



CMS COLLEGE KOTTAYAM

(AUTONOMOUS)

Affiliated to the Mahatma Gandhi University, Kottayam, Kerala

CURRICULUM FOR UNDERGRADUATE PROGRAMME

BACHELOR OF SCIENCE IN CHEMISTRY

UNDER CHOICE BASED CREDIT SYSTEM 2018
(With effect from 2018)

Approved by the Board of Studies on 3-4-2018

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PREFACE

To understand the life's processes, the education of science particularly chemistry has to be taken care of. The attaining of this goal can be brought about only by a strong understanding of the subject at the undergraduate level. With this view in mind we have prepared the syllabi giving sufficient importance to meet the needs of the present scenario. The novel developments in the broad areas of chemistry, environmental aspects have been dealt with special thrust. Chemistry being an experimental science, sufficient emphasis is given in the syllabus for training in laboratory skills and instrumentation.

The syllabi will for sure equip the students to envision the different aspects with a chemist's view. Being an inter-link between other branches of science particularly physics and biology, the interdisciplinary approach has also been taken care of at times needed. This curriculum will expose students to various fields in chemistry and develop interest in related disciplines. Sufficient care has been taken that the syllabi meets international standards and is compatible with the syllabi of other universities.

CURRICULUM

GRADUATE PROGRAMME OUTCOMES (GPO)

At the completion of the B.Sc. Chemistry Degree Programme, the student will be able to accomplish the following outcomes:

GPO No.	Graduate Programme Outcomes
GPO.1	Critical Thinking: Take an informed and analytical approach to learning and demonstrate in-depth knowledge of the subject and give opinion(s) supported by logical reasoning that one have judged to be appropriate and understanding different approaches and using them
GPO.2	Effective Communication: Demonstrate proficiency in communicating competently in groups and organizations, competence in interpersonal communication; possess skills to effectively deliver formal and informal presentations to a variety of audiences in multiple contexts
GPO.3	Social Interaction: Foster social skills and peer interaction enabling them to make all people feel valued and respect their differences by being responsible citizens for creating a socially inclusive society
GPO.4	Ethical Standards: Recognize values such as justice, trust, equity, fairness, kindness and develop a commitment to meeting and upholding standards of ethical behavior in all walks of life and comprehending the moral dimensions of decisions and actions
GPO.5	Environmental Consciousness: Discern the issues of environmental contexts and engages in promoting values and attitudes that claim coexistence and sustainable living with reduced, minimal, or no harm upon ecosystems
GPO.6	Lifelong Learning: Acquire the skill to be an independent lifelong learner embracing real-time changes in the socio-technological context, promoting continuous development and improvement of the knowledge and skills needed for employment and personal fulfilment

PROGRAMME SPECIFIC OUTCOMES (PSO)

Sl No	PSO No.	Intended Programme Specific Outcomes <i>Upon completion of the B.Sc. Chemistry Degree Programme, the graduates will be able to:</i>	GPO No.
1	PSO-1	Understand basic concepts of Organic, Physical, Inorganic, Environmental, Computational and Analytical chemistry.	1,5,6
2	PSO-2	Identify and estimate organic and inorganic compounds using classical and modern laboratory methods.	1,6
3	PSO-3	Develop skills in synthesis and characterization of specified organic and inorganic compounds using documented laboratory procedures.	1,6
4	PSO-4	Develop skills in evaluation, interpretation and synthesis of chemical information and data.	1,6
5	PSO-5	Interpret and explain the limits and accuracy of experimental data in terms of significance and underlying theory.	1,2,6
6	PSO-6	Develop skills in the safe-handling of chemical materials, taking into account of their physical and chemical properties including any specific hazards associated with their use.	1,6
7	PSO-7	Use concepts, tools and techniques related to Mathematics and Physics to acquire required knowledge and its application in Chemistry	1,6
8	PSO-LG	Organize and deliver relevant applications of knowledge through effective written, verbal, graphical/virtual communications and interact productively with people from diverse backgrounds.	2,3,4,6

PROGRAMME DESIGN

B.Sc. CHEMISTRY PROGRAMME

The UG programme in Chemistry includes compulsory core courses, complementary courses, Open Course, choice based elective course, project work, English and additional languages namely Malayalam/ Hindi/ Syriac. For the successful completion of this UG programme, a student shall acquire minimum 120 credits. Provision has also been made for acquiring Extra credits through the Extra Credit Courses and Add on programmes. The course design is given below.

Sl. No.	Course type	No. of courses	Total credits
1	Common course I-English	6	22
2	Common course II- Additional language	4	16
3	Core	12	34
4	Core Practical	12	12
5	Complementary I	4	10
6	Complementary I Practical	4	4
7	Complementary II	4	14
8	Choice Based Open Courses	1	3
9	Choice Based Elective Courses	1	3
10	Project work	1	2
Total		49	120

PROGRAMME STRUCTURE - B.Sc. CHEMISTRY
(SEMESTER WISE)

SEMESTER I					
Course Code	Title of the Course	Course Category	Hours/week	Total hours	Credits
EN1811501	Fine-tune Your English	Common I - English – 1	5	90	4
EN1811502	Pearls from the Deep	Common I - English – 2	4	72	3
	Additional Language	Common Course-II			
HN1811501	Prose and One Act Plays	Common II – Hindi 1			
ML1811501	<i>Kathasahithyam</i>	Common II – Malayalam 1	4	72	4
SC1811501	Poetry/ Grammar & History of Syriac Language & Literature	Common II – Syriac 1			
CH1811101	General and Analytical Chemistry	Core course-1	2	36	2
CH1811601	Volumetric Analysis-Practical	Core Practical-1	2	36	1
MT1811201	Partial Differentiation, Matrices, Trigonometry And Numerical Methods	Complementary 1 - Mathematics	4	72	3
PH1811202	Properties of Matter & Thermodynamics	Complementary 1 - Physics	2	36	2
PH1811702	Properties of Matter & Thermodynamics (P)	Complementary 1 – Physics Practical	2	36	1
		Total	25	450	20
SEMESTER II					
Course Code	Title of the Course	Course Category	Hours/week	Total hours	Credits
EN1812503	Issues that Matter	Common I English – 3	5	90	4
EN1812504	Savouring the Classics	Common I English – 4	4	72	3
	Additional Language	Common Course II			
HN1812503	Short stories and Novel	Common II – Hindi 2			
ML1812504	Kavitha	Common II – Malayalam 2	4	72	4
SC1812503	Poetry/ Grammar & History of Syriac Literature	Common II – Syriac 2			
CH1812102	Theoretical and Inorganic Chemistry	Core course-2	2	36	2
CH1812602	Volumetric Analysis - Practical	Core Practical-2	2	36	1
MT1812203	Integral Calculus And Differential Equations	Complementary 2 - Mathematics	4	72	3

PH1812204	Mechanics And Superconductivity	Complementary 2 - Physics	2	36	2
PH1812704	Mechanics And Superconductivity (P)	Complementary 2 – Physics Practical	2	36	1
		Total	25	450	20
SEMESTER III					
Course Code	Title of the Course	Course Category	Hours/week	Total hours	Credits
EN1813505	Literature and/ as Identity	Common I English – 5	5	90	4
	Additional Language	Common Course II			
HN1813505	Poetry Grammar and Translation	Common II – Hindi 3			
ML1813507	Drishyakalasaahithyam	Common II - Malayalam 3	5	90	4
SC1813505	Prose, Grammar & Literature	Common II – Syriac 3			
CH1813103	Organic Chemistry-1	Core course-3	3	54	3
CH1813603	Qualitative Organic Analysis	Core Practical-3	2	36	1
MT18113205	Vector Calculus, Analytic Geometry And Abstract Algebra	Complementary 3 – Mathematics	5	90	4
PH1813206	Modern Physics And Magnetism	Complementary 3 – Physics	3	54	3
PH1813706	Modern Physics And Magnetism (P)	Complementary 3 – Physics Practical	2	36	1
		Total	25	450	20
SEMESTER IV					
Course Code	Title of the Course	Course Category	Hours/week	Total hours	Credits
EN1814507	Illuminations	Common I English – 6	5	90	4
	Additional Language	Common Course II			
HN1814506	Drama and Long Poem	Common II – Hindi 4			
ML1814508	MalayalaGadyarachanakal	Common II – Malayalam 4	5	90	4
SC1814506	Poetry, Grammar & Syriac Heritage in India	Common II – Syriac 4			
CH1814104	Organic Chemistry –II	Core course-4	3	54	3
CH1814604	Qualitative Organic Analysis	Core Practical-4	2	36	1
MT1814206	Fourier series, Laplace transform and complex analysis	Complementary 4 - Mathematics	5	90	4
PH1814208	Optics And Solid State Physics	Complementary 4 - Physics	3	54	3
PH1814708	Optics And Solid State Physics (P)	Complementary 4 – Physics Practical	2	36	1

		Total	25	450	20
SEMESTER V					
Course Code	Title of the Course	Course Category	Hours/week	Total hours	Credits
CH1815106	Organic Chemistry-III	Core Course-5	3	54	3
CH1815606	Organic Preparations and basic laboratory Techniques-Practical	Practical Core Course-5	2	36	1
CH1815107	Physical Chemistry -1	Core Course-6	2	36	2
CH1815607	Physical Chemistry Practical	Practical Core Course-6	3	54	1
CH1815108	Physical Chemistry-II	Core Course -7	2	36	3
CH1815605	Qualitative Inorganic Analysis- Practical	Practical Core Course-7	3	54	1
CH1815105	Environmental Chemistry and Human Rights	Core Course-8	4	72	4
CH1815401	Forensic Science	Open Course	4	72	3
CH1815802	Project	Core Course	2	36	-
		Total	25	450	18
SEMESTER VI					
Course Code	Title of the Course	Course Category	Hours/week	Total hours	Credits
CH1816301	Nanochemistry and Nanotechnology	Choice Based Course (Elective)	3	54	3
CH1816109	Inorganic Chemistry	Core Course -9	3	54	3
CH1816608	Qualitative Inorganic Analysis-Practical	Practical Core Course-8	3	54	1
CH1816110	Organic Chemistry-IV	Core Course -10	3	54	3
CH1816609	Organic Preparations and basic laboratory Techniques-Practical	Practical Core Course-9	2	36	1
CH1816111	Physical Chemistry -III	Core Course -11	3	54	3
CH1816610	Physical Chemistry Practical	Practical Core Course-10	3	54	1
CH1816112	Physical Chemistry-IV	Core Course -12	3	54	3
CH1816611	Gravimetric Analysis-Practical	Practical Core Course-11	2	36	2
CH1816802	Project (Evaluation)	Core Course	-	-	2
		Total	25	450	22

