	-	M	-	H	M	M	H
CO3	L2	M	M	M	-	-	-	L	M	-	-	M	-	-	M	H	H
CO4	L2	M	M	M	-	-	-	L	M	-	-	M	-	-	M	H	H
CO5	L2	M	L	-	-	-	-	L	M	-	-	M	-	-	M	M	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC503C: ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLYNUCLEAR HYDROCARBONS AND UV, IR SPECTROSCOPY

Course Objective:

- To understand the chemistry and applications of 3d elements.
- To get the basics of organometallic compounds.
- To impart the knowledge of bio-inorganic chemistry and role of metal ions present in biological systems.
- To understand the fundamentals of functional group chemistry, polynuclear hydrocarbons and heterocyclic compounds through the study of methods of preparation, properties and chemical reactions with underlying mechanism.
- To use basic theoretical principles underlying UV-visible and IR spectroscopy as a tool for functional group identification in organic molecules.

UNIT	CONTENTS	CONTACT HOURS
I	***Section A: Inorganic Chemistry-4*** **Chemistry of 3d metals:** Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.	17
II	**Organometallic Compounds:** Definition and Classification with appropriate examples based on nature of metalcarbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies).	13
III	**Bio-Inorganic Chemistry:** A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).	10
IV	***Section B: Organic Chemistry-4*** **Polynuclear and heteronuclear aromatic compounds:** Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene , Furan, Pyrrole,	6

	Thiophene, and Pyridine. **Active methylene compounds:** *Preparation:* Claisen ester condensation. Keto-enol tautomerism. *Reactions:* Synthetic uses of ethylacetoacetate (preparation of non-heteromolecules having upto 6 carbon).	
V	**Application of Spectroscopy to Simple Organic Molecules** Application of visible, ultraviolet and Infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, λmax & εmax, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating l max of conjugated dienes and α,β – unsaturated compounds. Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).	14
	TOTAL	60

Reference Books:

1 James E. Huheey, Ellen Keiter & Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
2 G. L. Miessler & Donald A. Tarr: Inorganic Chemistry, Pearson Publication.
3 J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
4 F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley & Sons.
5 I. L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S.
6 John R. Dyer: Applications of Absorption Spectroscopy of Organic Compounds, Prentice Hall.
7 R.M. Silverstein, G. C. Bassler & T. C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley & Sons.
8 R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
9 Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
10 Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.

Course Outcomes:

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

CO1:	Understand the chemistry and applications of 3d elements.
CO2:	Get the basics of organometallic compounds
CO3:	Impart the knowledge of bio-inorganic chemistry and role of metal ions present in biological systems.
CO4:	Understand the synthesis of polynuclear hydrocarbons and heterocyclic compounds.
CO5:	Identify organic molecules through UV-visible and IR spectroscopy as a tool for functional group

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	M	M	-	-	-	-	-	M	-	-	M	-	-	M	M	H
CO2	L2	M	L	-	-	-	-	-	M	M	-	M	-	-	M	H	H
CO3	L3	M	M	M	L	L	-	-	M	M	-	M	-	-	L	M	M
CO4	L5	M	M	H	M	L	-	M	M	M	-	M	-	H	M	M	H
CO5	L4	M	M	H	M	L	M	M	M	M	L	M	-	H	M	M	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC503D: Chemistry of Main Group Elements, Theories of Acids and Bases
Course Objective:

- To understand the basics of acids & bases and their inter relations.
- To get the knowledge about general principles of metallurgy.
- To impart the comprehension of s- and p-block elements.
- To explain different compounds and their applications in industrial and environmental chemistry, hydrides of groups 13 to 17, interhalogen and pseudohalides compounds.
- To give the basic knowledge of noble gases and inorganic polymers.

UNIT	CONTENTS	CONTACT HOURS
I	**Acids and Bases:** Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.	10
II	**General Principles of Metallurgy:** Chief modes of occurrence of metals based on standard electrode potentials, Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agents. Hydrometallurgy with reference to cyanide process for gold and silver. Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn, Au): electrolytic refining, zone refining, van Arkel-de Boer process, Parting Process, Mond's process and Kroll Process.	10
III	***s*- and *p*-Block Elements:** Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electron gain enthalpy, electronegativity (Pauling scale). General characteristics of *s*-block metals like density, melting and boiling points, flame colour and reducing nature. Oxidation states of *s*- and *p*-block elements, inert-pair effect, diagonal relationships and anomalous behaviour of first member of each group. Allotropy in C, P and S. Complex forming tendency of *s* block elements and a preliminary idea of crown ethers and cryptates, structures of basic beryllium acetate, salicylaldehyde/ acetylacetonato complexes of Group 1 metals. Solutions of alkali metals in liquid ammonia and their properties. Common features, such as ease of formation, solubility and stability of oxides, peroxides, superoxides, sulphates and carbonates of *s*-block metals.	15
IV	Structure, bonding and properties (acidic/ basic nature, oxidizing/ reducing nature and hydrolysis of the following compounds and their applications in industrial and environmental chemistry wherever	12

	applicable: Diborane and concept of multicentre bonding, hydrides of Groups 13 (EH_3), 14, 15, 16 and 17. Oxides of N and P, Oxoacids of P, S and Cl. Halides and oxohalides of P and S (PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2) Interhalogen compounds. A brief idea of pseudohalides.	
V	**Noble gases:** Rationalization of inertness of noble gases, clathrates, preparation and properties of XeF_2, XeF_4 and XeF_6 ,bonding in these compounds using VBT and shapes of noble gas compounds using VSEPR Theory . **Inorganic Polymers:** Types of inorganic polymers and comparison with organic polymers, structural features, classification and important applications of silicates. Synthesis, structural features and applications of silicones. Borazines and cyclophosphazenes – preparation, properties and reactions. Bonding in $(NPCl_2)_3$.	13
	TOTAL	60

Reference Books:

1 Lee, J. D. *Concise Inorganic Chemistry* ELBS, 1991.

2 Cotton, F. A., Wilkinson, G. & Gaus, P. L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.

3 Douglas, B. E., McDaniel, D. H. & Alexander, J. J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.

4 Greenwood, N. N. & Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.

5 Rodger, G. E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.

6 Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* 4th Ed., Pearson, 2010.

7 Atkin, P. *Shriver & Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).

Course Outcomes:

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

CO1:	Understand the basics of acids & bases and their inter relations.
CO2:	Explain about general principles of metallurgy.
CO3:	Know the importance of s- and p-block elements.
CO4:	Analyse properties and applications of hydrides of groups 13 to 17, interhalogen and pseudohalides compounds in industrial and environmental chemistry.
CO5:	Get the basic knowledge of noble gases and inorganic polymers.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	M	H	L	L	-	L	H	-	-	H	-	L	M	M	M
CO2	L3	L	L	L	L	L	-	L	L	-	-	L	-	L	M	M	M
CO3	L2	M	M	H	-	-	-	L	M	M	-	M	-	-	M	H	H
CO4	L4	M	M	H	L	L	-	L	M	-	-	M	L	M	H	H	H
CO5	L2	L	L	L	-	-	-	L	L	-	-	L	-	-	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC504A: DIGITAL, ANALOG AND INSTRUMENTATION

Course Objective:

- This paper aims to cover the basic digital and analog electronic systems.
- The concept of Boolean algebra is discussed in detail and arithmetic circuits are described.
- Students will learn the physics of semiconductor devices such as p-n junction, rectifier diodes and bipolar junction transistors.
- To review the concepts of instrumentation theory.

UNIT	CONTENTS	CONTACT HOURS
I	**Digital Circuits:** Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates.	04
	De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Minterms and Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.	05
	Binary Addition. Binary Subtraction using 2's Complement Method).Half Adders and Full Adders and Subtractors, 4-bit binary Adder-Subtractor.	04
II	**Semiconductor Devices and Amplifiers:** Semiconductor Diodes: p and n type semiconductors. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode. PN junction and its characteristics. Static and Dynamic Resistance. Principle and structure of (1) LEDs (2) Photodiode (3) Solar Cell.	05
	Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Active, Cutoff, and Saturation Regions. Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line and Qpoint. Voltage Divider Bias Circuit for CE Amplifier. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Class A, B, and C Amplifiers.	12
	Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop& Closed-loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and Non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4)	13

III	Differentiator, (5) Integrator, (6) Zero Crossing Detector.	
	Sinusoidal Oscillators: Barkhausen's Criterion for Self-sustained Oscillations. Determination of Frequency of RC Oscillator	05
IV	**Instrumentations:** Introduction to CRO: Block Diagram of CRO. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.	03
V	**Power Supply**: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency, Basic idea about capacitor filter, Zener Diode and Voltage Regulation	06
	Timer IC: IC 555 Pin diagram and its application as Astable & Monostable, Multivibrator	03
	TOTAL	**60**

Reference Books:

1 J. Millman and C. C. Halkias "Integrated Electronics" Tata Mc-Graw Hill. 1991

2 S. Salivahanan and N. Suresh Kumar, "Electronic devices and circuits," Tata Mc-Graw Hill. 2012

3 M. H. Rashid, "Microelectronic Circuits," 2nd Edn. Cengage Learning. 2011

4 Helfrick & Cooper, "Modern Electronic Instrumentation & Measurement Tech.," PHI Learning 1990

5 A.P. Malvino, D.P. Leach & Saha, "Digital Principles & Applications," 7th Ed., Tata McGraw Hill 2011

6 A.S. Sedra, K. C. Smith, A. N. Chandorkar, "Microelectronic circuits," 6th Edn., Oxford University Press. 2014

7 A. Anand Kumar, "Fundamentals of Digital Circuits," 2nd Edition, PHI Learning Pvt. Ltd. 2009

8 R. A. Gayakwad, "OP-AMP and Linear Digital Circuits," PHI Learning Pvt. Ltd. 2000

Course outcomes:

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

CO1	Knowledge of analog and digital circuits, Number systems, their inter-conversions, Basic logic gates and combinational circuits.
CO2	Knowledge of P and N type semiconductors, P-N junctions, LEDs, photodiode and solar cells, transistors.
CO3	Use the principles of digital electronics to explain the Physics of daily life.
CO4	Understand the working of digital and analog instruments like CRO.
CO5	Recognize and use Operational amplifiers and its characterization.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L3	H	H	H	L	L	-	M	L	L	L	L	M	L	L	H	L
CO2	L2	M	L	H	-	L	M	-	-	M	-	M	M	L	M	M	M
CO3	L3	L	M	H	L	M	M	-	L	H	L	L	M	H	M	L	M
CO4	L2	M	-	H	-	L	M	-	-	M	M	M	M	L	M	L	H
CO5	L4	-	L	M	L	L	M	L	L	L	L	L	M	H	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC504B: ELEMENTS OF MODERN PHYSICS

Course Objective:

- The objective of this course is to teach the physical and mathematical foundations necessary for learning various topics in modern physics which are crucial for understanding atoms, molecules, photons, nuclei and elementary particles.
- These concepts are also important to understand phenomena in laser physics, condensed matter physics and astrophysics.
- To review the concepts of modern physics.

UNIT	CONTENTS	CONTACT HOURS
I	Planck's quantum, Planck's constant and light as a collection of photons; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment.	08
II	Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra.	04
	Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.	04
III	Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation fornon-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wave function, probabilities and normalization; Probability and probability current densities in one dimension.	11
IV	One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier.	12
	Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy.	06
V	Radioactivity: stability of nucleus; Law of radioactive decay; Mean life and half-life; α decay; β decay - energy released, spectrum and Pauli's prediction of neutrino; γ-ray emission.	11
	Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions.	04
	TOTAL	**60**

Reference Books:

1	Arthur Beiser, "Concepts of Modern Physics, McGraw-Hill	2009
2	John R. Taylor, Chris D. Zafiratos, Michael A. Dubson, "Modern Physics," PHI Learning	2009
3	Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, Mc Graw Hill.	2003
4	E.H. Wichman, "Quantum Physics," Berkeley Physics Course Vol.4. Tata McGraw-Hill Co.	2008
5	R. A. Serway, C. J. Moses, and C. A. Moyer, "Modern Physics," Cengage Learning	2005
6	G. Kaur and G. R. Pickrell, "Modern Physics," McGraw Hill	2014

Course outcomes:

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

CO1	Know main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics.
CO2	Understanding the properties of nuclei, nuclear forces and structure of atomic nucleus.
CO3	Understand fission and fusion to produce nuclear energy in nuclear reactor and stellar energy in stars.
CO4	Understand various interactions of electromagnetic radiation with matter.
CO5	Understand the Radioactivity.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	-	L	L	L	L	M	L	L	L	L	M	H	L	M	M
CO2	L2	M	L	H	L	L	M	M	L	M	M	-	M	L	M	M	L
CO3	L2	-	L	-	H	M	L	M	-	-	L	M	M	L	H	L	H
CO4	L2	M	M	H	M	L	M	L	M	M	L	L	M	L	M	L	M
CO5	L2	M	L	M	L	L	M	L	L	L	M	M	L	H	L	H	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC504C: MATHEMATICAL PHYSICS

Course Objective:

- The emphasis of course is to equip students with the mathematical tools required in solving problem of interest to physicists.
- The course will expose students to fundamental computational physics skills and hence enable them to solve a wide range of physics problems.
- To review the concepts of mathematical physics.