PROGRAMME STRUCTURE – B.Sc. Chemistry
(CATEGORY WISE)
COMMON COURSES

Sl.No	Course Name		Credit	Hrs/ Week	Semester
1	Common I -English 1 Fine-tune Your English		4	5	1
2	Common I- English 2 Pearls from the Deep		3	4	1
3	Common I -English 3 Issues that Matter		4	5	2
4	Common I- English 4 Savouring the Classics		3	4	2
5	Common I – English 5 Literature and/ as Identity		4	5	3
6	Common I – English 6 Illuminations		4	5	4
7	Additional language –1		4	4	1
	Prose and One Act Plays	Common II - Hindi 1			
	Kathasahithyam	Common II - Malayalam 1			
	Poetry/ Grammar & History of Syriac Language & Literature	Common II –Syriac 1			
8	Additional language –1		4	4	2
	Short stories and Novel	Common II - Hindi 2			
	Kavitha	Common II- Malayalam 2			
	Poetry/ Grammar & History of Syriac Literature	Common II –Syriac 2			
9	Additional Language - 1		4	4	3
	Poetry Grammar and Translation	Common II -Hindi 3			
	Drishyakalasaahithyam	Common II- Malayalam 3			
	Prose, Grammar & Literature	Common II- Syriac 3			
10	Additional Language – 1		4	4	4
	Drama and Long Poem	Common II- Hindi 4			
	Malayala Gadyarachanakal	Common II- Malayalam 4			
	Poetry, Grammar & Syriac Heritage in India	Common II- Syriac 4			
Total			38		

CORE COURSES

SI No	Title of the Course	Semester	Hours/ week	Credits
1	General and Analytical Chemistry	1	2	2
2	Theoretical and Inorganic Chemistry	2	2	2
3	Organic Chemistry-1	3	3	3
4	Organic Chemistry –II	4	3	3
5	Organic Chemistry-III	5	3	3
6	Physical Chemistry -1	5	2	2
7	Physical Chemistry-II	5	2	3
8	Environmental Chemistry and Human Rights	5	4	4
9	Project	5	2	-
10	Inorganic Chemistry	6	3	3
11	Organic Chemistry-IV	6	3	3
12	Physical Chemistry -III	6	3	3
13	Physical Chemistry-IV	6	3	3
14	Project	6	-	2
		Total	35	36

CORE PRACTICAL COURSES

SI No	Title of the Course	Semester	Hours/ week	Credits
1	Volumetric Analysis-Practical	1	2	1
2	Volumetric Analysis -Practical	2	2	1
3	Qualitative Organic Analysis	3	2	1
4	Qualitative Organic Analysis	4	2	1
5	Organic Preparations and basic laboratory Techniques- Practical	5	2	1
6	Physical Chemistry Practical	5	3	1
7	Qualitative Inorganic Analysis-Practical	5	3	1
8	Qualitative Inorganic Analysis-Practical	6	3	1
9	Organic Preparations and basic laboratory Techniques- Practical	6	2	1
10	Physical Chemistry Practical	6	3	1
11	Gravimetric Analysis- Practical	6	2	2
		Total	26	12

COMPLEMENTARY COURSES

Sl.No	Course Name	Semester	Credit	Hrs/Week
1	Basic Theoretical & Analytical Chemistry	1	2	2
2	Basic Organic Chemistry	2	2	2
3	Advanced Inorganic And Organic Chemistry	3	3	3
4	Advanced Bio-Organic Chemistry	4	3	3
	Total		10	10

COMPLEMENTARY PRACTICAL COURSES

Sl.No	Course Name	Semester	Credit	Hrs/Week
1	Volumetric Analysis(P)	1	1	2
2	Volumetric Analysis(P)	2	1	2
3	Organic Analysis(P)	3	1	2
4	Organic Analysis(P)	4	1	2
	Total		4	8

CHOICE BASED OPEN COURSES

Sl. No.	Course name	Semester	Credit	Hr/Week
1	Forensic Science	5	3	4

CHOICE BASED ELECTIVE COURSES

Sl. No.	Course name	Semester	Credit	Hr/Week
1	Polymer Chemistry	6	3	3
2	Nano-chemistry and nanotechnology	6	3	3

EXTRA CREDIT COURSES

Sl.No	Course Name	Hours	Credit
1	Numerical methods & data analysis in chemistry	36	2

ADD-ON COURSE

Sl.No	Course Name	Hours
1	Computational Molecular Modelling	36

DETAILED SYLLABUS OF THE COURSES
Offered by the Department

SEMESTER I

Course Code	Title of the Course	Course Category	Hours/ week	Credits
EN1811501	Fine-tune Your English	Common I - English – 1	5	4
EN1811502	Pearls from the Deep	Common I - English – 2	4	3
	Additional Language	Common Course-II		
HN1811501	Prose and One Act Plays	Common II – Hindi 1		
ML1811501	Kathasahithyam	Common II – Malayalam 1	4	4
SC1811501	Poetry/ Grammar & History of Syriac Language & Literature	Common II – Syriac 1		
CH1811101	General and Analytical Chemistry	Core course-1	2	2
CH1811601	Volumetric Analysis-Practical	Core Practical-1	2	1
MT1811201	Partial Differentiation, Matrices, Trigonometry And Numerical Methods	Complementary 1 - Mathematics	4	3
PH1811202	Properties of Matter & Thermodynamics	Complementary 1 - Physics	2	2
PH1811702	Properties of Matter & Thermodynamics (P)	Complementary 1 – Physics Practical	2	1
		Total	25	20

Course	Details				
Code	CH1811101				
Title	GENERAL AND ANALYTICAL CHEMISTRY				
Degree	B.Sc.				
Branch(s)	Chemistry				
Year/Semester	1/1				
Type	Core Course				
Credits	2	Hrs/Week	2	Total Hours	36

CO No.	<i>Expected Course Outcomes</i> <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Describe about the methodology of Science in general and Chemistry in particular.	U	PSO-1
2	Explain the basic concepts of periodic table and the associated periodic properties.	U	PSO-1
3	Apply the concepts of periodic table and periodic properties	Ap	PSO-1
4	Discuss the various analytical tools in Chemistry	U	PSO-1 PSO-2
5	Describe various Chromatographic techniques	U	PSO-1 PSO-2
6	Evaluate analytical data	E	PSO-4

*PSO-Program Specific Outcome; CO-Course Outcome;
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Methodology of Chemistry		
1.1	Definition of Science. Scientific methods - observation-posing a question - formulation of hypothesis- experiment – theory - law.	2	1
1.2	Falsification of hypothesis - inductive and deductive reasoning- revision of scientific theories and laws.	1	1
1.3	Evolution of Chemistry-ancient speculation on the nature of matter. Early form of chemistry-alchemy, origin of modern chemistry.	1	1
1.4	Structure of chemical science: Scope, theory and experiment - branches of chemistry.	1	1
1.5	Role of chemistry as a central science connecting physics, biology and other branches of science	1	1

1.6	Interdisciplinary areas involving chemistry: Nanotechnology and biotechnology.	1	1
2.0	Periodic Table and Periodic Properties		
2.1	Modern periodic law – Long form periodic table. Diagonal relationship and anomalous behaviour of first element in a group.	1	2
2.2	Periodicity in properties: Atomic and ionic radii - ionization enthalpy - electron affinity (electron gain enthalpy) – electronegativity.	2	3
2.3	Electronegativity scales: Pauling and Mullikan scales. Effective nuclear charge – Slater rule and its applications – polarising power.	2	3
3.0	Analytical Methods in Chemistry		
3.1	Molecular mass - mole concept – molar volume. Oxidation and reduction – oxidation number and valency – variable valency - equivalent mass.	1	4
3.2	Qualitative analysis: Applications of solubility product and common ion effect in the precipitation of cations. Principle of intergroup separation of cations. Interfering acid radicals and their elimination (oxalate, fluoride, borate and phosphate).	2	4
3.3	Titrimetric analysis - fundamental concepts. Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, ppm and ppb.	2	4
3.4	Primary and secondary standards, quantitative dilution – problems.	1	4
3.5	Acid base titrations- titration curves – pH indicators. Redox titrations – titration curve –titrations involving MnO_4^- and $\text{Cr}_2\text{O}_7^{2-}$ - redox indicators.	2	4
3.6	Complexometric titrations – EDTA titrations - titration curves – metal ion indicators.	1	4
3.7	Gravimetric analysis: Unit operations in gravimetric analysis - illustrations using iron and barium estimation.	1	4
3.8	Separation and purification techniques – filtration, crystallization and precipitation – fractional distillation, solvent extraction.	2	4
4.0	Chromatographic Methods		
4.1	Column Chromatography: Principle, types of adsorbents, preparation of the column, elution, recovery of substances and applications.	2	5
4.2	Thin Layer Chromatography: Principle, choice of adsorbent and solvent, preparation of Chromatoplates, R _f -values, significance of R _f values.	2	5
4.3	Ion exchange chromatography: Principle and experimental techniques.	1	5
4.4	Gas Chromatography: Principle and experimental techniques	1	5
4.5	High Performance Liquid Chromatography (HPLC): Principle and experimental techniques.	1	5
5.0	Evaluation of Analytical Data		
5.1	Units, significant digits, rounding, scientific and prefix notation, graphing of data.	1	6

5.2	Precision and accuracy-types of errors – ways of expressing precision – ways to reduce systematic errors - reporting analytical data.	2	6
5.3	Statistical treatment of analytical data – population and samples –Mean and standard deviation – distribution of random errors.	2	6

Text Books for Reference

1. J. A. Lee, Scientific Endeavour, Addison Wesley Longman
2. C. N. R. Rao, College General Chemistry, MacMillan India (Ltd.)
3. D. A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
4. J. D. Lee, Concise Inorganic Chemistry, 5th edn., Blackwell Science, London, 2010.
5. B. R. Puri, L. R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
6. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1*, 5th Edition, S. Chand and Sons, New Delhi, 2012.
7. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.

Text Books for Enrichment

1. R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press, Hyderabad, 2009.
2. Vogels Textbook of Quantitative Chemical Analysis, 6thEdn., Pearson Education Ltd.