UNIT	CONTENTS	CONTACT HOURS
I	**Calculus of functions of more than one variable**: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.	06
II	**Fourier Series**: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series.	10
III	**Frobenius Method and Special Functions**: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Orthogonality. Simple recurrence relations.	16
IV	**Some Special Integrals:** Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).	04
	Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry.	10
V	**Complex Analysis**: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula.	14
	TOTAL	**60**

Reference Books:

1	Mathematical Methods for Physicists: Arfken, Weber, Harris, Elsevier.	2005
2	Fourier Analysis by M.R. Spiegel, Tata McGraw-Hill.	2004
3	Mathematics for Physicists, Susan M. Lea, Thomson Brooks/Cole.	2004
4	An Introduction to Ordinary Differential Equations, Earl A Coddington, PHI Learning.	1961
5	Differential Equations, George F. Simmons, Tata McGraw-Hill.	2006
6	Essential Mathematical Methods, K.F. Riley and M.P. Hobson, Cambridge University Press.	2011
7	Partial Differential Equations for Scientists and Engineers, S.J. Farlow, Dover Publications.	1993
8	Mathematical methods for Scientists and Engineers, D.A. McQuarrie, Viva Books.	2003

Course outcomes:

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

CO1	Knowledge of calculus, vectors, vector calculus.
CO2:	Learn the Fourier analysis of periodic functions and their applications in physical problems.
CO3:	Learn the beta, gamma and the error functions and their applications in doing integrations.
CO4:	Know about the basic theory of errors, their analysis, and estimation.
CO5:	Acquire knowledge of methods to solve partial differential equations.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	-	H	H	L	L	L	-	L	1	M	M	-	M	H	M	M
CO2	L2	M	L	-	M	M	L	M	M	M	L	L	H	M	M	L	M
CO3	L2	L	-	M	L	L	-	L	L	H	-	L	M	M	L	L	M
CO4	L2	M	L	H	H	-	L	M	M	M	L	M	M	M	M	L	H
CO5	L3	L	L	M	L	M	L	L	L	L	M	M	L	H	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC504D: SOLID STATE PHYSICS

Course Objective:

- This course introduces the basic concepts and principles required to understand the various properties exhibited by condensed matter, especially solids.
- It enables the students to appreciate how the interesting and wonderful properties exhibited by matter depend upon its atomic and molecular constituents.
- The gained knowledge helps to solve problems in solid state physics using relevant mathematical tools.
- It also communicates the importance of solid state physics in modern society.

UNIT	CONTENTS	CONTACT HOURS
I	**Crystal Structure:** Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.	12
II	**Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T3 law	10
III	**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.	12
IV	**Dielectric Properties of Materials:** Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons.	10
V	**Elementary band theory:** Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient.	10
	Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect.	06
	TOTAL	60

Reference Books:

1	Introduction to Solid State Physics, Charles Kittel, 8th Ed., Wiley India Pvt. Ltd.	2004
2	Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., Prentice-Hall of India	2006
3	Introduction to Solids, Leonid V. Azaroff, Tata Mc-Graw Hill	2004
4	Solid State Physics, Neil W. Ashcroft and N. David Mermin, Cengage Learning	1976
5	Solid State Physics, Rita John, McGraw Hill	2014
6	Solid-state Physics, H. Ibach and H Luth, Springer	2009
7	Elementary Solid State Physics, 1/e M. Ali Omar, Pearson India	1999
8	Solid State Physics, M.A. Wahab, Narosa Publications	2011

Course outcomes:

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

COs	Statements
CO1:	Understand about crystalline and amorphous substances.
CO2:	Knowledge of lattice vibrations, phonons and theory of specific heat of solids.
CO3:	Knowledge of different types of magnetism and hysteresis loops and energy loss.
CO4:	Understanding the band theory of solids and must be able to differentiate insulators, conductors and semiconductors.
CO5:	Understand the Idea about superconductors and their classifications.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom's Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	-	M	L	L	M	L	M	L	L	L	M	M	M	L	M	H
CO2	L2	M	H	M	H	-	M	L	M	M	L	-	H	-	M	L	M
CO3	L2	H	L	M	M	M	M	-	1	H	M	M	L	M	L	H	M
CO4	L2	M	H	-	L	L	H	H	M	M	M	L	M	M	M	L	H
CO5	L2	H	M	L	L	M	L	L	L	L	L	H	L	H	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC505A: ANALYTICAL METHODS IN CHEMISTRY LAB

Course Objective:

- To get the skills of Chromatography which is a Separation Techniques
- To get the skills of Solvent Extractions
- To understand the different parameters of soil analysis.
- To impart the knowledge of spectrophotometry in different experiments.

S.No	Experiments
1	**I. Separation Techniques** Chromatography: (a) Separation of mixtures (i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}. (ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.
2	(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.
3	(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC
4	**II. Solvent Extractions:** (i) To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMG complex in chloroform, and determine its concentration by spectrophotometry.
5	(ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.
6	Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
7	Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
8	Analysis of soil: (i) Determination of pH of soil. (ii) Total soluble salt (iii) Estimation of calcium, magnesium, phosphate, nitrate
9	Ion exchange: (i) Determination of exchange capacity of cation exchange resins and anion exchange resins.
10	(ii) Separation of metal ions from their binary mixture.
11	(iii) Separation of amino acids from organic acids by ion exchange chromatography.
12	**III Spectrophotometr**y Determination of pKa values of indicator using spectrophotometry.
13	Structural characterization of compounds by infrared spectroscopy.
14	Determination of dissolved oxygen in water.
15	Determination of chemical oxygen demand (COD).
16	Determination of Biological oxygen demand (BOD).
17	Determine the composition of the ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Reference Books:

1 Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons, 1989.

2 Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

3 Christian, G.D; *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.

4 Harris, D. C. *Exploring Chemical Analysis*, Ed. New York, W.H. Freeman, 2001.

5 Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher, 2009.

6 Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.

7 Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

8 Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand, 1974.

Course Outcomes:

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

CO1	Get the skills of Separation Techniquesby Chromatography.
CO2	Get the skills of Solvent Extractions
CO3	Understand the different parameters of soil analysis.
CO4	Impart the knowledge of spectrophotometry in different experiments.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L5	H	H	M	M	M	L	L	H	-	-	H	-	M	H	H	H
CO2	L5	M	M	M	L	L	L	L	M	-	-	M	-	M	H	M	H
CO3	L3	H	H	M	M	M	L	L	H	-	-	H	-	M	M	H	H
CO4	L5	H	M	M	M	M	M	L	H	-	-	H	-	H	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC505B: NOVEL INORGANIC SOLIDS LAB

Course Objective:

- To determine cation exchange method and total difference of solids.
- To synthesis of hydrogel and synthesis of silver and gold metal nanoparticles.

S. No.	Experiments
1	Determination of cation exchange method.
2	Determination of total difference of solids.
3	Synthesis of hydrogel by co-precipitation method.
4	Synthesis of silver and gold metal nanoparticles.

Reference Books:

1 Fahlman, B.D. *Materials Chemistry,* Springer, 2004.

Course Outcomes:

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

CO1	Understand and analyze cation exchange method and total difference of solids.
CO2	Synthesis of hydrogel and understand the process of silver and gold metal nanoparticles synthesis.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L4	H	H	H	-	-	-	L	H	-	-	H	-	L	H	H	H
CO2	L5	H	H	H	M	M	-	L	H	-	-	H	-	M	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC505C: ORGANOMETALLICS BIOINORGANIC CHEMISTRY POLYNUCLEAR HYDROCARBONS AND UV IR SPECTROSCOPY LAB

Course Objective:

- To understand the separation of mixtures by chromatography and measure the R_f value.
- To know the preparation of complexes and measurement of their conductivity.
- To understand the systematic qualitative organic analysis of organic compounds and preparation of their derivative.

S. No.	Experiments
1	***Section A: Inorganic Chemistry*** 1. Separation of mixtures by chromatography: Measure the R_f value in each case. (Combination of two ions to be given) Paper chromatographic separation of Fe^{3+}, $A1^{3+}$ and Cr^{3+} or Paper chromatographic separation of Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+}
2	2. Preparation of any two of the following complexes and measurement of their conductivity: (i) tetraamminecarbonatocobalt (III) nitrate (ii) tetraamminecopper (II) sulphate (iii) potassium trioxalatoferrate (III) trihydrate Compare the conductance of the complexes with that of M/1000 solution of NaCl, $MgCl_2$ and $LiCl_3$.
3	***Section B: Organic Chemistry*** Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

Reference Books:

1 A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.

2 A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.

3 Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.

4 Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

Course Outcomes:

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

CO1	Utilize chromatography techniques for the separation of mixtures and measure the R_f value.
CO2	Prepare metal complexes and measure their conductivity.
CO3	Interpret the systematic qualitative organic analysis of organic compounds and preparation of their derivative.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L4	M	M	M	M	M	-	L	M	-	-	M	-	M	H	H	H
CO2	L3	M	M	M	M	L	-	L	M	-	-	M	-	L	M	M	H
CO3	L5	M	M	M	M	M	-	L	M	-	-	M	-	M	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC505D: CHEMISTRY OF MAIN GROUP ELEMENTS, THEORIES OF ACIDS AND BASES LAB.

Course Objective:

- To quantitative estimation of some chemical species.
- To acquire the skills of preparation of double salt and complex.

S. No.	Experiments
1	Iodometric estimation of potassium dichromate and copper sulphate
2	Iodimetric estimation of antimony in tartaremetic
3	Estimation of amount of available chlorine in bleaching powder and household bleaches
4	Estimation of iodine in iodized salts.
5	Iodimetric estimation of ascorbic acid in fruit juices.
6	Estimation of dissolved oxygen in water samples.
7	Gravimetric estimation of sulphate as barium sulphate.
8	Gravimetric estimation of aluminium as oximato complex
9	Preparation of the following: potash alum, chrome alum, tetraamminecopper(II) sulphate monohydrate, potassium trioxalatoferrate(III) (any two, including one double salt and one complex).

Reference Books:

1 Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.

2 Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.

Course Outcomes:

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

CO1	Estimate of some chemical species.
CO2	Acquire the skills of preparation of double salt and complex.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L5	M	L	L	L	L	-	L	M	-	-	M	-	L	H	H	H
CO2	L5	M	M	M	L	L	-	L	M	-	-	M	-	L	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC506A: DIGITAL, ANALOG AND INSTRUMENTATIONLAB

Course Objective:

- This paper aims to cover the basic digital and analog electronic systems.
- The concept of Boolean algebra is discussed expermentally and arithmetic circuits are described.
- Students will learn the physics of semiconductor devices such as p-n junction, rectifier diodes and bipolar junction transistors.
- To review the concepts of instrumentation theory.

S. No.	Experiment
1	To measure (a) Voltage, and (b) Frequency of a periodic waveform using a CRO
2	To verify and design AND, OR, NOT and XOR gates using NAND gates.
3	To minimize a given logic circuit.
4	Half adder, Full adder and 4-bit Binary Adder. 19
5	Adder-Subtractor using Full Adder I.C.
6	To design an astable multivibrator of given specifications using 555 Timer.
7	To design a monostable multivibrator of given specifications using 555 Timer.
8	To study IV characteristics of PN diode, Zener and Light emitting diode
9	To study the characteristics of a Transistor in CE configuration.
10	To design a CE amplifier of a given gain (mid-gain) using voltage divider bias.
11	To design an inverting amplifier of given gain using Op-amp 741 and study its frequency response.
12	To design a non-inverting amplifier of given gain using Op-amp 741 and study its Frequency Response.
13	To study a precision Differential Amplifier of given I/O specification using Opamp.
14	To investigate the use of an op-amp as a Differentiator
15	To design a Wien Bridge Oscillator using an op-amp.

Reference Books:

1 P.B. Zbar, A.P. Malvino, M.A. Miller, "Basic Electronics: A text lab manual," Mc-Graw Hill. 1994

2 J.D. Ryder, "Electronics: Fundamentals and Applications," Prentice Hall. 2004

3 OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, Prentice Hall. 2000

4 Albert Malvino, "Electronic Principle," Tata Mc-Graw Hill. 2008

Course outcomes:

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

COs	Statements
CO1	Understand the difference between analog and digital circuits.
CO2	Know the working of P-N junction, Forward and Reverse biased junctions, LEDs, photodiode and solar cells.
CO3	Use the principles of digital electronics to explain the Physics of daily life.
CO4	Understand the working of digital and analog instruments like CRO.
CO5	Student will gain hands-on experience of using various digital and analog instruments.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L3	L	L	H	L	H	M	H	M	M	-	H	M	H	M	L	L
CO2	L2	H	-	H	L	L	L	M	-	M	L	L	L	L	M	M	H
CO3	L3	L	L	M	M	M	L	H	L	L	M	H	L	L	H	L	L
CO4	L2	M	L	-	L	L	H	L	M	L	M	L	H	L	M	L	M
CO5	L4	-	H	H	L	H	L	H	M	-	H	H	H	M	L	L	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC506B: ELEMENTS OF MODERN PHYSICSLAB

Course Objective:

- The objective of this course is to understanding atoms, molecules, photons, nuclei and elementary particles.
- These concepts are also important to understand phenomena in laser physics, condensed matter physics and astrophysics.
- To review the concepts of modern physics.

S. No.	Experiment
1	To determine value of Boltzmann constant using V-I characteristic of PN diode.
2	To determine work function of material of filament of directly heated vacuum diode.
3	To determine value of Planck's constant using LEDs of at least 4 different colours.
4	To determine the ionization potential of mercury.
5	To determine the wavelength of H-alpha emission line of Hydrogen atom.
6	To determine the absorption lines in the rotational spectrum of Iodine vapour.
7	To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photosensor and compare with incoherent source – Na light.
8	Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
9	To determine the value of e/m by magnetic focusing.
10	To setup the Millikan oil drop apparatus and determine the charge of an electron.

Reference Books:

1 B. L. Flint and H. T. Worsnop "Advanced Practical Physics for students", 1971 Asia

2 Michael Nelson and Jon M. Ogborn "Advanced level Physics Practicals" 1985 4th

3 S.Panigrahi & B. Mallick "Engineering Practical Physics" Cengage 2015 Learning India Pvt. Ltd

4 InduPrakash and Ramakrishna "A Text Book of Practical Physics" 11th 2011 Edition, KitabMahal, New Delhi.

Course outcomes:

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

COs	Statements
CO1	Know main aspects of dual nature of matter.
CO2	Understanding the properties of nuclei, nuclear forces and structure of atomic nucleus.
CO3	Understand fission and fusion to produce nuclear energy in nuclear reactor and stellar energy in stars.
CO4	Understand the spontaneous and stimulated emission of radiation, optical pumping and population inversion.
CO5	Student will gain hands-on experience of using various phenomena.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	L	-	L	H	M	-	M	M	-	H	M	H	L	L	L
CO2	L2	-	H	L	L	L	L	L	M	M	L	L	L	L	L	H	L
CO3	L2	L	L	M	M	M	L	H	L	L	L	H	L	L	M	L	M
CO4	L2	M	L	H	L	L	-	L	M	L	M	L	H	M	H	L	M
CO5	L4	L	-	H	L	H	L	H	M	-	H	H	H	M	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC506C: MATHEMATICAL PHYSICSLAB

Course Objective:

- The emphasis of course is to equip students with the mathematical tools required in solving problem of interest to physicists.
- The course will expose students to fundamental computational physics skills and hence enable them to solve a wide range of physics problems.
- To review the concepts of mathematical physics.

S. No.	Experiment
1	Introduction and Overview: Computer architecture and organization, memory and Input/output devices.
2	Basics of scientific computing: Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & over flow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods
3	Errors and error Analysis: Truncation and round off errors, Absolute and relative errors, Floating point computations.
4	Review of C & C++ Programming fundamentals: Introduction to Programming, constant variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While-Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops), Arrays (1D&2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects.
5	Programs: using C/C++ language: Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending-descending order, Binary search
6	Random number generation: Area of circle, area of square, volume of sphere, value of pi **($\boldsymbol{\pi}$)**
7	Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods: Solution of linear and quadratic equation, solving $\alpha = tan\alpha; I = I_0 \left(\frac{sin\alpha}{\alpha}\right)^2$ in optics.
8	Interpolation by Newton Gregory Forward and Backward difference formula, Error, estimation of linear interpolation: Evaluation of trigonometric functions e.g.sin θ, cos θ, tanθ, etc.
9	Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method: Given Position with equidistant time data to calculate velocity and acceleration and vice-versa. Find the area of B-H Hysteresis loop

10	Solution of Ordinary Differential Equations (ODE), First order Differential equation Euler, modified Euler and Runge-Kutta (RK), second and fourth order methods: First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Attempt following problems using RK 4 order method: • Solve the coupled differential equations $\frac{dx}{dt} = y + x - \frac{x^3}{3}$; $\frac{dy}{dx} = -x$ for four initial conditions $x(0) = 0$; $y(0) = -1, -2, -3, -4$ plot x vs y for each of the four initial conditions on the same screen for 0≤ t ≤ 15. The differential equation describing the motion of a pendulum is $\frac{d^2\theta}{dt^2} = -sin(\theta)$. The pendulum is released from rest at an angular displacement α, i.e.$\theta(0) = \alpha$ and$\theta'(0) = 0$. Solve the equation for $\alpha = 0.1, 0.5$ and 1.0 and plot θas a function of time in the range $0 \leq t \leq 8\pi$. Also plot the analytic solution valid for small $\theta, \sin(\theta) = \theta$.

Reference Books:

1	Introduction to Numerical Analysis, S. S. Sastry, 5thEdn., PHI Learning Pvt. Ltd.	2012
2	Schaum's Outline of Programming with C++. J. Hubbard, McGraw-Hill Publications.	2000
3	Numerical Recipes in C++: The Art of Scientific Computing, W.H. Pressetal., 3rdEdn., Cambridge University Press.	2007
4	A first course in Numerical Methods, Uri M. Ascher and Chen Greif, PHI Learning	2012
5	Elementary Numerical Analysis, K.E. Atkinson, 3rdEdn. , Wiley India Edition.	2007
6	Numerical Methods for Scientists and Engineers, R.W. Hamming, Courier Dover Pub.	1973
7	An Introduction to Computational Physics, T. Pang, 2ndEdn., Cambridge Univ. Press	2006

Course outcomes:

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

COs	Statements
CO1	Knowledge of calculus, vectors, vector calculus.
CO2	Learn the Fourier analysis of periodic functions and their applications in physical problems.
CO3	Learn the beta, gamma and the error functions and their applications in doing integrations.
CO4	Know about the basic theory of errors, their analysis, and estimation with examples of simple experiments in Physics.
CO5	Learn the fundamentals of the C and C^{++} programming languages and their applications.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L4	H	L	H	M	-	M	H	M	M	H	L	M	H	L	M	L
CO2	L3	-	H	L	L	L	L	L	M	M	L	L	L	L	H	L	M
CO3	L2	L	L	M	H	M	L	H	L	-	L	H	L	L	L	L	M
CO4	L2	M	L	-	L	L	H	L	M	L	M	L	H	M	M	L	H
CO5	L3	L	-	H-	L	H	L	H	M	H	H	H	H	M	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC506D: SOLID STATE PHYSICSLAB

Course Objective:

- This course introduces the basic concepts and principles required to understand the various properties exhibited by condensed matter, especially solids.
- To understand the concept of Magnetic susceptibility.
- To study the BH curve.
- The gained knowledge helps to solve problems in solid state physics using relevant mathematical tools.
- It also communicates the importance of solid state physics in modern society.

S. No.	Experiment
1	Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2	To measure the Magnetic susceptibility of Solids.
3	To determine the Coupling Coefficient of a Piezoelectric crystal.
4	To measure the Dielectric Constant of a dielectric Materials with frequency
5	To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6	To determine the refractive index of a dielectric layer using SPR
7	To study the PE Hysteresis loop of a Ferroelectric Crystal.
8	To draw the BH curve of iron using a Solenoid and determine the energy loss from Hysteresis.
9	To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (from room temperature to 150 ^{o}C) and to determine its band gap.
10	To determine the Hall coefficient of a semiconductor sample.

Reference Books:

1 B. L. Flint and H. T. Worsnop "Advanced Practical Physics for students", AsiaPublishing House 1971

2 Michael Nelson and Jon M. Ogborn "Advanced level Physics Practicals" 4th Edition, reprinted, Heinemann Educational Publishers 1985

3 S. Panigrahi & B. Mallick "Engineering Practical Physics" Cengage Learning 2015

4 Indu Prakash and Ramakrishna "A Text Book of Practical Physics" 11th Edition, Kitab Mahal, New Delhi. 2011

Course outcomes:

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

COs	Statements
CO1:	Know about crystalline and amorphous substances.
CO2:	Knowledge of lattice vibrations, phonons of solids.
CO3:	Knowledge of different types of magnetism and hysteresis loops and energy loss.
CO4:	Understand the basic idea about superconductors and their classifications.
CO5:	To carry out experiments based on the theory that they have learned.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	-	L	-	M	M	M	H	M	M	H	L	M	H	M	L	L
CO2	L2	M	H	L	L	L	L	L	M	-	L	L	L	L	H	M	M
CO3	L2	L	L	M	-	M	L	H	L	H	L	H	L	H	M	L	L
CO4	L2	M	L	-	L	L	M	L	M	L	M	L	H	M	M	M	M
CO5	L4	L	H	H	L	H	L	H	M	-	H	H	H	M	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

SIXTH SEMESTER

THEORY PAPERS		No. of Teaching Hours			Marks Allocation			
Code	**Subject/Paper**	**L**	**T**	**P**	**IA**	**EA**	**Total**	**Credits**
BSC601	**SEC-4 (Choose any one)**	3	-	-	30	70	100	3
BSC601A	Transportation and Game Theory							
BSC601B	Graph Theory							
BSC601C	Applied optics							
BSC601D	Basic instrumentation skills							
BSC601E	Chemical Technology & Society							
BSC601F	Fuel Chemistry							
BSC602	DSE-1B **(Choose any one)**	6	-	-	30	70	100	6
BSC602A	Numerical Methods							
BSC602B	Complex Analysis							
BSC602C	Linear Programming)							
BSC603	DSE-2B **(Choose any one)**	5	-	-	30	70	100	5
BSC603A	Polymer Chemistry							
BSC603B	Green Chemistry							
BSC603C	Instrumental Methods of Analysis							
BSC603D	Quantum Chemistry, Spectroscopy & Photochemistry							
BSC604	DSE-3B **(Choose any one)**	5	2*	-	30	70	100	5 (+2*)
BSC604A	Quantum Mechanics							
BSC604B	Embedded System: Introduction to microcontroller							
BSC604C	Nuclear and Particle Physics (Theory + Tutorials 2*)							

BSC604D	Medical Physics							
PRACTICALS/VIVA-VOCE		**No. of Teaching Hours**			**Sessional**	**Practical**	**Total**	**Credits**
BSC605	DSE-2B **(Choose any one)**	-	-	4	30	20	50	2
BSC605A	Polymer Chemistry Lab							
BSC605B	Green Chemistry Lab							
BSC605C	Instrumental Methods of Analysis Lab							
BSC605D	Quantum Chemistry, Spectroscopy & Photochemistry Lab							
BSC606	DSE-3B **(Choose any one)**	-	-	4	30	20	50	2
BSC606A	Quantum Mechanics Lab							
BSC606B	Embedded System: Introduction to microcontroller Lab							
BSC606C	Nuclear and Particle Physics Lab							
BSC606D	Medical Physics Lab							
TOTAL		**19**	**-**	**8**	**180**	**320**	**500**	**23**

BSC601A: TRANSPORTATION AND GAME THEORY

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Transportation problem, algorithm for solving transportation problem, assignment problem, Job Sequencing Problems, and Game theory.

UNIT	CONTENTS	CONTACT HOURS
I	Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution,	9
II	algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.	7
III	Job Sequencing Problems	4
IV	Game theory: formulation of two person zero sum games, solving two person zero sum games,	5
V	Games with mixed strategies, graphical solution procedure. Solution by Simplex Method.	6
	TOTAL	30

Reference Books:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.