Course	Details				
Code	CH1811601				
Title	VOLUMETRIC ANALYSIS				
Degree	B.Sc.				
Branch(s)	Chemistry				
Year/Semester	I/1				
Type	Core Chemistry Practical				
Credits	1	Hrs/Week	2	Total Hours	36

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Standardize various solutions	Ap	PSO-2
2	Estimate the amount of substance present in a given solution	An	PSO-2
3	Determine the hardness of water	An	PSO-2

*PSO-Program Specific Outcome; CO-Course Outcome;
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Acidimetry and Alkalimetry		
1.1	Strong acid-Strong base	2	1
1.2	Strong acid – Weak base	2	1
1.3	Strong base – Weak acid	2	1
1.4	Estimation of Na ₂ CO ₃ and NaHCO ₃ in a mixture	2	2
1.5	Estimation of NaOH and Na ₂ CO ₃ in a mixture	2	2
1.6	Estimation of ammonia in ammonium salts by direct and indirect methods	2	2
2.0	Complexometric Titrations Using EDTA		
2.1	Estimation of Zn	4	2
2.2	Estimation of Mg	4	2
2.3	Estimation of Mg and Ca in a mixture	6	2
2.4	Estimation of Ni	4	2
2.5	Determination of hardness of water	6	3

Text Books for Reference

1. A. I. Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)
2. D.A.Skoog, D.M.West and S.R.crouch, Fundamentals of Analytical Chemistry, 8thEdn., Brooks/Cole Nelson.
3. Vogels Textbook of Quantitative Chemical Analysis, 6thEdn., Pearson Education Ltd.

Semester II				
Course Code	Title of the Course	Course Category	Hours/week	Credits
EN1812503	Issues that Matter	Common I English – 3	5	4
EN1812504	Savouring the Classics	Common I English – 4	4	3
	Additional Language	Common Course II		
HN1812503	Short stories and Novel	Common II – Hindi 2	4	4
ML1811504	Kavitha	Common II – Malayalam 2		
SC1812503	Poetry/ Grammar & History of Syriac Literature	Common II – Syriac 2		
CH1812102	Theoretical and Inorganic Chemistry	Core course-2	2	2
CH1812602	Volumetric Analysis -Practical	Core Practical-2	2	1
MT1812203	Integral Calculus And Differential Equations	Complementary 2 - Mathematics	4	3
PH1812204	Mechanics And Superconductivity	Complementary 2 - Physics	2	2
PH1812704	Mechanics And Superconductivity (P)	Complementary 2 –Physics Practical	2	1
		Total	25	20

Course	Details				
Code	CH1812102				
Title	THEORETICAL AND INORGANIC CHEMISTRY				
Degree	B.Sc.				
Branch(s)	Chemistry				
Year/Semester	I/II				
Type	Core Course				
Credits	2	Hrs/Week	2	Total Hours	36

CO No.	<i>Expected Course Outcomes</i> <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Explain different models of atoms	U	PSO-1
2	Calculate Radius, Energy, velocity of an electron	Ap	PSO-1
3	Discuss octet rule and its limitations	U	PSO-1
4	Classify different types of bonds	Ap	PSO-1
5	Predict the shape and hybridisation of molecules	U	PSO-1
6	Draw molecular orbitals of homo and hetero diatomic molecules	R	PSO-1
7	Understand about various intermolecular forces	U	PSO-1
8	Discuss the Chemistry of s, p, d and f block elements	U	PSO-1

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Atomic Structure		
1.1	Introduction based on historical development (Dalton's atomic theory, Thomson's atom model Rutherford's atom model), Failure of classical physics – black body radiation	1	1
1.2	Planck's quantum hypothesis - photoelectric effect - generalization of quantum theory	1	1
1.3	Atomic spectra of hydrogen and hydrogen like atoms– Bohr theory of atom – Calculation of Bohr radius, velocity and energy of an electron - explanation of atomic spectra - limitations of Bohr theory	1	2
1.4	Sommerfeld modification. Louis de Broglie's matter waves – wave-particle duality - electron diffraction - Heisenberg's uncertainty principle.	1	1
1.5	Schrödinger wave equation (derivation not expected), wave functions – significance of ψ and ψ^2 – atomic orbitals and concept of quantum numbers - shapes of orbitals (<i>s</i> , <i>p</i> and <i>d</i>).	1	1
1.6	Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – electronic configuration of atoms.	1	1
2.0	Chemical Bonding – I		
2.1	Introduction – Octet rule and its limitations.	1	3
2.2	Types of bonds: Ionic bond - factors favouring the formation of ionic bonds - lattice energy of ionic compounds - Born- Lande	1	4

	equation with derivation -		
2.3	Solvation enthalpy and solubility of ionic compounds – Born-Haber cycle and its applications – properties of ionic compounds - polarisation of ions – Fajan's rule and its applications.	1	4
2.4	Covalent Bond: Valence Bond Theory and its limitations. Concept of resonance – resonance structures of borate, carbonate and nitrate ions.	1	4
2.5	Hybridization: Definition and characteristics– shape of molecules (BeCl ₂ , C ₂ H ₂ , BF ₃ , C ₂ H ₄ , CH ₄ , NH ₃ , H ₂ O, NH ₄ ⁺ , H ₃ O ⁺ , PCl ₅ , SF ₆ and IF ₇).	2	5
2.6	VSEPR theory: Postulates - applications - shapes of molecules CCl ₄ , NH ₃ , H ₂ O, ClF ₃ , XeF ₂ , SF ₆ , IF ₅ , XeF ₄ , IF ₇ and XeF ₆ .	2	5
2.7	Properties of covalent compounds - polarity of bonds – percentage of ionic character – dipole moment and molecular structure.	1	4
3.0	Chemical Bonding – II		
3.1	Covalent Bond: Molecular Orbital Theory – LCAO - bonding and anti-bonding molecular orbitals – bond order and its significance.	2	6
3.2	MO diagrams of homonuclear and heteronuclear diatomic molecules: H ₂ , He ₂ , Li ₂ , Be ₂ , B ₂ , C ₂ , N ₂ , O ₂ , F ₂ , CO and NO	3	6
3.3	Comparison of bond length, magnetic behaviour and bond energy of O ₂ , O ₂ ⁺ , O ₂ ²⁺ , O ₂ ⁻ and O ₂ ²⁻	1	6
3.4	Metallic Bond: free electron theory, valence bond theory and band theory (qualitative treatment only) - explanation of metallic properties based on these theories.	1	4
3.5	Intermolecular forces: Hydrogen bond - intra and inter molecular hydrogen bonds – effect on physical properties.	1	7
3.6	Van der Waals forces, ion-dipole, dipole-dipole, ion-induced dipole, dipole-induced dipole and induced dipole-induced dipole interactions	1	7
4.0	Chemistry of s and p Block Elements		
4.1	Periodicity in s-and p- block elements with respect to electronic configuration, atomic and ionic size, ionization energy and electro negativity.	2	8
4.2	Inert pair effect.	1	8
5.0	Chemistry of d and f Block Elements		
5.1	Transition Metals: General characteristics: Metallic character, oxidation states, size, density, melting points, boiling points, ionization energy, colour, magnetic properties, reducing properties, catalytic properties, non-stoichiometric compounds, complex formation and alloy formation.	3	8
5.2	Difference between first row and other two rows.	1	8
5.3	Preparation, properties, structure and uses of KMnO ₄ and K ₂ Cr ₂ O ₇ .	2	8
5.4	Lanthanides: Electronic configuration and general characteristics – Occurrence of lanthanides	1	8
5.5	Isolation of lanthanides from monazite sand - Separation by ion exchange method.	1	8
5.6	Lanthanide contraction: Causes and consequences. Industrial importance of lanthanides.	1	8

Text Books for Reference

1. R.K. Prasad, *Quantum Chemistry*, New Age International, 2001
2. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books.
3. I. N. Levine, *Physical Chemistry*, Tata McGraw Hill,
4. ManasChanda, *Atomic structure and Chemical bonding in Molecular Spectroscopy”* Tata McGraw Hill.
5. J. D. Lee, *Concise Inorganic Chemistry*, 5th edn., Blackwell Science, London.
6. B. R. Puri, L. R. Sharma, Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi.
7. F. A. Cotton, G. Wilkinson and P. L. Gaus, *Basic Inorganic Chemistry*, 3rd edn., John Wiley.
8. B. Douglas, D. Mc Daniel, J. Alexander, *Concepts and models in Inorganic Chemistry*.

Text Books for Enrichment

1. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1*, 5th Edition, S. Chand and Sons, New Delhi, 2012.
2. R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press, Hyderabad, 2009.

Course	Details				
Code	CH1812602				
Title	VOLUMETRIC ANALYSIS				
Degree	B.Sc.				
Branch(s)	Chemistry				
Year/Semester	I/ II				
Type	Core Chemistry Practical				
Credits	1	Hrs/Week	2	Total Hours	36

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Standardize various solutions	Ap	PSO-2
2	Estimate the amount of substance present in a given solution	An	PSO-2

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Permanganometry (Oxidation – Reduction Titration)		
1.1	Estimation of ferrous iron	3	2
1.2	Estimation of oxalic acid	3	2
1.3	Estimation of sodium oxalate	3	2
1.4	Estimation of calcium	3	2
2.0	Dichrometry (Oxidation – Reduction Titration)		
2.1	Estimation of ferrous iron using internal indicator	4	2
2.2	Estimation of ferrous iron using external indicator	4	2
2.3	Estimation of ferric iron using internal indicator	4	2
2.4	Estimation of ferric iron using external indicator	4	2
3.0	Iodimetry and Iodometry (Oxidation – Reduction Titration)		
3.1	Estimation of copper	4	2
3.2	Estimation of arsenious oxide	4	8

*PSO-Program Specific outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Text Books for Reference

1. A. I. Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)
2. D.A.Skoog, D.M.West and S.R.crouch, Fundamentals of Analytical Chemistry, 8thEdn., Brooks/Cole Nelson.
3. Vogels Textbook of Quantitative Chemical Analysis, 6thEdn., Pearson Education Ltd.