2. F. S. Hillier and G. J. Lieberman, *Introduction to Operations Research,* 9th Ed., Tata McGraw Hill, Singapore, 2009.

3. Hamdy A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice-Hall India, 2006.

Course Outcomes:

This course will enable the students to:

COs	Statements
CO1:	Formulate the transportation problems and to solve them.
CO2:	Learn about the job sequencing problem and its applications.
CO3:	Learn about the Assignment problems and its applications.
CO4:	Provide knowledge of Game Theoryand its applications.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L3	H	H	H	-	H	H	H	H	H	H	H	M	H	H	M	M
CO2	L4	H	H	H	-	H	H	H	H	H	H	M	M	H	H	H	H

CO3	L4	H	H	H	-	H	H	H	H	H	H	H	M	H	H	H	M
CO4	L4	H	H	H	-	H	H	H	H	H	H	M	M	H	H	M	H

M**H- High, M- Moderate, L- Low, '-' for No correlation**

BSC601B: GRAPH THEORY

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Graph Theory and its applications.

UNIT	CONTENTS	CONTACT HOURS
I	Definition, examples and basic properties of graphs, seudographs, complete graphs, bi-partite graphs,	**9**
II	isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles,	**4**
III	the adjacency matrix, weighted graph,	**3**
IV	travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.	**8**
V	Trees. Spanning trees.	**6**
	TOTAL	**30**

Reference Books:

1. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2003.

2. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

Course Outcomes: This course will enable the students to:

CO1:	Appreciate the definition and basics of graphs along with types and their examples.
CO2:	Understand the definition of a tree and learn its applications to fundamental circuits.
CO3:	Know the applications of graph theory to network flows.
CO4:	Understand the notion of planarity and coloring of a graph.
CO5:	Relate the graph theory to the real-world problems.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO 3
CO1	L2	H	H	-	H	-	H	H	H	L	H	M	H	H	H	M	L
CO2	L2	H	H	-	H	-	H	H	H	M	H	H	M	H	H	M	L
CO3	L3	H	H	-	H	-	H	H	H	1	H	L	L	H	H	M	L
LCO4	L2	H	H	-	H	-	H	H	H	M	H	M	M	H	M	M	M
CO5	L4	H	H	-	H	-	H	H	H	H	H	H	H	H	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC601C: APPLIED OPTICS

Course Objective:

- This paper provides the conceptual understanding of various branches of modern optics to the students.
- This course introduces basic principles of LASER, Holography and signal transmission via optical fiber.
- To review the concepts of optics and their applications.

UNIT	CONTENTS	CONTAT HOURS
I	**Sources and Detectors** Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers. **Experiments on Lasers:** a. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser. b. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser. c. To find the polarization angle of laser light using polarizer and analyzer d. Thermal expansion of quartz using laser **Experiments on Semiconductor Sources and Detectors:** a. V-I characteristics of LED b. Study the characteristics of solid state laser c. Study the characteristics of LDR d. Photovoltaic Cell e. Characteristics of IR sensor	**09**
II	**Fourier Optics** Concept of Spatial frequency filtering, Fourier transforming property of a thin lens **Experiments on Fourier Optics:** **a. Fourier optic and image processing** 1. Optical image addition/subtraction 2. Optical image differentiation 3. Fourier optical filtering 4. Construction of an optical 4f system	**03**

III	**Fourier Transform Spectroscopy** Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science. **Experiment:** To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done.	03
IV	**Holography** Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition **Experiments on Holography and interferometry:** 1. Recording and reconstructing holograms 2. Constructing a Michelson interferometer or a Fabry Perot interferometer 3. Measuring the refractive index of air 4. Constructing a Sagnac interferometer 5. Constructing a Mach-Zehnder interferometer 6. White light Hologram	06
V	**Photonics: Fibre Optics** Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating **Experiments on Photonics: Fibre Optics** a. To measure the numerical aperture of an optical fibre b. To study the variation of the bending loss in a multimode fibre c. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern d. To measure the near field intensity profile of a fibre and study its refractiveindex profile e. To determine the power loss at a splice between two multimode fibre.	09
	TOTAL	**30**

Reference Books:

1	Fundamental of optics, F. A. Jenkins & H. E. White, Tata McGraw hill.	1981
2	LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, Tata McGraw Hill.	2010
3	Fibre optics through experiments, M. R. Shenoy, S. K. Khijwania, et.al. Viva Books.	2009
4	Nonlinear Optics, Robert W. Boyd, (Chapter-I), Elsevier.	2008
5	Optics, Karl Dieter Moller, Learning by computing with model examples, Springer.	2007
6	Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.	2009
7	Optoelectronic Devices and Systems, S.C. Gupta, PHI Learning Pvt. Ltd.	2005
8	Optical Physics, A.Lipson, S.G.Lipson, H. Lipson, 4th Edn., Cambridge Univ. Press.	1996

Course outcomes:

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

CO1	Understand optical phenomena and technology.
CO2	Qualitative understanding of basic lasing mechanism, types of Lasers, and its applications in developing LED, Holography.
CO3	Understand propagation of electromagnetic wave in a nonlinear media.
CO4	Develop cooperative skills and reinforce their understanding of concepts.
CO5	Use the concepts of applied optics in daily life.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	-	L	H	M	M	M	M	L	L	H	M	M	H	L	L	L
CO2	L2	H	H	M	-	H	H	-	M	M	M	M	H	L	M	L	M
CO3	L2	L	M	L	M	L	M	L	M	-	M	L	M	L	M	L	H
CO4	L4	M	H	-	L	M	L	M	-	M	H	H	M	L	L	L	M
CO5	L4	H	M	M	M	L	M	M	L	L	L	M	H	H	H	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC601D: BASIC INSTRUMENTATION SKILLS

Course Objective:

- To expose the students to various aspects of instruments and their usage through hands-on mode.
- To provide them a thorough understanding of basics of measurement, measurement devices such as electronic voltmeter, Oscilloscope, signal and pulse generators, Impedance bridges, digital instruments etc.
- To review the concepts of basic instrumentation skills.

UNIT	CONTENTS	CONTACT HOURS
I	**Basic of Measurement:** Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. **Multimeter:** Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.	**04**
II	**Electronic Voltmeter:** Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/Multimeter and their significance. **AC millivoltmeter:** Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter**,** specifications and their significance	**04**
III	**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. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.	09
IV	**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.	07

V	**Digital Instruments:** Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter. **Digital Multimeter:** Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution. **The test of lab skills will be of the following test items:** 1. Use of an oscilloscope. 2. CRO as a versatile measuring device. 3. Circuit tracing of Laboratory electronic equipment, 4. Use of Digital multimeter/ VTVM for measuring voltages 5. Circuit tracing of Laboratory electronic equipment, 6. Winding a coil / transformer. 7. Study the layout of receiver circuit. 8. Trouble shooting a circuit 9. Balancing of bridges **Laboratory Exercises:** 1. To observe the loading effect of a multimeter while measuring voltage across alow resistance and high resistance. 2. To observe the limitations of a multimeter for measuring high frequency voltageand 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. Measurement of distortion of a RF signal generator using distortion factor meter. 8. Measurement of R, L and C using a LCR bridge/ universal bridge. **Open Ended Experiments:** 1. Using a Dual Trace Oscilloscope 2. Converting the range of a given measuring instrument (voltmeter, ammeter)	06
	TOTAL	**30**

Reference Books:

1	Digital Circuits and systems, Venugopal, Tata McGraw Hill.	2011
2	Logic circuit design, Shimon P. Vingron, Springer.	2012
3	Digital Electronics, SubrataGhoshal, Cengage Learning.	2012
4	Electronic Devices and circuits, S. Salivahanan &N. S.Kumar, 3rd Ed., Tata Mc-Graw Hill	2012
5	Electronic circuits: Handbook of design and applications, U. Tietze, Ch. Schenk Springer	2008
6	Electronic Devices, 7/e Thomas L. Floyd, Pearson India	2008

Course outcomes:

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

CO1:	Develop skills to use basic electrical instruments.
CO2:	Acquire efficiency in making signal generators and analysis of obtained signals.
CO3:	Learn to understand and use various types of digital instruments.
CO4:	Develop knowledge of making measurements with Impedance Bridges and Q meters.
CO5:	Knowledge on accuracy, precision, resolution, range and errors/uncertainty in measurements.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L4	H	-	H	L	M	L	M	L	L	H	M	M	L	L	H	L
CO2	L2	L	H	H	M	L	L	L	H	M	M	H	L	-	M	M	M
CO3	L4	L	-	L	M	-	M	M	H	H	M	L	M	L	M	L	M
CO4	L2	M	H	H	L	M	H	-	M	M	H	H	H	L	M	L	H
CO5	L3	H	M	H	L	M	M	M	M	M	M	M	M	M	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC601E: CHEMICAL TECHNOLOGY & SOCIETY

Course Objective:

- To understand the use of basic principles of chemical technology.
- To introduce the scope of different equipments needed in chemical technology.
- To develop scientific solutions for societal needs.
- To learn about energy from natural sources.
- To acquire the knowledge of proteins and nucleic acids.

UNIT	CONTENTS	CONTACT HOURS
I	**Chemical Technology:** Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid liquid extraction, separation by absorption and adsorption.	5
II	An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.	8
III	**Society:** Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants).	8
IV	Energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues.	4
V	Proteins and nucleic acids, and molecular reactivity and interconversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.	5
	TOTAL	30

Reference Books:

1 John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for changing times*13th Ed.

Course Outcomes:

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

CO1:	Understand the basic principles of chemical technology.
CO2:	Know the scope of different equipments needed in chemical technology.
CO3:	Develop scientific solutions for societal needs.
CO4:	Learn about energy from natural sources.
CO5:	Acquire the knowledge of proteins and nucleic acids.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L2	M	M	-	L	L	-	L	M	-	-	M	-	M	H	M	H
CO2	L2	M	M	M	L	L	M	L	M	M	-	M	-	M	H	M	H
CO3	L4	M	M	-	-	-	-	L	M	M	-	M	H	L	H	M	H
CO4	L2	M	M	-	-	-	-	L	M	M	-	M	-	-	H	M	H
CO5	L2	L	L	-	-	-	-	L	L	M	-	L	-	-	H	M	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC601F: FUEL CHEMISTRY

Course Objective:

- To understand the renewable and non-renewable energy sources and some basics of coal.
- To understand the process of formation of coke from coal.
- To get the knowledge of petroleum and petrochemical Industry.
- To learn the reforming of petroleum and non-petroleum fuels, synthesis of fuel from waste, gaseous and liquids synthetic fuels and petrochemical products:
- To develop the basic knowledge about lubricants.

UNIT	CONTENTS	CONTACT HOURS
I	Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. *Coal:* Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal.Coal gas, producer gas and water gas—composition and uses.	7
II	Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.	6
III	*Petroleum and Petrochemical Industry:* Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking).	6
IV	Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.	7
V	*Lubricants:* Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants.	4
	TOTAL	30

Reference Books:

1. KG Bhattacharya and AK Talukdar. Catalysis in Petroleum and Petrochemical Industries Hardcover, 2005 Published by Narosa Publishing House.
2. RM Mortier, ST Orszulik.Chemistry and Technology of Lubricants.Publishedby Springer Science & Business.
3. Theo Mang. Wilfried DreselLubricants and Lubrication.Publishedby John Wiley & Sons.

4. Balasubramanian Viswanathan. Energy Sources: Fundamentals of Chemical Conversion Processes and Applications. Published by Newnes.
5. Thomas B. Johansson, Henry Kelly, Amulya K. N. Reddy, Laurie Burnham, Robert H. Williams. Renewable Energy: Sources for Fuels and Electricity. Published by Island Press.
6. Gopal Nath Tiwari, Rajeev Kumar Mishra. Advanced Renewable Energy Sources Published by Royal Society of Chemistry.
7. Anne E. Maczulak. Renewable Energy: Sources and Methods. Published by Infobase Publishing.
8. G. Ali Mansoori. Energy: Sources, Utilization, Legislation, Sustainability, Illinois As Model . Published by World Scientific.

Course Outcomes:

By the end of the course, the students will be able to:

CO1	Understand the renewable and non-renewable energy sources and basics of coal.
CO2	Explain the process of formation of coke from coal.
CO3	Get the knowledge of petroleum and petrochemical Industry.
CO4	Learn the reforming of petroleum and non-petroleum fuels, synthesis of fuel from waste, gaseous and liquids synthetic fuels and petrochemical products:
CO5	Illustrate about lubricants.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L2	M	M	M	-	-	-	L	M	L	-	M	-	L	H	M	H
CO2	L5	M	M	M	-	-	-	L	M	-	-	M	-	L	H	M	H
CO3	L2	M	M	M	-	-	-	L	M	L	-	M	-	L	H	M	H
CO4	L4	M	M	M	-	-	-	L	M	-	-	M	-	M	H	M	H
CO5	L2	L	L	-	-	-	-	L	L	-	-	L	-	-	H	M	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC602A: NUMERICAL METHODS

Course Objectives: The objective of this course is to expose student to understand the basic concepts of various numerical methods to find the solutions of algebraic and transcendental equations, Simultaneous equations, Interpolations techniques, Numerical differentiation and integration.

UNIT	CONTENTS	CONTACT HOURS
I	Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method,	12
II	LU decomposition, Gauss- Jacobi, Gauss-Siedel and SOR iterative methods.	10
III	Lagrange and Newton interpolation: linear and higher order, finite difference operators.	13
IV	Numerical differentiation: forward difference, backward difference and central Difference.	15
V	Integration: trapezoidal rule, Simpson's rule, Euler's method.	10
	TOTAL	60

Reference Books:

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

2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific andEngineering Computation*, 5th Ed., New age International Publisher, India, 2007.

Course Outcomes: This course will enable the students to:

CO1	Obtain numerical solutions of algebraic and transcendental equations.
CO2	Find numerical solutions of system of linear equations and check the accuracy of the Solutions.
CO3	Learn about various interpolating and extrapolating methods.
CO4	Solve initial and boundary value problems in differential equations using numerical Methods.
CO5	Apply various numerical methods in real life problems.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOM'S LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L2	H	H	H	H	H	H	H	L	H	H	H	L	H	H	H	L
CO2	L3	H	H	H	H	H	H	H	L	H	H	H	M	H	H	H	L
CO3	L2	H	H	H	H	H	H	H	L	H	H	H	L	H	H	M	L
CO4	L3	H	H	H	H	H	H	H	L	H	H	H	L	H	H	H	L
CO5	L4	H	H	H	H	H	H	H	L	H	H	H	M	H	H	H	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC602B: COMPLEX ANALYSIS

Course Objectives: The objective of this course is to expose student to understand the basic concepts of complex variables, complex functions and their derivatives and integrations, Contour integrals, Convergence of sequences and series.

UNIT	CONTENTS	CONTACT HOURS
I	Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable,	**10**
II	Mappings.Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.	**10**
III	Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions,	**13**
IV	Definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem, Cauchy integral formula.	**10**
V	Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series.	**15**
	TOTAL	**60**

Reference Books:

1. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications,* 8thEd., McGraw – Hill International Edition, 2009.122

2. Joseph Bak and Donald J. Newman, *Complex analysis,* 2nd Ed., UndergraduateTexts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

Course Outcomes: This course will enable the students to:

CO1	Visualize complex numbers as points of ℝ² and stereographic projection of complex plane on the Riemann sphere.
CO2	Understand the significance of differentiability and analyticity of complex functions leading to the Cauchy-Riemann equations.
CO3	Learn the role of Cauchy-Goursat theorem and Cauchy integral formula in evaluation of contour integrals.
CO4	Apply Liouville's theorem in fundamental theorem of algebra.
CO5	Understand the convergence, term by term integration and differentiation of a power series.
CO6	Learn Taylor and Laurent series expansions of analytic functions, classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOM'S LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L2	H	H	H	H	H	-	H	M	H	H	H	L	H	H	M	M
CO2	L2	H	H	H	H	H	-	H	L	H	H	H	L	H	M	H	H
CO3	L3	H	H	H	H	H	-	H	M	H	H	H	M	H	H	H	H
CO4	L3	H	H	H	H	H	-	H	L	H	H	H	L	H	M	H	M
CO5	L3	H	H	H	H	H	-	H	L	H	H	H	L	H	H	M	M
CO6	L4	H	H	H	H	H	-	H	M	H	H	H	M	H	H	H	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC602C: LINEAR PROGRAMMING

Course Objectives: The objective of this course is to expose student to understand the basic concepts of Linear Programming Problems, Theory of simplex method, simplex method to solve LPP, Assignment and Transportation problems.

UNIT	CONTENTS	CONTACT HOURS
I	Linear Programming Problems, Graphical Approach for Solving some Linear Programs.	**13**
II	Convex Sets, Supporting and Separating Hyperplanes. Theory of simplex method, optimality and unboundedness, the simplex algorithm,	**10**
III	simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.	**12**
IV	Duality, formulation of the dual problem, primal- dual relationships, economic interpretation of the dual, sensitivity analysis.	**13**
V	Assignment and Transportation problems	**12**
	TOTAL	**60**

Reference Books:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.

2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research,* 8th Ed., Tata McGraw Hill, Singapore, 2004.

3. Hamdy A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice-Hall India, 2006.

Course Outcomes: This course will enable the students to:

CO1	Analyze and solve linear programming models of real life situations.
CO2	Provide graphical solution of linear programming problems with two variables, and illustrate the concept of convex set and extreme points.
CO3	Solve linear programming problems using simplex method.
CO4	Learn techniques to solve transportation and assignment problems.
CO5	Solve two-person zero sum game problems.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOM'S LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PS O1	PS O2	PS O3
CO1	L3	H	H	H	L	H	H	H	H	H	H	H	L	H	H	H	M
CO2	L2	H	H	H	L	H	H	H	H	H	H	H	M	H	H	H	H
CO3	L2	H	H	H	M	H	H	H	H	H	H	H	L	H	H	M	H
CO4	L4	H	H	H	L	H	H	H	H	H	H	H	L	H	H	M	M
CO5	L4	H	H	H	L	H	H	H	H	H	H	H	M	H	H	M	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC603A: POLYMER CHEMISTRY

Course Objective:

- To know about history of polymeric materials, classification and different mechanisms of polymerization and polymerization techniques.
- To evaluate kinetic chain length of polymers based on their mechanism.
- To understand the crystallization & crystallinity, structure property relationships and different methods of finding out average molecular weight of polymers.
- To understand about glass transition temperature (Tg) and crystalline melting point (Tm) with their determinations.
- To know about solid and solution properties of polymers with properties and applications of various useful polymers in our daily life.

UNIT	CONTENTS	CONTACT HOURS
I	**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. Bi-functional systems, Poly-functional systems.	11
II	**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.	9
III	**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.	12
IV	**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.	14

V	**Properties of Polymer**s (Physical, thermal, flow & mechanical properties). Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].	14
	TOTAL	60

Reference Books:

1 Seymour, R.B. &Carraher, C.E. *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.

2 Odian, G. *Principles of Polymerization*, 4th Ed. Wiley, 2004.

3 Billmeyer, F.W. *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.

4 Ghosh, P. *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.

5 Lenz, R.W. *Organic Chemistry of Synthetic High Polymers.* Interscience Publishers, New York, 1967.

Course Outcomes:

At the end of this course, students will be able to:

CO1:	Understand polymeric materials, classification and different mechanisms of polymerization and polymerization techniques.
CO2:	Learn the kinetics of polymerization.
CO3:	Understand the crystallization process and structure property relationships of polymers.
CO4:	Explain about glass transition temperature (Tg) and crystalline melting point (Tm) with their determinations.
CO5:	Know the importance and properties of polymers which are useful in our daily life.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L2	H	M	L	L	L	-	L	H	-	-	H	-	-	H	H	H
CO2	L2	H	H	H	L	L	-	L	H	-	-	H	-	-	M	M	H
CO3	L4	H	H	H	L	L	-	L	H	-	-	H	-	M	H	H	H
CO4	L2	H	M	L	-	-	-	L	H	-	-	H	-	-	M	M	H
CO5	L2	H	M	L	-	-	-	L	H	-	-	H	-	-	M	M	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC603B: GREEN CHEMISTRY

Course Objective:

- To understand the twelve principles of green chemistry, toxicity, hazard, risk of chemical substances, atom economy and minimization of toxicity.
- To understand benefits of use of catalyst and bio catalyst, green solvents, microwaves and ultrasonic energy.
- To know the ISD, Bhopal Gas Tragedy, and Flixiborough accident.
- To green synthesis of some compounds, microwave assisted reactions in water, ultrasound assisted reactions and surfactants for carbon dioxide.
- To get the skills for designing of environmentally safe marine antifoulant, rightfit pigment, green synthesis of plastic from corn.

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction to Green Chemistry:** What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry. **Principles of Green Chemistry and Designing a Chemical synthesis I:** Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following (1-2): 1. Designing a Green Synthesis using these principles; Prevention of Waste/byproducts; maximum incorporation of the materials used in the process into the final products , Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. 2. Prevention/ minimization of hazardous/ toxic products reducing toxicity. risk = (function) hazard × exposure; waste or pollution prevention hierarchy.	15
II	**Principles of Green Chemistry and Designing a Chemical synthesis II:** Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following (3-6): 1. Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents. 2. Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy. 3. Selection of starting materials; avoidance of unnecessary derivatization –careful use of blocking/protecting groups.	12

	4. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.	
III	**Principles of Green Chemistry and Designing a Chemical synthesis II:** Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following (7-8): 1. Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation. 2. Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.	13
IV	**Examples of Green Synthesis/ Reactions and some real world cases I:** 1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis) 2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction 3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine) 4 Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments.	12
V	**Examples of Green Synthesis/ Reactions and some real world cases II:** 5 Designing of Environmentally safe marine antifoulant. 6 Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments. 7 An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn. 8 Healthier fats and oil by Green Chemistry: Enzymatic interesterification for production of no Trans-Fats and Oils 9 Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting **Future Trends in Green Chemistry** Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal ontrolled solid state synthesis (C2S3); Green chemistry in sustainable development.	18
	TOTAL	60

Reference Books:

1 Ahluwalia, V.K. & Kidwai, M.R. *New Trends in Green Chemistry*, Anamalaya Publishers (2005).

2 Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).

3 Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).

4 Cann, M.C. &Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).

5 Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).

6 Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.

Course Outcomes:

At the end of this course, students will be able to:

CO1	Understand the all principles of green chemistry.
CO2	Know the benefits of catalysts/ bio catalyst, green solvents, microwaves and ultrasonic energy.
CO3	Understand the ISD and know the facts of Bhopal Gas Tragedy, and Flixiborough accident.
CO4	Know the green synthesis of some compounds, microwave assisted reactions in water, ultrasound assisted reactions and surfactants for carbon dioxide.
CO5	Get the skills for designing of Environmentally safe marine antifoulant, rightfit pigment, green synthesis of plastic from corn.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L2	H	M	L	M	L	-	L	H	M	-	H	H	L	M	M	H
CO2	L2	H	H	M	-	-	-	L	H	H	-	H	H	-	M	M	H
CO3	L2	H	H	M	-	-	-	L	H	H	L	H	H	-	L	M	M
CO4	L3	H	H	M	L	L	-	L	H	H	-	H	H	M	M	M	H
CO5	L6	H	H	M	M	M	-	L	H	H	-	H	H	M	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC603C: INSTRUMENTAL METHODS OF ANALYSIS

Credits: 05, Max. Marks: 100, Exam Hours: 3 hours

Course Objective:

- To perform experiment with accuracy and precision and knowledge of infrared spectroscopy.
- To understand basic principle and instrumentation of UV-Visible spectroscopy.
- To learn separation of analytes by chromatography and details of Mass spectroscopy.
- To get the knowledge of Atomic spectroscopy.
- To impart the advanced knowledge of NMR spectroscopy,electroanalytical methods: and radiochemical methods.

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction to spectroscopic methods of analysis:** Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation. **Molecular spectroscopy I:** *Infrared spectroscopy:* Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.	15
II	**Molecular spectroscopy II:** *UV-Visible/ Near IR* – emission, absorption, fluorescence and photoaccoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluorescent tags).	10
III	**Separation techniques** *Chromatography:* Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility,	16

	solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis. *Immunoassays and DNA techniques:* *Mass spectroscopy:* Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).	
IV	**Elemental analysis:** Mass spectrometry (electrical discharges). Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).	9
V	**NMR spectroscopy**: **P**rinciple, Instrumentation, Factors affecting chemical shift, Spin-coupling, Applications. **Electroanalytical Methods: P**otentiometry & Voltammetry **Radiochemical Methods** **X-ray analysis and electron spectroscopy (surface analysis)**	10
	TOTAL	60

Reference Books:

1 Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.

2 Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

3 P.W. Atkins: Physical Chemistry.

4 G.W. Castellan: Physical Chemistry.

5 C.N. Banwell: Fundamentals of Molecular Spectroscopy.

6 Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.