SEMESTER III				
Course Code	Title of the Course	Course Category	Hours/week	Credits
EN1813505	Literature and/ as Identity	Common I English – 5	5	4
	Additional Language	Common Course II	5	4
HN1813505	Poetry Grammar and Translation	Common II – Hindi 3		
	Drishyakalasaahithyam	Common II - Malayalam 3		
SC1813505	Prose, Grammar & Literature	Common II – Syriac 3		
CH1813103	Organic Chemistry-1	Core course-3	3	3
CH1813603	Qualitative Organic Analysis	Core Practical-3	2	1
MT18113205	Vector Calculus, Analytic Geometry And Abstract Algebra	Complementary 3 – Mathematics	5	4
PH1813206	Modern Physics And Magnetism	Complementary 3 – Physics	3	3
PH1813706	Modern Physics And Magnetism (P)	Complementary 3 – Physics Practical	2	1
		Total	25	20

Course	Details				
Code	CH1813103				
Title	ORGANIC CHEMISTRY – I				
Degree	B.Sc.				
Branch(s)	Chemistry				
Year/Semester	II/III				
Type	Core				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Explain the basic concepts of organic chemistry	U	PSO-1
2	Identify how stereochemistry affects a chemical reaction	Ap	PSO-1
3	Describe nucleophiles and electrophiles	R	PSO-1
4	Assess reaction mechanisms to predict the outcome of reactions	E	PSO-4
5	Analyse various concerted reactions	An	PSO-5
6	Predict the category to which the reaction belong to	Ap	PSO-1
7	Define the synthesis of alkanes, alkenes etc	R	PSO-1
8	Explain the role of aromaticity	U	PSO-1

*PSO-Program Specific Outcome; CO-Course Outcome;
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Fundamentals of Organic Chemistry	8	
1.1	Classification and IUPAC system of nomenclature of common organic compounds (both aliphatic and aromatic).	1	1
1.2	Line diagram drawing. Factors affecting reaction mechanism. Polarity of bonds.	1	1
1.3	<i>Electronic displacements</i> : Inductive effect, electromeric effect, mesomeric effect, resonance and hyperconjugation, steric effects.	2	1
1.4	<i>Cleavage of bonds</i> : Homolysis and heterolysis with suitable examples, curly arrow rules, formal charges.	1	1
1.5	<i>Types of reagents</i> : Nucleophiles and electrophiles.	1	1
1.6	<i>Types of organic reactions</i> : Addition, elimination, substitution, rearrangement and redox reactions (definition and one example each).	2	6
2.0	Stereochemistry	15	
2.1	Stereoisomerism – definition, classification.	1	1
2.2	<i>Optical isomerism</i> : Optical activity, specific rotation, concept of chirality (upto two carbon atoms). Configuration. Enantiomerism, diastereomerism and meso compounds. Racemic mixture and methods of resolution. Asymmetric synthesis (partial and absolute). Threo and erythro; <i>d</i> and <i>l</i> designations; Cahn-Ingold-Prelog rules: R/S notation (for upto 2 chiral carbon atoms).	5	2

2.3	<i>Geometrical isomerism: cis-trans, syn-anti and E/Z nomenclature (for upto two C=C systems) with C.I.P rules. Methods of distinguishing geometrical isomers.</i>	5	2
2.4	<i>Conformational analysis: Conformational analysis with respect to ethane, butane and cyclohexane. Relative stability and energy diagrams. Interconversion of Wedge formula, Newman, Sawhorse and Fischer projection formulae. Chair, boat and twist boat forms of cyclohexane with energy diagrams. Conformation of methyl cyclohexane. Origin of ring strain in cyclic systems. Baeyer's strain theory.</i>	4	2
3.0	Aliphatic Hydrocarbons and Alkyl Halides	12	
3.1	<i>Alkanes: Preparation - catalytic hydrogenation, Wurtz reaction, Wurtz-Fittig reaction, from Grignard reagent. Reactions - free radical substitution - halogenation.</i>	2	7
3.2	<i>Alkenes: Preparation - Elimination reactions - mechanism of E1 and E2 reactions. Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's and Hofmann's rules). Reactions - cis-addition (alkaline KMnO₄) and trans-addition (bromine). Addition of HX (Markownikoff's and anti-Markownikoff's addition with mechanisms), Hydration, Ozonolysis.</i>	3	7
3.3	<i>Alkynes: Preparation - Acetylene from CaC₂ and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides. Reactions - Acidity of alkynes, formation of metal acetylides, alkylation of terminal alkynes and conversion into higher alkynes, addition of bromine and alkaline KMnO₄.</i>	2	7
3.4	<i>Alkyl Halides: Preparation - From alkenes and alcohols. Reactions - Types of aliphatic nucleophilic substitution reactions - S_N¹ and S_N² mechanisms with stereochemical aspects and effects of substrate structure, solvent, nucleophile and leaving group.</i>	3	7
3.5	<i>Organometallic compounds of Mg (Grignard reagents) – Formation, structure and important reactions/synthetic applications.</i>	2	7
4.0	Aromatic Hydrocarbons and Aryl Halides	15	
4.1	<i>Aromaticity : Definition, Hückel's rule - application to benzenoid (benzene, naphthalene and anthracene) and non-benzenoid (cyclopropenyl cation, cyclopentadienyl anion and tropylium cation) compounds.</i>	4	8
4.2	<i>Benzene: Molecular orbital picture and resonance energy. Preparation - from phenol, by decarboxylation, from acetylene, from aromatic acids. Reactions - Electrophilic aromatic substitution: nitration, halogenation, sulphonation and Friedel-Craft's reaction (alkylation and acylation) with their mechanism. Orientation of aromatic substitution. <i>ortho</i>, <i>para</i> and <i>meta</i> directing effects of groups. Ring</i>	4	8

	activating and deactivating groups with examples. <i>Naphthalene and Anthracene</i> : Molecular orbital picture and resonance energy. Preparation - (of Naphthalene): Haworth synthesis		
4.3	Reactions - Electrophilic substitutions (halogenation, nitration and sulphonation) of naphthalene.	4	3
4.4	<i>Aryl Halides</i> : Preparation - chloro, bromo and iodo-benzene from phenol, Sandmeyer and Gattermann reactions. Reactions - aromatic nucleophilic substitutions – bimolecular displacement mechanism, elimination-addition (benzyne intermediate) mechanism.	3	4
5.0	Pericyclic Reactions		
5.1	Classification – electrocyclic reactions, cycloadditions - Diels-Alder reaction	2	5
5.2	Sigmatropic rearrangements - Claisen rearrangement (with mechanism).	2	5

References

1. Morrison, R.T., Boyd, R.N. & Bhattacharjee, S.K. *Organic Chemistry*, 7th ed., Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
2. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons, 2014.
3. McMurry, J. *Organic Chemistry*, 7th ed. Cengage Learning, 2013.
4. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, 1988.
5. Eliel, E.L. & Wilen, S.H. *Stereochemistry of Organic Compounds*, Wiley, 1994.
6. Finar, I.L. *Organic Chemistry* (Vol. 1 & 2), Dorling Kindersley (India) Pvt. Ltd (Pearson Education).
7. Jain, M.K. & Sharma, S.C. *Modern Organic Chemistry*, Vishal Publishing Co. 2010.
8. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
9. Kalsi, P. S. *Stereochemistry - Conformation and Mechanism*; New Age International, 2005.

Text Books for Enrichment

1. Pillai, C.N. *Organic Chemistry*, Universities Press, 2008.
2. Gupta, S.S. *Organic Chemistry*, Oxford College Press, 2014.

Course	Details				
Code	CH1813603				
Title	QUALITATIVE ORGANIC ANALYSIS				
Degree	B.Sc.				
Branch(s)	Chemistry				
Year/Semester	II/III				
Type	Core				
Credits	1	Hrs/Week	2	Total Hours	36

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Explain the chemistry of common organic chemistry reactions	U	PSO-1
2	Analyse various organic compounds using documented procedures	R	PSO-2
3	Classify organic compounds based on functional groups	Ap	PSO-1
4	Distinguish the reactions of various functional group	Ap	PSO-2

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Tests for elements: Nitrogen, Halogens and Sulphur Tests for unsaturation. Tests for aromatic character.	12	2
2.0	Study of the reactions of the following functional groups: carboxylic acid, 1,2-dicarboxylic acid, phenol, aldehyde, ketone, ester, reducing and nonreducing sugars, polynuclear hydrocarbon, primary, secondary and tertiary amines, amides, diamide, nitro and halogen compounds.	24	6

References

1. Furniss, B.S.; Hannaford, A.J.; Rogers, V. Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry*, 5th ed., Pearson Education, 2005.
2. Mann, F.G.; Saunders, B.C. *Practical Organic Chemistry*, 4th ed., Pearson Education, 2009.
3. Ahluwalia, V.K.; Dhingra, S. *Comprehensive Practical Organic Chemistry – Qualitative Analysis*, Universities Press, 2000.
4. Vishnoi, N.K. *Advanced Practical Organic Chemistry*, 3rd ed., Vikas Publishing House, New Delhi, 2010.

SEMESTER IV				
Course Code	Title of the Course	Course Category	Hours/week	Credits
EN1814507	Illuminations	Common I English – 6	5	4
	Additional Language	Common Course II		
HN1814506	Drama and Long Poem	Common II – Hindi 4		
	MalayalaGadyarachanakal	Common II – Malayalam 4	5	4
SC1814506	Poetry, Grammar & Syriac Heritage in India	Common II – Syriac 4		
CH1814104	Organic Chemistry –II	Core course-4	3	3
CH1814604	Qualitative Organic Analysis	Core Practical-4	2	1
MT1814206	Fourier series, Laplace transform and complex analysis	Complementary 4 - Mathematics	5	4
PH1814208	Optics And Solid State Physics	Complementary 4 - Physics	3	3
PH1814708	Optics And Solid State Physics (P)	Complementary 4 – Physics Practical	2	1
		Total	25	20

Course	Details				
Code	CH1814104				
Title	ORGANIC CHEMISTRY –II				
Degree	B.Sc.				
Branch(s)	Chemistry				
Year/Semester	II/IV				
Type	Core				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Reproduce the various synthetic methods leading to alcohols, carbonyl compounds and carboxylic acids	R	PSO-1
2	Verify the number of alkoxy groups present in a molecule	Ap	PSO-5
3	Predict the reactivity of alcohols and carbonyl compounds	Ap	PSO-4
4	Devise synthetic procedures based on rearrangements	C	PSO-3
5	Examine the reactivity of carboxylic acids	An	PSO-4
6	Decide the effect of substituents on the reactivity of carboxylic acids	Ap	PSO-1
7	Summarise the general reactions of sulphonic acids	U	PSO-1
8	Recall the synthesis and reactivity of carboxylic acid derivatives	U	PSO-3

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Alcohols, Phenols and Ethers	16	
1.1	Alcohols: Preparation - 1, 2 and 3 alcohols using Grignard reagent, ester hydrolysis, reduction of aldehydes, ketones, carboxylic acids and esters (Bouveault-Blanc reduction). Reactions - with sodium, HX (Lucas test), esterification, oxidation (with PCC, alkaline KMnO ₄ , OsO ₄ , acidic dichromate, conc. HNO ₃). Oppenauer oxidation (with mechanism). Ascent and descent of alcohol series.	7	1
1.2	<i>Diols</i> : Preparation - hydroxylation of alkenes, hydrolysis of epoxides. Reactions - oxidative cleavage of diols using lead tetraacetate and periodic acid. Pinacol - Pinacolone rearrangement (with mechanism).	2	3
1.3	<i>Phenols</i> : Preparation - cumene hydroperoxide method, from diazonium salts. Reactions - Electrophilic substitution - nitration, halogenation and sulphonation. Reimer-Tiemann reaction and Fries rearrangement (with mechanisms). Preparation and uses of nitrophenols, picric acid, resorcinol and quinol.	4	1
1.4	<i>Ethers and Epoxides</i> : Preparation - ethers and epoxides - Williamson's ether synthesis. Reactions of ethers - cleavage with HI. Zeisel's method of estimation of alkoxy groups. Reactions of epoxides - with alcohols, ammonia derivatives and LiAlH ₄ .	3	2