7 W.J. Moore: Physical Chemistry.

Course Outcomes:

At the end of this course, students will be able to:

CO1:	Perform experiment with accuracy and precision and knowledge of infrared spectroscopy.
CO2:	Understand basic principle and instrumentation of UV-Visible spectroscopy.
CO3:	Learn separation of analytes by chromatography and details of Mass spectroscopy.
CO4:	Know the Atomic spectroscopy.
CO5:	Understand NMR spectroscopy, electroanalytical methods: and radiochemical methods and they will help to identify the unknown compound.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L4	M	M	H	H	M	-	M	M	M	-	M	-	H	H	M	H
CO2	L2	H	M	H	M	M	H	M	H	M	L	M	-	M	M	L	M
CO3	L3	M	M	H	H	M	H	M	M	M	L	M	-	M	H	M	H
CO4	L2	H	M	H	H	M	H	M	H	M	L	M	-	M	M	L	M
CO5	L3	M	M	H	H	M	H	M	M	M	L	M	-	M	H	M	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC603D: QUANTUM CHEMISTRY, SPECTROSCOPY & PHOTOCHEMISTRY

Course Objective:

- To learn about limitations of classical mechanics and solution in terms of quantum mechanics for atomic/molecular systems.
- To develop an understanding of quantum mechanical operators, quantization, probability distribution, uncertainty principle and application of quantization to spectroscopy.
- To understand the covalent bonding, valence bond, molecular orbital approaches and LCAO-MO treatment of different chemical species.
- To interpret various types of spectra and know about their application in structure elucidation.
- To impart the basic knowledge of photochemistry.

UNIT	CONTENTS	CONTACT HOURS
I	**Quantum Chemistry I:** Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy. Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.	11
II	**Quantum ChemistryII:** Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution. Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).	9
III	**Chemical Bonding:** Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and	10

	their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH2, H2O) molecules. Qualitative MO theory and its application to AH2 type molecules.	
IV	**Molecular Spectroscopy:** Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation. *Rotation spectroscopy:* Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. *Vibrational spectroscopy:* Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches. *Raman spectroscopy:* Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.	15
V	**Electronicspectroscopy***:* Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model. *Nuclear Magnetic Resonance (NMR) spectroscopy:* Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules. *Electron Spin Resonance (ESR) spectroscopy:* Its principle, hyperfine structure, ESR of simple radicals. **Photochemistry:** Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.	15
	TOTAL	60

Reference Books:

1 Banwell, C. N. &McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).

2 Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).

3 House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).

4 Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).

5 Kakkar, R. *Atomic & Molecular Spectroscopy*: *Concepts & Applications*, Cambridge University Press (2015).

Course Outcomes:

By the end of the course, the students will be able to:

CO1	Learn the limitations of classical mechanics and solution in terms of quantum mechanics for atomic/molecular systems.
CO2	Develop an understanding of quantum mechanical operators, quantization, probability distribution, uncertainty principle and application of quantization to spectroscopy.
CO3	Understand the covalent bonding, valence bond, molecular orbital approaches and LCAO-MO treatment of different chemical species.
CO4	Interpret various types of spectra and know about their application in structure elucidation.
CO5	Impart the basic knowledge of photochemistry.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom Level	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L2	M	M	H	H	H	-	L	M	L	L	L	-	L	H	M	H
CO2	L2	M	M	H	H	H	-	L	M	L	L	L	-	L	M	L	M
CO3	L2	M	M	H	L	M	-	L	M	-	L	L	-	L	M	L	M
CO4	L5	H	H	H	H	H	H	M	M	L	M	M	-	H	H	M	H
CO5	L2	M	M	M	L	L	-	L	M	-	L	L	-	L	M	L	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC604A: QUANTUM MECHANICS

Course Objective:

- After learning the elements of modern physics, in this course students would be exposed to more advanced concepts in quantum physics and their applications to problems of the sub atomic world.
- To review the concepts of quantum mechanics.
- Understanding the applications of quantum concepts on real world problems.

UNIT	CONTENTS	CONTACTHOURS
I	**Time dependent Schrodinger equation**: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.	06
II	**Time independent Schrodinger equation**-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to the spread of Gaussian wavepacket for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle.	**10**
III	**General discussion of bound states in an arbitrary potential**-continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method.	12
IV	**Quantum theory of hydrogen-like atoms**: time independent Schrodinger equation in spherical polar coordinates; separation of variables for the second order partial differential equation; angular momentum operator and quantum numbers; Radial wavefunctions from Frobenius method; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells (idea only)	10
V	**Atoms in Electric and Magnetic Fields**:- Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.	08

	Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect.	04
	Many electron atoms:- Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J-J couplings.	10
	TOTAL	**60**

Reference Books:

1	A Text book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, 2nd Ed., McGraw Hill	2010
2	Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., Wiley.	2002
3	Quantum Mechanics, Leonard I. Schiff, 3rd Edn. Tata McGraw Hill.	2010
4	Quantum Mechanics, G. Aruldhas, 2nd Edn. PHI Learning of India.	2002
5	Quantum Mechanics, Bruce Cameron Reed, Jones and Bartlett Learning.	2008
6	Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, Cambridge University Press	2008

Course outcomes:

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

CO1:	Know inadequacies of classical mechanics in explaining microscopic phenomena, quantum theory formulation.
CO2:	Understand the concept of wave function of quantum particle and probabilistic nature of its location.
CO3:	Understand the influence of electric and magnetic fields on atoms.
CO4:	The experiments using Sci-lab will enable the student to appreciate nuances involved in the theory.
CO5:	Understand quantum many body problems.

Table: Mapping of Course Outcomes with ProgramLearning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L4	-	M	-	L	L	L	M	L	L	-	L	M	H	L	H	L
CO2	L2	M	-	L	L	M	M	M	M	M	M	M	M	M	L	M	M
CO3	L3	H	L	M	M	M	L	L	M	H	M	M	L	M	H	L	M
CO4	L4	M	H	M	L	-	M	M	-	M	H	H	M	L	M	L	M
CO5	L2	L	M	L	L	M	L	L	L	L	L	M	L	M	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC604B: EMBEDDED SYSTEM: INTRODUCTION TO MICROCONTROLLER

Course Objective:

- This course familiarizes students to the designing and development of embedded systems.
- This course gives a review of microprocessor and introduces microcontroller 8051.
- To review the concepts of microcontroller.

UNIT	CONTENTS	CONTACT HOURS
I	**Embedded system introduction:** Introduction to embedded systems and general purpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems, challenges and design issues in embedded systems, operational and non-operational quality attributes of embedded systems, elemental description of embedded processors and microcontrollers.	06
II	**Review of microprocessors:** Organization of Microprocessor based system, 8085µp pin diagram and architecture, concept of data bus and address bus, 8085 programming model, instruction classification, subroutines, stacks and its implementation, delay subroutines, hardware and software interrupts.	04
III	**8051 microcontroller:** Introduction and block diagram of 8051 microcontroller, architecture of 8051, overview of 8051 family, 8051 assembly language programming, Program Counter and ROM memory map, Data types and directives, Flag bits and Program Status Word (PSW) register, Jump, loop and call instructions. **8051 I/O port programming:** Introduction of I/O port programming, pin out diagram of 8051 microcontroller, I/O port pins description and their functions, I/O port programming in 8051, (Using Assembly Language), I/O programming: Bit manipulation.	16
IV	**Programming of 8051:** 8051addressing modes and accessing memory using various addressing modes, assembly language instructions using each addressing mode, arithmetic & logic instructions, 8051 programming in C:- for time delay and I/O operations and manipulation, for arithmetic & logic operations, for ASCII and BCD conversions.	12
	Timer and counter programming: Programming 8051 timers, counter programming. **Serial port programming with and without interrupt:** Introduction to 8051 interrupts, programming timer interrupts, programming external hardware interrupts and serial communication interrupt, interrupt priority in the 8051.	09
	Interfacing 8051 microcontroller to peripherals: Parallel and serial ADC, DAC interfacing, LCD interfacing.	02

V	**Programming Embedded Systems:** Structure of embedded program, infinite loop, compiling, linking and locating, downloading and debugging.	03
	Embedded system design and development: Embedded system development environment, file types generated after cross compilation, disassembler/ decompiler, simulator, emulator and debugging, embedded product development life-cycle, trends in embedded industry.	08
	TOTAL	**60**

Reference Books:

1	Embedded Systems: Architecture, Programming & Design, R. Kamal, Tata McGraw Hill	2008
2	The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., Pearson Education India.	2007
3	Embedded Microcomputor System: Real Time Interfacing, J.W. Valvano, Brooks/Cole	2000
4	Embedded Systems and Robots, SubrataGhoshal, Cengage Learning	2009
5	Introduction to embedded system, K.V. Shibu, 1st Edition, McGraw Hill	2009
6	Microcontrollers in practice, I.Susnea and M.Mitescu, Springer.	2005
7	Embedded Systems: Design & applications, 1/e S.F. Barrett, Pearson Education India	2008
8	Embedded Microcomputer systems: Real time interfacing, J.W.Valvano,Cengage Learning	2011

Course outcomes:

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

CO1	Understand Embedded systems including its generic architecture, design and classifications.
CO2	Know organization of intel microprocessor 8085, its architecture, pin diagram, timing diagram.
CO3	Know programming with and without interrupt service request.
CO4	Understand interfacing parallel and serial ADC and DAC.
CO5	Know basics of embedded system development and product development with a brief introduction to Arduino.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L4	H	H	-	L	L	L	M	L	L	M	M	M	H	L	-H	L
CO2	L2	-	L	M	L	M	H	M	M	M	L	M	-	H	M	M	H-
CO3	L4	L	H	L	M	M	M	L	-	-	H	H	M	L	M	L	M
CO4	L2	M	-	M	L	M	-	H	M	M	M	L	M	M	M	M	H
CO5	L2	H	L	L	M	L	M	L	L	L	L	H	L	M	L	L	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC604C: NUCLEAR AND PARTICLE PHYSICS

Course Objective:

- The objective of the course is to impart the understanding of the sub atomic particles and their properties.
- It will emphasize to gain knowledge about the different nuclear techniques and their applications in different branches Physics and societal application.
- The course will focus on the developments of problem based skills.
- To review the concepts of nuclear and particle physics.

UNIT	CONTENTS	CONTACT HOURS
I	**General Properties of Nuclei**: Constituents of nucleus and their Intrinsic properties, quantitative facts about size, mass, charge density (matter energy), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.	10
II	**Nuclear Models**: Liquid drop model approach, semi empirical mass formula and significance of various terms, condition of nuclear stability. Two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force. **Radioactivity decay**:(a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy, decay Chains. (b) β-decay: energy kinematics for β-decay, β-spectrum, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission from the excited state of the nucleus & kinematics, internal conversion.	12
III	**Nuclear Reactions:** Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering). **Interaction of Nuclear Radiation with matter**: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation, Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.	10
IV	**Detector for Nuclear Radiations:** Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si &Ge) for charge particle and photon detection (concept of charge carrier and mobility).	08

	Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.	06
V	**Particle physics:** Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons.	14
	TOTAL	**60**

Reference Books:

1. Introductory nuclear Physics by Kenneth S. Krane, Wiley India Pvt. Ltd., 2008
2. Concepts of nuclear physics by Bernard L. Cohen, Tata Mcgraw Hill. 1998
3. Introduction to the physics of nuclei & particles, R.A. Dunlap, Thomson Asia. 2004
4. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde, IOP- Institute of Physics Publishing. 2004
5. Radiation detection and measurement, G.F. Knoll, John Wiley & Sons. 2000
6. Theoretical Nuclear Physics, J.M. Blatt & V. F. Weisskopf, Dover Pub.Inc. 1991

Course outcomes:

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

COs	Statements
CO1	Learn the ground state properties of a nucleus, mass number and atomic number.
CO2	Learn about the process of radioactivity, the radioactive decay law
CO3	Learn the basic aspects of nuclear reactions, the Q-value of such reaction and its derivation from conservation laws.
CO4	Learn some basic aspects of interaction of nuclear radiation with matter.
CO5	Learn about the detectors of nuclear radiations.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom's Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L3	H	H	H	L	M	L	M	L	L	M	M	M	H	-M	M	L
CO2	L3	M	-	L	L	M	L	L	-	M	H	H	-	L	L	L	M
CO3	L2	L	H	L	M	-	M	M	M	-	-	M	M	M	M	L	L
CO4	L2	M	-	L	L	M	M	L	M	M	M	M	M	L	M	-M	M
CO5	L2	L	M	L	L	M	L	L	L	L	M	H	L	M	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC604D: MEDICAL PHYSICS

Course Objective:

- This course introduces a student to the basics of Medical Physics.
- To review the concepts of medical physics.
- To use physics laws and theories on biological systems.