2.0	Aldehydes and Ketones	20	
2.1	Preparation, properties and reactions of formaldehyde, acetaldehyde, acetone, benzaldehyde and benzophenone.	4	1
2.2	Preparation - from alcohols, acid chlorides, esters and nitriles. Reactions - Structure of the carbonyl group and acidity of α -hydrogen. (i) Additions reactions - with HCN, ROH, NaHSO ₃ , Grignard reagents and ammonia derivatives.	4	3
2.3	Aldol, Claisen, Claisen-Schmidt, Knoevenagel and Benzoin condensations (with mechanisms). Cannizzaro reaction, Wittig reaction and Mannich reaction (with mechanisms). Michael addition (with mechanism)	4	3
2.4	(ii) Oxidation reactions - Tollen's and Fehling's tests, Iodoform test, Baeyer-Villiger oxidation (with mechanism) (iii) Reduction reactions - Clemmensen, Wolff-Kishner, Meerwein-Ponndorff-Verley, LiAlH ₄ , and NaBH ₄ reductions (with mechanisms)	4	4
2.5	(iv) Rearrangement reactions - Beckmann, and benzil-benzilic acid rearrangements (with mechanisms).	4	4
3.0	Carboxylic Acids, Sulphonic Acids and their Derivatives	18	
3.1	Preparation - Oxidation of alcohols and aldehydes, hydrolysis of nitriles, side chain oxidation and carbonylation of grignard reagents. Acidic and alkaline hydrolysis of esters.	4	5,6
3.2	Reactions - structure of carboxylate ion, effect of substituents on acid strength. Ascent and descent of acid series. Reduction and decarboxylation reactions.	3	5,6
3.3	Reactions with PCl ₅ , PCl ₃ and SOCl ₂ . Reaction with ammonia, esterification and halogenation. Hell - Volhard - Zelinsky reaction (with mechanism).	3	5,6
3.4	Carboxylic acid derivatives (aliphatic): <i>Preparation</i> - acid chlorides, anhydrides, esters and amides from acids. Reactions - comparative study of nucleophilicity of acyl derivatives. Perkin condensation and Reformatsky reaction (with mechanisms).	4	8
3.5	Dicarboxylic acids, hydroxy acids and unsaturated acids Methods of formation, important reactions and uses of dicarboxylic acids, hydroxy acids and unsaturated acids like oxalic acid, malonic acid, adipic acid, phthalic acid, citric acid, salicylic acid, cinnamic acid, anthranilic acid, acrylic acid, maleic acid and fumaric acid.	2	1
3.6	Sulphonic acids and their derivatives Preparation, reactions and uses of benzene sulphonic acid, benzene sulphonyl chloride and ortho- and para- toluene sulphonyl chlorides.	2	7

References

1. Morrison, R.T., Boyd, R.N. & Bhattacharjee, S.K. *Organic Chemistry*, 7th ed., Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
2. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, Wiley, 2014.
3. McMurry, J. *Organic Chemistry*, 7th ed. Cengage Learning, 2013.
4. Finar, I.L. *Organic Chemistry* (Vol. 1), Dorling Kindersley (India) Pvt. Ltd (Pearson Education).
5. Carey, F.A., Giuliano, R.M. *Organic Chemistry*, 8th ed., Tata McGraw Hill, 2012
6. Jain, M.K. & Sharma, S.C. *Modern Organic Chemistry*, Vishal Publishing Co. 2010.
7. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
8. Tewari, K.S. & Vishnoi, N.K. *Organic Chemistry*, Vikas Publishing House, 2012.

Text Books for Enrichment

9. Pillai, C.N. *Organic Chemistry*, Universities Press, 2008.
10. Gupta, S.S. *Organic Chemistry*, Oxford College Press,

Course	Details				
Code	CH1814604				
Title	QUALITATIVE ORGANIC ANALYSIS				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester	II/ IV				
Type	Core				
Credits	1	Hrs/Week	2	Total Hours	36

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Explain the chemistry of common organic chemistry reactions	U	PSO-1
2	Analyse various organic compounds using documented procedures	R	PSO-2
3	Synthesise specific organic compounds using documented procedures	Ap	PSO-4
4	Determine the physical constants	E	PSO-3
5	Classify organic compounds based on functional groups	Ap	PSO-1
6	Distinguish the reactions of various functional group	Ap	PSO-2

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Determination of physical constants of solids and liquids – melting and boiling points.	6	4
2.0	Systematic analysis and preparation of solid derivative of the following organic compounds: carboxylic acid, 1,2-dicarboxylic acid, unsaturated acids, phenol, hydroxy acids, aldehyde, ketone, ester, reducing and nonreducing sugars, polynuclear hydrocarbon, primary, secondary and tertiary amines, amide, diamide, nitro and halogen compounds	30	2,3,4

References

- Furniss, B.S.; Hannaford, A.J.; Rogers, V. Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry*, 5th ed., Pearson Education, 2005.
- Mann, F.G.; Saunders, B.C. *Practical Organic Chemistry*, 4th ed., Pearson Education, 2009.
- Ahluwalia, V.K.; Dhingra, S. *Comprehensive Practical Organic Chemistry – Qualitative Analysis*, Universities Press, 2000.
- Vishnoi, N.K. *Advanced Practical Organic Chemistry*, 3rd ed., Vikas Publishing House, New Delhi, 2010.

SEMESTER V				
Course Code	Title of the Course	Course Category	Hours/week	Credits
CH1815106	Organic Chemistry-III	Core Course-5	3	3
CH1815606	Organic Preparations and basic laboratory Techniques-Practical	Practical Core Course-5	2	1
CH1815107	Physical Chemistry -1	Core Course-6	2	2
CH1815607	Physical Chemistry Practical	Practical Core Course-6	3	1
CH1815108	Physical Chemistry-II	Core Course -7	2	3
CH1815605	Qualitative Inorganic Analysis- Practical	Practical Core Course-7	3	1
CH1815105	Environmental Chemistry and Human Rights	Core Course-8	4	4
CH1815401	Forensic Science	Open Course	4	3
CH1815801	Project	Core Course	2	-
		Total	25	18

Course	Details				
Code	CH1815106				
Title	Organic chemistry III				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester	3/ V				
Type	Core				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	<i>Expected Course Outcomes</i> <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Understand the chemistry of nitro-compounds and amines.	U	PSO-1
2	Distinguish primary, secondary and tertiary amines in a mixture of amines.	Ap	PSO-2
3	Explain the stereochemistry of amines and preparation and applications of diazonium salts.	An	PSO-2
4	Illustrate the preparation and applications of phenyl hydrazine, diazomethane, diazoacetic ester and to explain various name reactions.	Ap	PSO-1
5	Define heterocyclic compounds and their aromaticity.	R	PSO-1
6	Explain the synthesis and reactions of heterocyclic compounds.	An	PSO-1
7	Identify active methylene compounds and to explain its preparation, isomerism and applications.	R	PSO-1
8	Classify carbohydrates and to illustrate its structure and properties.	An	PSO-1
9	Show the inter-conversion of aldoses and ketoses.	Ap	PSO-1
10	Categorize carbohydrates into mono, di and polysaccharides.	An	PSO-1
11	Explain artificial sweeteners and applications of polysaccharides.	An	PSO-1
12	Discuss the classification uses and mode of action of various drugs.	E	PSO-1
13	Predict the after effects of drug addiction and drug abuse, propose prevention and treatment.	C	PSO-1
14	Verify colour and constitution, explain the classification, preparation and applications of Dyes.	E	PSO-2
15	Discuss the classification, polymerization mechanism and Recycling of plastics.	E	PSO-6

*PSO-Program Specific Outcome; CO-Course Outcome;
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Nitrogen Containing Compounds		
1.1	Nitro compounds (aliphatic and aromatic): Preparation: Methods of preparation of nitroalkanes and aromatic nitro compounds. Reactions: Tautomerism of nitromethane. Reduction products of nitrobenzene in acidic, neutral and alkaline media. Electrolytic reduction and selective reduction of polynitro compounds. Formation of charge transfer complexes.	2	1
1.2	Amines (aliphatic and aromatic): Preparation: From alkyl halides, Reduction of nitro compounds and nitriles, Reductive amination of aldehydes and ketones, Gabriel's phthalimide synthesis, Hofmann bromamide reaction (with mechanism).	2	1
1.3	Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO ₂ .	2	2
1.4	Separation of a mixture of 1°, 2° and 3° amines using Hinsberg reagent. Stereochemistry of amines.	2	2
1.5	Structural features affecting basicity of aliphatic and aromatic amines. Comparative study of aliphatic and aromatic amines. Schotten – Baumann Reaction (with mechanism).	2	3
1.6	Electrophilic substitution reactions of aniline: Halogenation, nitration and sulphonation. Quaternary amine salts as phase-transfer catalysts.	1	3
1.7	Diazonium salts: Preparation: From aromatic amines. Reactions: Structure and stability of benzene diazonium salts. Conversion to benzene, phenol, chloro, bromo, iodo and fluoro benzenes, nitro benzene and azo dyes.	1	3
1.8	Mechanisms of Sandmeyer and Gatterman reactions. Schiemann and Gomberg reactions.	1	3
1.9	Preparation, structure and uses of Phenyl hydrazine, Diazomethane and Diazoacetic ester. Arndt – Eistert synthesis – Mechanism of Wolff rearrangement.	2	4
2.0	Heterocyclic Compounds		
2.1	Classification and nomenclature. Structure and aromaticity of 5-membered and 6-membered rings containing one heteroatom.	2	5
2.2	Synthesis and reactions of: Furan, Thiophene, Pyrrole (Paal Knorr synthesis and Knorr pyrrole synthesis)	2	6
2.3	Pyridine (Hantzsch synthesis), Indole (Fischer's indole synthesis),	2	6
2.4	Quinoline (Skraup synthesis and Friedlander's synthesis) and Isoquinoline (Bischler-Napieralski reaction).	2	6
3.0	Active Methylene Compounds		
3.1	Preparation: Ethyl acetoacetate by Claisen ester condensation. Reactions: Keto-enol tautomerism.	1	7
3.2	Synthetic uses of ethylacetoacetate, diethyl malonate and ethyl cyanoacetate (preparation of non-heteromolecules only).	3	7
3.3	Alkylation of carbonyl compounds via enamines.	1	7

4.0	Carbohydrates		
4.1	Classification of carbohydrates. Reducing and non-reducing sugars. General Properties of Glucose and Fructose, their open chain structure.	2	8
4.2	Epimers, mutarotation and anomers.	1	8
4.3	Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose.	2	9
4.4	Chain lengthening and chain shortening of aldoses - Kiliani-Fischer synthesis and Wohl degradation. Interconversion of aldoses and ketoses	2	9
4.5	Linkage between monosaccharides. Structure of the disaccharides sucrose, maltose and cellobiose (excluding their structure elucidation).	2	10
4.6	Reactions and uses of sucrose. Artificial sugars (sweeteners) – sucralose.	1	11
4.7	Structure of the polysaccharides starch and cellulose (excluding their structure elucidation). Industrial applications of cellulose	1	11
5.0	Drugs		
5.1	Classification of drugs. Structure, therapeutic uses and mode of action (synthesis not required) of Antibiotics: Ampicillin and Chloramphenicol,	2	12
5.2	Sulpha drugs: Sulphanilamide, Antipyretics: Paracetamol, Analgesics: Aspirin and Ibuprofen.	1	12
5.3	Antimalarials: Chloroquine, Antacids: Ranitidine, Anti-cancer drugs: Chlorambucil and Anti-HIV agents: Azidothymidine (Zidovudine)	1	12
5.4	Psychotropic drugs: Tranquilizers, antidepressants and stimulants with examples. Drug addiction and abuse. Prevention and treatment.	1	13
6.0	Dyes		
6.1	Theories of colour and chemical constitution. Classification of dyes – according to chemical constitution and method of application. Natural and synthetic dyes.	1	14
6.2	Synthesis and applications of: Azo dyes – Methyl orange; Triphenyl methane dyes - Malachite green and Rosaniline	1	14
6.3	Synthesis and applications of Phthalein dyes – Phenolphthalein and Fluorescein	1	14
6.4	Synthesis and applications of Indigoid dyes - Indigotin; Anthraquinoid dyes – Alizarin. Edible dyes (Food colours) with examples.	1	14
7.0	Polymers		
7.1	Introduction and classification. Polymerisation reactions - Addition and condensation - Mechanism of cationic, anionic and free radical addition polymerization	1	15
7.2	Metallocene-based Ziegler-Natta polymerisation of alkenes	1	15
7.3	Preparation and applications of plastics – thermosetting (Phenol-formaldehyde, Urea-formaldehyde, Polyurethane) and thermosoftening (Polythene, PVC); Fibres (acrylic, polyamide,	2	15

	polyester).		
7.4	Synthetic rubbers – SBR, Nitrile rubber and Neoprene. Introduction to conducting polymers with examples. Environmental hazards and biodegradability of polymers. Recycling of plastics.	2	15

Text Books for Reference

1. Morrison, R.T., Boyd, R.N. & Bhattacharjee, S.K. Organic Chemistry, 7th ed., Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
2. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. Organic Chemistry, Wiley, 2014.
3. McMurry, J. Organic Chemistry, 7th ed. Cengage Learning, 2013.
4. Finar, I.L. Organic Chemistry (Vol. 1 & 2), Dorling Kindersley (India) Pvt. Ltd (Pearson Education).
5. Jain, M.K. & Sharma, S.C. Modern Organic Chemistry, Vishal Publishing Co. 2010.
6. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
7. John R. Dyer: Applications of Absorption Spectroscopy of Organic Compounds, Prentice Hall.
8. R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of Organic Compounds, Wiley.

Text Books for Enrichment

1. Pillai, C.N. Organic Chemistry, Universities Press, 2008.
2. Gupta, S.S. Organic Chemistry, Oxford University Press, 2014.

Course	Details				
Code	CH1815107				
Title	PHYSICAL CHEMISTRY – I				
Degree	B.Sc.				
Branch(s)	Chemistry				
Year/Semester	III/V				
Type	Core				
Credits	2	Hrs/Week	2	Total Hours	36

CO No.	Expected Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Understand the intermolecular forces in gases and Perform calculations based on gas laws and van der Waals equation	Ap	PSO-1 PSO-4
2	Learn and perform calculations based on different gas velocities, Boltzmann distribution and collision properties	An	PSO-1 PSO-4
3	Understand the intermolecular forces in liquids and determine the surface tension and viscosity of liquids	E	PSO-1 PSO-4
4	Learn the laws of crystallography, structure of various solids and identify Bravais lattice from unit cell parameters	An	PSO-1 PSO-4
5	Predict the lattice type (cubic) from X-ray diffraction data, Perform calculations based on Bragg's equation and other crystallographic data	C	PSO-1 PSO-4 PSO-5
6	Understand semiconductors, the defects in crystals, superconductivity	U	PSO-1

7	Understand the types and structure and applications of liquid crystals	U	PSO-1 PSO-4 PSO-5
8	Understand the phenomenon of adsorption	U	PSO-1
9	Determine the surface area from Langmuir and BET data	E	PSO-1 PSO-4
10	Understand preparation, purification and properties of colloids	U	PSO-1

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO No.
1	Gaseous State	12	
1.1	Postulates of kinetic theory of gases and derivation of kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases.	3	1
1.2	Boyle temperature (derivation not required). Critical phenomena and Andrews isotherms of CO ₂ , critical constants and their calculation from van der Waals equation.	3	1
1.3	Virial equation of state, van der Waals equation expressed in virial form.	1	1
1.4	Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphical representation – derivation not required) and their importance. Temperature dependence of these distributions.	2	2
1.5	Most probable, average and root mean square velocities (no derivation).	1	2
1.6	Collision properties: Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Relation between mean free path and coefficient of viscosity.	2	2
2	Liquid State	3	
2.1	Intermolecular forces in liquids (qualitative idea only).	1	3
2.2	Surface tension and its measurement by stalagmometer method, factors affecting Surface tension	1	3
2.3	Viscosity, Poiseuille's equation, Determination of viscosity by Ostwald's viscometer.	1	3
3	Solid State	12	
3.1	The nature of the solid state – anisotropy –Forms of solids. Crystal lattice, unit cells, crystal systems, Bravais lattice types and identification of lattice planes, density of cubic crystals.	2	4
3.2	Laws of Crystallography – Law of constancy of interfacial angles, Law of rational indices. Miller indices.	2	4
3.3	X-Ray diffraction by crystals, Bragg's law. Bragg's X-ray diffractometer method and powder pattern method.	2	5
3.4	Analysis of powder diffraction patterns of NaCl and KCl,	2	5
3.5	Structure of ionic compounds of the type AX (NaCl, CsCl, ZnS) and AX ₂ (CaF ₂ , Na ₂ O)	1	5
3.6	Defects in crystals – stoichiometric and non-stoichiometric defects, extrinsic and intrinsic defects.	1	6

3.7	Electrical conductivity, semiconductors, n-type, p-type, Superconductivity – an introduction.	1	6
3.8	Liquid crystals and its thermographic behaviour. Classification, structure of nematic and cholestric phases	1	7
4	Surface Chemistry and Colloidal State	9	
4.1	Adsorption – types, adsorption of gases by solids – factors influencing adsorption – Freundlich adsorption isotherm	1	8
4.2	Langmuir adsorption isotherm –derivation of Langmuir adsorption isotherm. The BET theory (no derivation) – use of BET equation for the determination of surface area.	2	9
4.3	Types of solutions – true, colloid and suspensions, Purification of colloids – Ultra filtration and electro-dialysis, optical and electrical properties of colloids.	3	10
4.4	Electrical double layer and zeta potential. Coagulation of colloids, Hardy-Schulz rule.	2	10
4.5	Micelles and critical micelle concentration, sedimentation and streaming potential.	1	10

References

1. R P W Atkins, “*Physical Chemistry*”, Oxford College Press
2. R J Silby and R A Alberty, “*Physical Chemistry*”, John Wiley & Sons
3. F Daniels and A Alberty, “*Physical Chemistry*”, Wiley Eastern
4. Puri, Sharma and Pathania, “*Principles of Physical Chemistry*”, Millennium Edition, Vishal Publishing Co
5. Barrow, G.M. “*Physical Chemistry*”, Tata McGraw-Hill (2007).
6. Castellan, G.W. “*Physical Chemistry*”, 4th Ed. Narosa (2004).
7. K. L. Kapoor, “*A Textbook of Physical chemistry*”, Volume 1, Macmillan India Ltd.,
8. B. R. Puri, L. R. Sharma, M. S. Pathania, “*Elements of Physical chemistry*”, Vishal Pub. Co.,
9. L V Azaroff, “*Introduction to Solids*”, McGraw Hill.
10. N B Hannay, “*Solid State Chemistry*”, Prentice Hall.

Text Books for Enrichment

1. A. McQuarrie, J. D. Simon, “*Physical Chemistry – A molecular Approach*”, Viva Books Pvt. Ltd.
2. Anthony R. West, “*Solid State Chemistry and its Applications*”, Wiley Eastern.

Course	Details				
Code	CH1815108				
Title	Physical Chemistry II				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester	III/5				
Type	Core				
Credits	3	Hrs/Week	2	Total Hours	36

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Discuss and interpret experiments that reveal the wave properties of matter, as well as how this motivates replacing classical mechanics with a wave equation.	U	PSO-1
2	Solve the Schrödinger equation for simple systems in one to three dimensions analytically and use these solutions to calculate associated probabilities, expectation values as well as give concise physical interpretations and reasoning underlying the mathematical results.	U	PSO-1
3	Outline the basic quantum-mechanical approach to deriving molecular orbitals from atomic orbitals and describe traits of bonding and antibonding molecular orbitals	U	PSO-1
4	Describe the basics behind interaction between light and matter and account for the most common spectroscopic methods and their possibilities and limitations for studies of molecules in the MW, IR, Raman, NMR, ESR and UV-Vis areas.	U	PSO-1 PSO-4 PSO-5
5	Calculate different molecular parameters for simple molecules from their MW, IR	Ap	PSO-4 PSO-5
6	Account for different types of electronic transitions and de-excitation process and electronic states.	U	PSO-1
7	Describe the relationship between absorbance, molar absorptivity, path length, and concentration in Beer's Law and predict how the intensity of light absorbed/transmitted will change with changes in solution type, solution concentration, container width, or light source.	U	PSO-1, PSO-4
8	Understand how nuclear spins are affected by a magnetic field, and be able to explain what happens when radiofrequency radiation is absorbed.	U	PSO-1
9	Understand the basics of ESR spectroscopy and explain the ESR spectrum of methyl methyl radical.	U	PSO-1, PSO-4