UNIT	CONTENTS	CONTACT HOURS
I	**PHYSICS OF THE BODY-I** 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. 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.	08
II	**PHYSICS OF THE BODY-II** **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. **Electrical system of the body:** Physics of the nervous system, Electrical signals and information transfer. **PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-I** **X-RAYS:** Electromagnetic spectrum, production of x-rays, x-ray spectra, Brehmsstrahlung, Characteristic x-ray. **X-ray tubes & types**: Coolidge tube, x-ray tube design, tube cooling stationary mode, Rotating anode x-ray tube, Tube rating, quality and intensity of x-ray. X-ray generator circuits, half wave and full wave rectification, filament circuit, kilo voltage circuit, types of X-Ray Generator, high frequency generator, exposure timers and switches, HT cables, HT generation. **RADIATION PHYSICS:** Radiation units exposure, absorbed dose, units: rad, gray, relative biological effectiveness, effective dose, inverse square law. Interaction of radiation with matter Compton & photoelectric effect, Rem & Sievert, linear attenuation coefficient. **Radiation Detectors**: Thimble chamber, condenser chambers, Geiger Muller counter, Scintillation counters and Solid State detectors, ionization chamber, Dosimeters, survey methods, area monitors, TLD, Semiconductor detectors.	**24**

III	**MEDICAL IMAGING PHYSICS:** Evolution of Medical Imaging, X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR), NMR imaging, MRI Radiological imaging, Ultrasound imaging, Physics of Doppler with applications and modes, Vascular Doppler. Radiography: Filters, grids, cassette, X-ray film, film processing, fluoroscopy. **Computed tomography scanner**- principle & function, display, generations, mammography. Thyroid uptake system and Gamma camera (Only Principle, function and display). **RADIATION ONCOLOGY PHYSICS:** External Beam Therapy (Basic Idea): Telecobalt, Conformal Radiation Therapy (CRT), 3DCRT, IMRT, Image Guided Radiotherapy, EPID, Rapid Arc, Proton Therapy, Gamma Knife, Cyber Knife. Contact Beam Therapy (Basic Idea): Brachytherapy-LDR and HDR, Intra Operative Brachytherapy. Radiotherapy, kilo voltage machines, deep therapy machines, Telecobaltmachines, Medical linear accelerator. Basics of Teletherapy units, deep x-ray, Telecobalt units, medical linear accelerator, Radiation protection, external beam characteristics, dose maximum and build up – bolus, percentage depth dose, tissue maximum ratio and tissue phantom ratio, Planned target Volume and Gross Tumour Volume.	18
IV	**RADIATION AND RADIATION PROTECTION:** Principles of radiation protection, protective materials-radiation effects, somatic, genetic stochastic and deterministic effect. Personal monitoring devices: TLD film badge, pocket dosimeter, OSL dosimeter. Radiation dosimeter. Natural radioactivity, Biological effects of radiation, Radiation monitors**.** Steps to reduce radiation to Patient, Staff and Public. Dose Limits for Occupational workers and Public. AERB: Existence and Purpose.	05
V	**PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-II** Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, Radioisotope imaging equipment, Single photon and positron emission tomography. Therapeutic nuclear medicine: Interaction between radiation and matter Dose and isodose in radiation treatment. Medical Instrumentation: Basic Ideas of Endoscope and Cautery, Sleep Apnea and Cpap Machines, Ventilator and its modes.	05
	TOTAL	**60**

Reference Books:

1 Medical Physics, J.R. Cameron and J.G. Skofronick, Wiley. 1978

2 Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi. 2003

3	Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins	1990
4	Physics of Radiation Therapy: F M Khan - Williams and Wilkins, Third edition.	2003
5	Physics of the human body, Irving P. Herman, Springer.	2007
6	The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition.	2002

Course outcomes:

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

COs	Statements
CO1	Learn the application of Physics to clinical medicine.
CO2	Gain a broad and fundamental understanding of Physics while developing particular expertise in medical applications.
CO3	Learn about the human body, its anatomy, physiology and bio Physics, exploring its performance as a physical machine. Other topics include the Physics of the senses.
CO4	Gain knowledge with reference to working of various diagnostic tools, medical imaging techniques, how ionizing radiation interacts with matter, how it affects living organisms and how it is used as a therapeutic technique and radiation safety practices.
CO5	Imparts functional knowledge regarding need for radiological protection and the sources of an approximate level of radiation exposure for treatment purposes.

Table: Mapping of Course Outcomes with Program Learning Outcomes

	Bloom's Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	-	H	H	L	L	L	M	L	L	M	L	H	H	M	M	L
CO2	L2	M	-	L	L	M	M	-	M	M	M	L	M	H	M	H	M
CO3	L3	M	M	M	M	L	L	L	M	M	-	-	M	L	M	L	M
CO4	L2	M	H	M	L	M	M	M	L	L	L	M	M	M	H	L	M
CO5	L3	L	M	L	L	M	L	L	L	L	L	M	L	M	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC605A: POLYMER CHEMISTRY LAB

Course Objective:

- To understand the process of polymer synthesis by using different methods and their purification.
- To know, how the polymers are characterized.
- To get the knowledge of polymer analysis.

Experiments

Polymer synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).

a. Purification of monomer

b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bisisobutylonitrile (AIBN)

2. Preparation of nylon 66/6

I. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein

a. Preparation of IPC

b. Purification of IPC

c. Interfacial polymerization

3. Redox polymerization of acrylamide

4. Precipitation polymerization of acrylonitrile

5. Preparation of urea-formaldehyde resin

6. Preparations of novalac resin/resold resin.

7. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:

(a) Polyacrylamide-aq.$NaNO_2$ solution

(b) (Poly vinyl proplylidine (PVP) in water

2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.

3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).

4. Testing of mechanical properties of polymers.

5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

*at least 7 experiments to be carried out.

Reference Books:

1 M. P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Ed., Oxford University Press, 1999.

2 H. R. Allcock, F.W. Lampe & J.E. Mark, *Contemporary Polymer Chemistry*, 3rd ed. Prentice-Hall (2003)

3 F.W. Billmeyer, *Textbook of Polymer Science*, 3rd ed. Wiley-Interscience (1984)

4 J.R. Fried, *Polymer Science and Technology*, 2nd ed. Prentice-Hall (2003)

5 P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. John Wiley & Sons (2002)

6 L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons (2005)

7 M.P. Stevens, *Polymer Chemistry: An Introduction* 3rd ed. Oxford University Press (2005).

8 Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

Course Outcomes:

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

CO1	Prepare polymers by using different methods and their purification.
CO2	Characterized the polymers.
CO3	Evaluate the properties of polymer.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L4	M	M	L	L	L	-	L	M	-	-	M	-	H	M	H	H
CO2	L5	H	H	M	L	L	-	L	H	-	-	H	-	M	M	H	H
CO3	L5	H	H	M	L	L	-	L	H	-	-	H	-	M	M	M	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC605B: GREEN CHEMISTRY LAB

Course Objective:

- To know the green synthesis of nanoparticles and their characterization.
- To understand the green synthesis of biodiesel.
- To learn the principle of atom economy.
- To know the importance of enzymes, green solvents and alternative sources of energy.

S. No.	Experiments
1	**Safer starting materials** Preparation and characterization of nanoparticles of gold using tea leaves.
2	**Using renewable resources** Preparation of biodiesel from vegetable/ waste cooking oil.
3	**Avoiding waste** Principle of atom economy.
4	Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.
5	Preparation of propene by two methods can be studied
6	(I) Triethylamine ion + OH^- → propene + trimethylpropene + water
7	(II) 1-propanol H_2SO_4/Δ propene + water
8	Other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.
9	**Use of enzymes as catalysts** Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.
10	**Alternative Green solvents** Extraction of D-limonene from orange peel using liquid CO2 prepared form dry ice. Mechanochemical solvent free synthesis of azomethines
11	**Alternative sources of energy** Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II). Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books:

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,* Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).

4 Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN 978-93-81141-55-7 (2013).

5 Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).

6 Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry,* American Chemical Society (2008).

7 Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.

8 Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. *Introduction to Organic Laboratory Techniques: A Microscale and Macro Scale Approach,* W.B. Saunders, 1995.

Course Outcomes:

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

CO1	Prepare nanoparticles by green synthesis and characterizethe nanoparticles.
CO2	Understand and utilize green synthesis for the preparation of biodiesel.
CO3	Learn the principle of atom economy.
CO4	Know the importance of enzymes, green solvents and alternative sources of energy.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L5	M	L	L	L	L	-	L	M	-	-	M	-	M	M	M	H
CO2	L5	M	M	M	L	L	-	L	M	L	-	M	-	M	M	M	H
CO3	L2	M	M	M	L	L	-	L	M	L	-	M	-	-	M	M	H
CO4	L5	M	M	M	L	L	-	L	M	L	-	M	-	L	M	M	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC605C: INSTRUMENTAL METHODS AND ANALYSIS LAB

Course Objective:

- To learn the working and applications of different instruments

S.No.	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 spec.)
6	Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7	IR Absorption Spectra (Study of Aldehydes and Ketones)
8	Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
9	Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
10	Separation of Carbohydrates by HPLC
11	Determination of Caffeine in Beverages by HPLC
12	Potentiometric Titration of a Chloride-Iodide Mixture
13	Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple
14	Nuclear Magnetic Resonance
15	Use of fluorescence to do “presumptive tests” to identify blood or other body fluids.
16	Use of “presumptive tests” for anthrax or cocaine
17	Collection, preservation, and control of blood evidence being used for DNA testing
18	Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome)
19	Use of sequencing for the analysis of mitochondrial DNA
20	Laboratory analysis to confirm anthrax or cocaine
21	Detection in the field and confirmation in the laboratory of flammable accelerants or explosives
22	Detection of illegal drugs or steroids in athletes
23	Detection of pollutants or illegal dumping
24	Fibre analysis

At least 10 experiments to be performed.

Reference Books:

1 Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.

2 Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

Course Outcome:

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

CO1:	Learn the working and applications of different instruments.
CO2:	Determine different drugs / steroids in athletes

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L5	H	M	M	M	M	H	L	H	M	-	H	-	H	H	H	H
CO2	L5	H	M	M	M	M	-	L	H	M	-	H	-	H	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC605D: QUANTUM CHEMISTRY, SPECTROSCOPY & PHOTOCHEMISTRY LAB

Credits: 02, Max. Marks: 50

Course Objective:

- To use the UV/Visible spectroscopy ant its applications.
- To understand the applications of colourimetry.

Experiments

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. Study the kinetics of iodination of propanone in acidic medium.

IV. Determine the amount of iron present in a sample using 1,10-phenathroline.

V. Determine the dissociation constant of an indicator (phenolphthalein).

VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

VII. Analyse the given vibration-rotation spectrum of HCl(g)

Reference Books:

1 Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.

2 Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

3 Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).

4 Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

Course Outcomes:

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

CO1:	Learn the working and applications of UV/Visible spectroscopy.
CO2:	Understand and utilize the colourimetry.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	BLOOMS LEVEL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PSO1	PSO2	PSO3
CO1	L5	H	M	M	M	L	H	L	H	-	-	H	-	H	H	H	H
CO2	L5	H	M	M	M	L	H	L	H	-	-	H	-	L	H	H	H

H- High, M- Moderate, L- Low, '-' for No correlation

BSC606A: QUANTUM MECHANICS LAB

Course Objective:

- In this course students would be exposed to more advanced concepts in quantum physics and their applications to problems of the sub atomic world.
- To review the concepts of quantum mechanics.
- Understanding the applications of quantum concepts on real world problems.
- Use C/C^{++}/Scilab for solving the problems based on Quantum Mechanics.

S. No.	Experiment
1	Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom: $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$, where $V(r) = -\frac{e^2}{r}$. Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is $\approx -13.6\, eV$. Take $e = 3.795(eV\text{Å})^{1/2}$, $\hbar c = 1973\ (eV\text{Å})$ and $m = 0.511 \times 10^6 eV/c^2$.
2	Solve the s-wave radial Schrodinger equation for an atom: $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$. Where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential $V(r) = -\frac{e^2}{r}e^{-r/a}$. Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take $= 3.795(eV\text{Å})^{1/2}$, $\hbar c = 1973\ (eV\text{Å}), m = 0.511 \times 10^6 eV/c^2$ and $a = 3\text{ Å}, 5\text{ Å}, 7\text{ Å}$. . The ground state energy is expected to be above $-12\ eV$ in all three cases.
3	Solve the s-wave radial Schrodinger equation for a particle of mass m: $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$. For the anharmonic oscillator potential $V(r) = \frac{kr^2}{2} + \frac{br^3}{3}$. For the ground state energy (in MeV) of the particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose $\hbar c = 197.3\ MeV\ fm,\ m = 940 MeV/c^2$, k = 100 MeV fm^{-2} and $b = 0, 10, 30\ MeV\ fm^{-3}$. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.
4	Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule: $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2\mu}{\hbar^2}[V(r) - E]$. where μ is the reduced mass of the two-atom system for the Morse potential $V(r) = D\left(e^{-2\alpha r'} - e^{-\alpha r'}\right), r' = \frac{r - r_0}{r}$. Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take: $m = 940 MeV/c^2$, D = 0.755501 eV, $\alpha = 1044, r_0 = 0.131349$ Å.
5	Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency

6 Study of Zeeman effect: with external magnetic field; Hyperfine splitting

7 To study the quantum tunnelling effect with solid state device, e.g. tunneling current in backward diode or tunnel diode.