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1	Quantum Mechanics	18	
1.0	Blackbody Radiation, Planck's Quantum Hypothesis	1	1
1.1	The Photoelectric Effect, Vibrations of Atoms in Crystals	1	1
1.2	The Hydrogen Atomic Spectrum, The Rydberg Formula	1	1
1.3	Angular Momentum, Quantized Angular Momentum	1	1
1.4	De Broglie Waves, The Relation between de Broglie Waves and Quantized Angular Momentum	1	1
1.5	Davisson and Germer's experiment	1	1
1.6	The Heisenberg Uncertainty Principle.	1	1
1.7	Postulates of quantum mechanics: Schrodinger wave equation – significance of Ψ , well behaved wave functions	1	1
1.8	Concept of operators, Operator algebra, Linear and Hermitian operators, Laplacian and Hamiltonian operators, Eigen functions and Eigen values of an operator.	2	1
1.9	Particle in 1-D box, normalization of wave function, application to linear conjugated polyene (butadiene).	2	2
1.10	Introductory treatment of Schrödinger equation for hydrogen atom.– The wave equation in spherical polar coordinates (derivation not required) - Separation of wave equation - Radial and angular functions (derivation not required) – Orbitals	2	2
1.11	Quantum numbers and their importance	1	2
1.12	Hydrogen like wave functions – radial and angular wave functions, radial distribution curves.	1	2
1.13	Molecular orbital theory: basic ideas – criteria for forming MO from AOs, construction of molecular orbital by LCAO method for H_2^+ ion (elementary idea only)	1	3
1.14	physical picture of bonding and anti bonding wave functions, concept of σ , σ^* , π , π^* orbitals and their characteristics.	1	3
2	Molecular Spectroscopy- I	8	
2.0	Introduction: electromagnetic radiation, regions of the spectrum, interaction of electromagnetic radiation with molecules, various types of molecular spectroscopic techniques	1	4
2.1	Born-Oppenheimer approximation	1	4
2.2	<i>Rotation spectroscopy</i> : Introduction to rotational spectroscopy, Rotational energy levels, Selection rules.	1	5
2.3	<i>Vibrational spectroscopy</i> : Introduction, Selection Rules, Classical equation of vibration, calculation of force constant	1	4,5
2.4	concept of anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands	1	4,5
2.5	Degrees of freedom for polyatomic molecules, modes of vibration (H_2O and CO_2 as examples), finger print region, Fermi resonance.	1	4,5
2.6	<i>Raman spectroscopy</i> : Introduction, Classical and quantum	1	4

	treatment of Raman effect, Qualitative treatment of Rotational Raman effect;		
2.7	Vibrational Raman spectra, Stokes and anti-Stokes lines: their intensity difference, rule of mutual exclusion.	1	4
3	Molecular Spectroscopy- II	10	
3.0	<i>Electronic spectroscopy</i> : Introduction, selection rule	1	6,7
3.1	Franck-Condon principle, electronic transitions	1	6,7
3.2	Singlet and triplet states, dissociation and predissociation	1	6,7
3.3	Polyatomic molecules – qualitative description of σ , π and n-molecular orbitals, their energy levels and the respective transitions	2	6
3.4	Lambert-Beer's law.	1	7
3.5	<i>Nuclear Magnetic Resonance (NMR) spectroscopy</i> : Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling.	2	8
3.6	<i>Electron Spin Resonance (ESR) spectroscopy</i> : Principle, hyperfine structure, ESR of simple radical - methyl radical.	2	9

Text Books for Reference

1. Mc Quarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books
2. Banwell, C. N. & Mc Cash, E. M. *Fundamentals of Molecular Spectroscopy*, 4th Ed. Tata McGraw-Hill: New Delhi (2006)

Text Books for Enrichment

1. I. N. Levine, *Physical Chemistry*, Tata McGraw Hill
2. N. J. Turro, *Modern Molecular Photochemistry*, 4th Edition College Science

Course	Details				
Code	CH1815105				
Title	ENVIRONMENTAL CHEMISTRY AND HUMAN RIGHTS				
Degree	B.Sc.				
Branch(s)	Chemistry				
Year/Semester	III/5				
Type	Core				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Identify various types of natural resources, human impact on these resources, and common resource management practices	R	PSO-1
2	Develop skills and a commitment to act independently and collectively to sustain and enrich the environment.	U	PSO-1
3	Understand the multidisciplinary nature, important theories and concepts of environmental science, ecosystems, natural resources and conservation	U	PSO-1
4	Describe environmental hazards and risks and the social and economic ramifications	E	PSO-1
5	Familiarize with the major environmental problems its causes and potential solutions	U	PSO-1
6	Discuss the Toxicology and Toxicological Effects of Pollution	U	PSO-1
7	Understand the basic concept of green chemistry	U	PSO-1
8	Describe the basic concept of nuclear chemistry and perform calculations based on it	AP	PSO-1
9	Debate issues related to nuclear waste management	E	PSO-1
10	Create awareness on various environmental acts in India	C	PSO-1
11	Identify issues and problems relating to the human rights.	U	PSO-1
12	Analyse country's situation or international situation in terms of human rights.	An	PSO-1

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO No.
1.0	Module 1	18	
1.1	Multidisciplinary nature of environmental studies Definition, scope and importance. Need for public awareness	2	3
1.2	Natural Resources and associate problems - Introduction, renewable and non-renewable resources	1	1,3
1.2.1	Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.	1	1
1.2.2	Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.	1	1
1.2.3	Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.	2	1
1.2.4	Food resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.	2	1
1.2.5	Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources, case studies.	1	1
1.2.6	Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification	1	1
1.2.7	Role of individual in conservation of natural resources. Equitable use of resources for sustainable life styles	1	2
1.3	Ecosystems - Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem	2	3
1.3.1	Ecological succession, food chains, food webs and ecological pyramids.	1	3
1.3.2	Introduction, types, characteristic features, structure and function of the given ecosystem- Forest ecosystem, grassland, desert	2	3
1.3.3	Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries.	1	3
2.0	Module 2	9	
2.1	Biodiversity and its conservation- Introduction, Definition: genetic, species and ecosystem diversity.	1	1,3
2.1.1	Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values	2	3
2.1.2	Biodiversity at global, national and local levels, India as a mega-diversity nation	2	3
2.1.3	Hot-spots of biodiversity	1	3
2.1.4	Threats to biodiversity: habitat loss, poaching of wildlife,	2	5

	man-wildlife conflicts. Endangered and endemic species of India.		
2.1.5	Conservation of biodiversity: In situ and Ex situ conservation of biodiversity	1	1,3
2.2	ENVIRONMENTAL POLLUTION AND SOCIAL ISSUES	18	4,5
2.2.1	Pollution Introduction and types of pollution	1	4,5
2.2.2	Causes, effects and control measures of: - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards and Municipal solid waste	3	4,5
2.2.3	Pollution case studies (Local and National). Role of an individual in prevention of pollution.	2	4,5
2.2.4	Disaster management: floods, earthquake, cyclone and landslides.	2	4,5
2.2.5	Environmental ethics: Consumerism, sustainable development	1	2
2.2.6	Water conservation, rain water harvesting, watershed management: its problems and concerns. Ramsar sites in Kerala	2	5,2
2.2.7	Climate change, global warming	1	5
2.2.8	Acid rain, ozone layer depletion	1	5
2.2.9	Environment Protection Act (1986) Air (Prevention and Control of Pollution) Act (1981)	2	10
2.2.10	Water (Prevention and control of Pollution) Act (1974), Wildlife Protection Act (1972).	1	10
2.2.11	Forest Conservation Act(1980). Issues involved in enforcement of environmental legislation. Biodiversity Act (2002)	2	10
3	Toxicology and Toxicological Effects of Pollution	3	
3.1	Toxic chemicals in the environment, impact of toxic chemicals on enzymes, biochemical effects of As, Cd, Pb, Hg, CO, Oxides of Nitrogen and Sulphur	2	6
3.2	Introduction to Green Chemistry		
	Introduction to green chemistry, twelve principles of green chemistry, atom economy – examples.	1	7
4	Environmental Aspects of Nuclear Chemistry	9	
4.1	Natural radioactivity. Modes of decay- group displacement law – rate of decay – decay constant – half-life period – Gieger-Nuttall rule	2	8
4.2	Disintegration series – transmutation reactions using protons, deuterons, α -particles and neutrons. Artificial radioactivity – positron emission and K electron capture – trans uranic elements, spallation reactions.	2	8
4.3	Applications of radioactivity: Radio carbon dating – rock dating – isotopes as tracers – study of reaction mechanism (ester hydrolysis).	2	8
4.4	Application of radioactive isotopes in medicine. Nuclear fission - atom bomb - nuclear reactors – fast breeder reactors. Nuclear fusion and hydrogen bomb.	2	8
4.5	Nuclear waste and its impact on environment – nuclear waste	1	9

	management		
5	Introduction to Human Rights	15	
5.1	An introduction to human rights, meaning, concept and development.	2	12
5.2	Three Generations of human rights (civil and political rights; economic, social and cultural rights).	2	12
5.3	Human Rights and United Nations Contributions, main human rights related organs - UNESCO, UNICEF, WHO, ILO	2	12
5.4	Mechanisms for checking violations of Human rights, National human right commission	1	12
5.5	Declarations for women and children, universal declaration of human rights.	1	11,12
5.6	Human rights in India – fundamental rights and Indian constitution, rights for children and women, Euthanasia, scheduled castes, scheduled tribes, other backward castes and minorities	2	11,12
	Visit to a local area to document environmental assets : community Initiatives in watershed management: Case study – Meenachil- Meenanthara- Kodur River re-linking Programme (Kottayam district)	5	

References

1. Bharucha Erach, Text Book of Environmental Studies for undergraduate Courses. College Press, IInd Edition 2013 (TB)
2. Clark.R.S., Marine Pollution, Clanderson Press Oxford (Ref)
Cunningham, W.P.Cooper, T.H.Gorhani, E & Hepworth, M.T.2001 Environmental Encyclopedia, Jaico Publ. House. Mumbai. 1196p .(Ref)
3. De A.K.Environmental Chemistry, Wiley Eastern Ltd.(Ref)
4. Down to Earth, Centre for Science and Environment (Ref)
5. Heywood, V.H & Watson, R.T. 1995. Global Biodiversity Assessment, Cambridge College Press 1140pb (Ref)
6. Jadhav.H & Bhosale.V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284p (Ref)
7. Mekinney, M.L & Schock.R.M. 1996 Environmental Science Systems & Solutions. Web enhanced edition 639p (Ref)
8. Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co. (TB)
Odum.E.P 1971. Fundamentals of Ecology. W.B. Saunders Co. USA 574p (Ref)
10. Rao.M.N & Datta.A.K. 1987 Waste Water treatment Oxford & IBII Publication Co.Pvt.Ltd.345p (Ref)
11. Rajagopalan. R, Environmental Studies from crisis and cure, Oxford College Press, Published: 2016 (TB)
12. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut (Ref)
13. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (Ref)
14. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media (Ref)
15. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (Ref)
16. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p (Ref)
17. H.J. Arnika, Essentials of Nuclear Chemistry, 4th Edition, New Age International (P) Ltd., New Delhi, 1995 (Reprint 2005).
18. S. Glasstone, Source Book on Atomic Energy, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, 1967.
19. U.N. Dash, Nuclear Chemistry, Sultan Chand and Sons (1991).