Reference Books:

1	Schaum's Outline of Programming with C++. J.Hubbard, McGraw-Hill Publications.	2000
2	Numerical Recipes in C: The Art of Scientific Computing, W.H. Press et al., 3rdEdn., Cambridge University Press.	2007
3	Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. , Wiley India Edition.	2007
4	A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 3rd Edn., Cambridge University Press	2014
5	Scilab(A Free Software to Matlab): H. Ramchandran, A.S. Nair. S. Chand and Company, New Delhi ISBN: 978-8121939706	2011
6	Quantum Mechanics, Leonard I. Schiff, 3rd Edn., Tata McGraw Hill.	2010
7	Quantum Mechanics, Bruce Cameron Reed, Jones and Bartlett Learning.	2008
8	Scilab Image Processing: Lambert M. Surhone. Betascript Publishing ISBN: 978-6133459274A	2010

Course outcomes:

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

COs	Statements
CO1:	Understand basic concepts of quantum mechanics.
CO2:	The interpretation of wave function of quantum particle and probabilistic nature of its location and subtler points of quantum phenomena are exposed to the student.
CO3:	Study of influence of electric and magnetic fields on atoms will help in understanding Stark effect and Zeeman Effect respectively.
CO4:	The experiments using Scilab will enable the student to appreciate nuances involved in the theory.
CO5:	In this course, with the exposure in computational programming in the computer lab, the student will be in a position to solve Schrodinger equation for ground state energy and wave functions of various simple quantum mechanical one dimensional and three dimensional potentials.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	-	L	H	M	M	M	-	M	M	H	L	M	H	M	M	L
CO2	L2	M	L	L	M	L	L	L	M	-	L	M	L	L	M	L	L
CO3	L4	L	L	M	-	M	L	H	L	H	L	-	L	-	M	L	M
CO4	L4	M	M	H	L	L	M	L	M	L	M	L	H	L	M	L	M
CO5	L4	L	-	H	L	H	L	H	M	H	L	H	H	M	L	M	M

H- High, M- Moderate, L- Low, '-' for No correlation

BSC606B: EMBEDDED SYSTEM: INTRODUCTION TO MICROCONTROLLER LAB

Course Objective:

- This course familiarizes students to the designing and development of embedded systems.
- This course gives a review of microprocessor and introduces microcontroller 8051.
- To review the concepts of microcontroller.

S. No.	Experiment
1	To find that the given numbers is prime or not.
2	To find the factorial of a number.
3	Write a program to make the two numbers equal by increasing the smallest number and decreasing the largest number.
4	Use one of the four ports of 8051 for O/P interfaced to eight LED's. Simulate binary counter (8 bit) on LED's.
5	Program to glow first four LED then next four using TIMER application.
6	Program to rotate the contents of the accumulator first right and then left.
7	Program to run a countdown from 9-0 in the seven segment LED display.
8	To interface seven segment LED display with 8051 microcontroller and display 'HELP' in the seven segment LED display.
9	To toggle '1234' as '1324' in the seven segment LED.
10	Interface stepper motor with 8051 and write a program to move the motor through a given angle in clock wise or counter clockwise direction.
11	Application of embedded systems: Temperature measurement, some information on LCD display, interfacing a keyboard.

Reference Books:

1	Embedded Systems: Architecture, Programming & Design, R. Kamal, Tata McGraw Hill	2008
2	The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., Pearson Education India.	2007
3	Embedded Microcomputor System: Real Time Interfacing, J.W. Valvano, Brooks/Cole	2000
4	Embedded System, B.K. Rao, PHI Learning Pvt. Ltd.	2011
5	Embedded Microcomputer systems: Real time interfacing, J.W.Valvano, Cengage Learning	2011

Course outcomes:

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

COs	Statements
CO1	Embedded systems including its generic architecture, design and classifications, Embedded processors and microcontrollers.
CO2	Organization of intel microprocessor 8085, its architecture, pin diagram, timing diagram, instruction set and programming in assembly language.
CO3	Interfacing parallel and serial ADC and DAC.
CO4	Basics of embedded system development and product development with a brief introduction to Arduino.
CO5	In the laboratory course, student shall be able to design, fabricate, test and run the programs.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L3	H	L	H	M	M	M	H	M	M	-	L	L	H	L	L	L
CO2	L3	M	L	L	L	L	L	L	M	H	L	M	-	L	-H	M	M
CO3	L2	L	L	M	-	L	L	-	L	-	L	L	L	H	M	L	M
CO4	L2	M	M	H	L	L	M	L	M	L	M	L	H	L	M	L	L
CO5	L4	L	-	H	H	H	L	H	M	H	L	H	M	M	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC606C: NUCLEAR AND PARTICLE PHYSICS LAB

Course Objective:

- The objective of the course is to impart the understanding of the sub atomic particles and their properties.
- It will emphasize to gain knowledge about the different nuclear techniques and their applications in different branches Physics and societal application.
- The course will focus on the developments of problem based skills.
- To review the concepts of nuclear and particle physics.

S. No.	Experiment
1	Estimate the energy loss of different ions in Water and carbon, using SRIM/TRIM etc simulation software.
2	Simulation study (using SRIM/TRIM or any other software) of radiation depth in materials (Carbon, Silver, Gold, Lead) using H-ion.
3	Comparison of interaction of H like ions in given medium (Carbon/Water) using simulation software (SRIM etc).
4	Study the background radiation in different places and identify the source material from gamma ray energy spectrum. (Data of gamma ray energies are available in the website http://www.nndc.bnl.gov/nudat2/)
5	Study the background radiation levels using Radiation meter.
6	Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
7	Study of counting statistics using background radiation using GM counter.
8	Study of radiation in various materials (e.g. KSO_4 etc.). Investigation of possible radiation in different routine materials by operating GM counter at operating voltage.
9	Study of absorption of beta particles in Aluminum using GM counter.
10	Detection of α particles using reference source & determining its half-life using spark counter
11	Gamma spectrum of Gas Light mantle (Source of Thorium)

Reference Books:

1 Nuclear and Particle Physics by W. E. Burcham and M. Jobes, Harlow Longman Group. 1995

2 G. F. Knoll, Radiation detection and measurement, 4th Edition, Wiley Publications. 2010

3 Fundamental Physics of Radiology by W .J. Meredith and J.B. Massey, John Wright and Sons, UK. 1989

4 An Introduction to Radiation Protection by A. Martin and S. A. Harbisor, John Willey & Sons, Inc. New York. 1981

5 Medical Radiation Physics by W. R. Hendee, Year book Medical Publishers, Inc., London. 1981

6 Nuclear Physics: Principles and Applications by John Lilley, Wiley Publication. 2006

Course outcomes:

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

COs	Statements
CO1	Learn the ground state properties of a nucleus.
CO2	Learn about the process of radioactivity, the radioactive decay law, the emission of alpha, beta and gamma rays.
CO3	Learn the basic aspects of nuclear reactions.
CO4	Learn about the detectors of nuclear radiations.
CO5	Gain knowledge on the basic aspects of particle Physics.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	M	L	-	M	M	M	H	M	M	H	L	L	H	L	L	L
CO2	L2	M	L	L	L	L	L	L	M	-	L	M	L	L	M	M	H
CO3	L3	H	L	M	M	L	L	-	L	M	L	L	L	M	H	L	M
CO4	L2	M	M	H	L	L	M	L	M	L	M	L	-	L	M	M	M
CO5	L1	L	-	L	H	H	M	H	M	H	L	H	M	M	L	L	L

H- High, M- Moderate, L- Low, '-' for No correlation

BSC606D: MEDICAL PHYSICS LAB

Course Objective:

- This course introduces a student to the basics of Medical Physics.
- To review the concepts of medical physics.
- To use physics laws and theories on biological systems.

S. No.	Experiment
1	Understanding the working of a manual Hg Blood Pressure monitor and measure the Blood Pressure.
2	Understanding the working of a manual optical eye-testing machine and to learn eye-testing.
3	Correction of Myopia (short sightedness) using a combination of lenses on an optical bench/breadboard.
4	Correction of Hypermetropia/Hyperopia (long sightedness) using a combination of lenses on an optical bench/breadboard.
5	To learn working of Thermoluminescent dosimeter (TLD) badges and measure the background radiation.
6	Familiarization with Geiger-Muller (GM) Counter and to measure background radiation.
7	Familiarization with Radiation meter and to measure background radiation.
8	Familiarization with the Use of a Vascular Doppler.

Reference Books:

1	Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi.	2003
2	Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins.	1990
3	Physics of Radiation Therapy: F M Khan - Williams and Wilkins, Third edition.	2003
4	The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and 36 Boone Lippincot Williams and Wilkins, Second Edition.	2002

Course outcomes:

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

COs	Statements
CO1:	Focus on the application of Physics to clinical medicine.
CO2:	Gain a broad and fundamental understanding of Physics while developing particular expertise in medical applications.
CO3:	Learn about the human body, its anatomy, physiology and bio Physics, exploring its performance as a physical machine. Other topics include the Physics of the senses.
CO4:	Gain knowledge with reference to working of various diagnostic tools, medical imaging techniques, how ionizing radiation interacts with matter, how it affects living organisms and how it is used as a therapeutic technique and radiation safety practices.
CO5:	In the laboratory course, the student will be exposed to the workings of various medical devices.

Table: Mapping of Course Outcomes with Program Learning Outcomes

CO	Blooms Level	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	L2	H	L	L	M	M	M	-	M	M	H	-	L	-	L	L	M
CO2	L2	M	L	L	L	L	L	L	M	L	L	M	L	M	M	M	L
CO3	L3	-	-	M	M	L	L	H	L	M	-	L	L	M	H	L	H
CO4	L2	M	M	-	L	L	M	L	M	L	M	L	L	L	L	L	M
CO5	L4	L	H	M	L	H	L	L	M	H	L	H	M	M	L	M	L

H- High, M- Moderate, L- Low, '-' for No correlation

6. Teaching-Learning Process/ Methodology (TLM):

The teaching-learning process should be aimed at systematic exposition of basic concepts so as to acquire knowledge of physical sciences in a canonical manner. In this context, applications of physical science and linkage with the theory constitute a vital aspect of the teaching-learning process. The course offers many modes of learning and assessment methods. Students have great freedom of choice of course which they can study. The various components of teaching learning process are summarized in the following heads.

1. **Class room Lectures:** The most common method of imparting knowledge is through lectures. There are diverse modes of delivering lectures such as through blackboard, power point presentation and other technology aided means. A judicious mix of these means is a key aspect of teaching-learning process.

2. Tutorials: To reinforce learning, to monitor progress, and to provide a regular pattern of study, tutorials are essential requirements. During these tutorials, difficulties faced by the students in understanding the lectures, are dealt with. Tutorials are also aimed at solving problems associated with the concepts discussed during the lectures.

3. **Practical:** To provide scientific visualization and obtaining results of Physical sciences in practical sessions. These sessions provide vital insights into scientific concepts and draw learner's attention towards limitations of scientific computations. During practical, scientific models arising in real life problems can also be simulated.

4. Choice based learning/Open elective: LOCF in this undergraduate programme provides great flexibility both in terms of variety of courses and range of references in each course.

5. **Field based learning:** Students may enhance their knowledge through field based learning while understanding the practical importance.

6. **Textbooks learning:** A large number of books are included in the list of references of each course for enrichment and enhancement of knowledge.

7. **E-learning:** Learner may also access electronic resources and educational websites for better understanding and updating the concepts.

8. **Self-study materials:** Self-study material provided by the teachers is an integral part of learning. It helps in bridging the gaps in the classroom teaching. It also provides scope for teachers to give additional information beyond classroom learning.

9. **Assignment/Problem solving:** Assignments at regular intervals involving applications of theory are necessary to assimilate basic concepts of courses. Hence, it is incumbent on the part of a learner to complete open-ended projects assigned by the teacher.

10. **Internships:** The teaching-learning process needs to be further supported by other activities devoted to subject-specific and interdisciplinary skills, summer and winter internships. During these internships it is expected that a learner will interact with experts and write a report on a topic provided to the learner.

11. **Institute visits:** Institute visit by a learner is also a part of learning process. During such visits a learner has access to knowledge by attending academic activities such as seminars, colloquia, library consultation and discussion with faculty members. These activities provide guidance and direction for further study.

12. **Industrial visits:** Industrial visits offer an opportunity to observe applications of scientific concepts. These visits also give an opportunity to realize the power of mathematical ideas and their translation in problem solving.

13. **Training programmes:** Training programmes organized by various agencies/institutes provide an opportunity to learn various dimensions of courses.