Course	Details				
Code	CH1815401				
Title	FORENSIC SCIENCE (OPEN COURSE)				
Degree	BA/BSC/BCOM (UNDERGRADUATE)				
Branch(s)					
Year/Semester	III/5				
Type	OPEN COURSE				
Credits	3	Hrs/Week	4	Total Hours	72

CO No.	<i>Expected Course Outcomes</i> <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Interpret crime investigation through diagnosis of poisoning and post-mortem.	U	PSO1
2	Describe heavy metal contamination in sea foods and their analysis.	R	PSO2
3	Explain explosions, causes and the security measures, bombs and corrosive chemicals.	U	PSO6
4	Define various security measures for VVIP and also explain metal detectors.	R	PSO1
5	Explain the methods of detecting, forgery in banks and educational records.	U	PSO3
6	Determine the purity of gold and the authenticity of diamond	Ap	PSO2
7	Analyse various tracks and traces (blood, urine, saliva, semen, fingerprints, footprints, hair, head, teeth etc.) and to distinguish various breeds of police dogs and their duties	An	PSO4
8	Predict the identification of DNA and steroid consumption in athletes and race horses.	C	PSO5
9	Describe the chemical methods used in crime investigation(Medical Aspects) (AIDS, burns, Plastic surgery)	R	PSO3
10	Discuss the classification and chemistry of arson and ballistics	E	PSO1

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	POISONS		
1.1	Poisons-types and classification-diagnosis of poisons in the living and the dead	3	1
1.2	Treatment in cases of poisoning - use of antidotes for common poisons.	3	1
1.3	Clinical symptoms – Post-mortem appearances	3	1
1.4	Heavy metal contamination (Hg, Pb, Cd) of sea foods-use of neutron activation analysis in detecting Arsenic in human hair	3	2
2.0	CRIME DETECTION		
2.1	Accidental explosion during manufacture of matches and fire works. Human bombs possible explosives (gelatin sticks and RDX)	3	3
2.2	Composition of bullets and detecting powder burn	3	3
2.3	Analysis of incendiary and timed bombs - spill of toxic and corrosive chemicals from tankers	3	3
2.4	Metal detector devices and other security measures for VVIP-	3	4
3.0	FORGERY AND COUNTERFEITING		
3.1	Documents - different types of forged signatures-simulated and traced forgeries	3	5
3.2	Inherent signs of forgery methods - writing deliberately modified - uses of ultraviolet rays	1	5
3.3	Comparison of type written letters - checking silver line water mark in currency notes	2	5
3.4	Alloy-analysis using AAS to detect counterfeit coins	2	5
3.5	Detection of gold purity in 22 carat ornaments - detecting gold plated jewels - authenticity of diamond	4	6
4.0	TRACKS AND TRACES		
4.1	Tracks and traces - small tracks and police dogs-	2	7
4.2	Foot prints - casting of foot prints – residue prints, walking pattern or tyre marks - miscellaneous traces and tracks	3	7
4.3	Glass fracture – tool mark paints – fibres	2	7
4.4	Analysis of biological substances - blood, saliva	2	7
4.5	Urine and hair analysis	2	7
4.6	Cranial analysis (head and teeth).	2	7
4.7	Fingerprints and their analysis	2	7
4.8	DNA Finger printing for tissue identification in dismembered Bodies.	2	8
4.9	Detecting steroid consumption in athletes and race horses	1	8
5.0	MEDICAL ASPECTS		
5.1	Aids - causes and prevention - misuse of scheduled drugs - burns and their treatment by plastic surgery.	3	9
5.2	Metabolite analysis using mass spectrum – gas chromatography.	3	9

5.3	Arson-Natural fires and arson - burning characteristics and chemistry of combustible materials -nature of combustion.	3	10
5.4	Ballistics - classification - internal and terminal ballistics - small arms	2	10
5.5	Laboratory examination of barrel washing and detection of powder residue by chemical tests.	1	10

Text Books for Reference

3. T H James, Forensic Sciences, Stanley Thornes Ltd.
4. Richard, Criminalistics -An introduction to Forensic Science (College Version)
5. 8th Edition, Sofestein, Printice Hall.

Course	Details				
Code	CH1815606				
Title	ORGANIC PREPARATIONS AND LABORATORY TECHNIQUES				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester	III/V				
Type	Core				
Credits	1	Hrs/Week	2	Total Hours	36

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Explain the basic laboratory techniques employed in organic chemistry	U	PSO-2
2	Identify various purification techniques	R	PSO-3
3	Deduce the quantitative yield of reactions	Ap	PSO-5

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Basic Laboratory Techniques		
1.1	Crystallisation – Any four compounds using ethyl acetate, ethanol, and water - Record the yield of recovery.	6	1, 2
1.2	Distillation - Purification of water and ethyl acetate-Record the yield of recovery.	6	1, 2
1.3	Solvent extraction – aniline from water - methyl benzoate from water - using ether-	6	1
1.4	Record the yield of recovery. (<i>Any two experiments shall be done</i>).	6	6
2.0	Chromatography		
2.1	TLC - Separation and identification- Determination of R _f value of <i>o</i> - and <i>p</i> -nitroanilines, <i>o</i> - and <i>p</i> -chloroanilines, <i>p</i> -chlorophenol and <i>p</i> -nitrophenol, <i>p</i> -chloroaniline and <i>p</i> - nitroaniline, benzil and <i>o</i> -nitroaniline or any two amino acids.	6	2
2.2	Column Chromatography – Purification of <i>o</i> -nitro aniline, <i>o</i> -nitrophenol, benzil, <i>m</i> -dinitro benzene, benzene azo – β -naphthol (<i>non-evaluative</i>).	6	2

References

1. Furniss, B.S.; Hannaford, A.J.; Rogers, V. Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry*, 5th ed., Pearson Education, 2005.
2. Mann, F.G.; Saunders, B.C. *Practical Organic Chemistry*, 4th ed., Pearson Education, 2009.
3. Ahluwalia, V.K.; Aggarwal, R. *Comprehensive Practical Organic Chemistry – Preparation and Quantitative Analysis*, Universities Press, 2000.
4. Vishnoi, N.K. *Advanced Practical Organic Chemistry*, 3rd ed., Vikas Publishing House, New Delhi, 2010.

Course	Details				
Code	CH1815607				
Title	PHYSICAL CHEMISTRY PRACTICALS				
Degree	BSc				
Branch(s)	CHEMISTRY				
Year/Semester	III/5				
Type	CORE				
Credits	1	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Verify the viscosity of common liquids and various mixture of liquids	E	PSO-2
2	Determine the heat of solution of salts in water and heat of neutralisation of HCl x NaOH	E	PSO-2
3	Determine the conductance and concentration of electrolytes	E	PSO-2
4	Interpret the transition temperature of a salt hydrate	Ap	PSO-2
5	Predict the surface tension of liquids	C	PSO-2

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	VISCOSITY EXPERIMENTS		
1.1	Viscosity of common liquids(water,benzene,nitrobenzene)	2	1
1.2	Viscosity – Percentage composition of a mixture	6	1
2.0	Heat of Solution		
2.1	Heat of solution of KNO ₃	3	2
2.2	Heat of solution of NH ₄ Cl	3	2
3.0	Heat of Neutralization		
3.1	Heat of neutralization of HCl x NaOH	6	2
4.0	Conductometric Experiments		
4.1	Determination of equivalent conductance of an electrolyte	3	3
4.2	Conductometric titration – Strong acid vs. Strong base	6	3
4.3	Conductometric titration – Weak acid Vs Strong base	6	3
5.0	Transition Temperature Experiments		
5.1	Transition temperature of salt hydrates. (Sodium thiosulphate)	3	4
5.2	Transition temperature of salt hydrates. (Sodium acetate)	3	4
6.0	Surface Tension Experiments		
6.1	Determination of the surface tension of a liquid(Drop number method)	6	5
6.2	Determination of the surface tension of a liquid(Drop weight method)	6	5

Text Books for Reference

1. W. G. Palmer: 'Experimental physical chemistry', Cambridge University Press.
2. J.B. Yadav: Advanced Practical Physical Chemistry Goel Publishing House.
3. R.C. Das and B. Behra; 'Experiments in Physical Chemistry' , Tata McGraw hill.
4. K.K. Sharma : 'An Introduction of Practical Chemistry': Vikas Publishing House, New Delhi.

Text Books for Enrichment

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

Course	Details				
Code	CH1815605				
Title	Qualitative Inorganic Analysis				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester	III/V				
Type	Core Practicals				
Credits	1	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Identify various ions present in a given inorganic sample	U	PSO2
2	Discuss and participate in the qualitative identification of ions present in water and soil	A	PSO4
3	Describe confirmatory and spot tests for ions	R	PSO1
4	Prepare reagents for qualitative inorganic analysis	U	PSO1
5	Show techniques like precipitation and centrifugation	A	PSO3
6	Identify and eliminate interfering anions in a given sample	An	PSO3
7	Test and interpret the solubility of inorganic salts	An	PSO3
8	Give a standard laboratory report	E	PSO4
9	Work in as laboratory technician	C	PSO4

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Qualitative inorganic analysis of simple salts	54	
1.1	Study of the reactions of the following radicals with a view to their identification and confirmation. Ag^+ , Hg^{2+} , Pb^{2+} , Cu^{2+} , Bi^{2+} , Cd^{2+} , As^{3+} , Sn^{2+} , Sb^{3+} , Fe^{2+} , Fe^{3+} , Al^{3+}	10	1
1.2	Cr^{3+} , Zn^{2+} , Mn^{2+} , Co^{2+} , Ni^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+} , Mg^{2+}	6	1
1.3	Li^+ , Na^+ , K^+ , NH_4^+	6	1
1.4	CO_3^{2-} , S_2 , SO_4^{2-} , NO_3^-	6	1
1.5	F^- , Cl^- , Br^-	6	1
1.6	BO_2^- , $\text{C}_2\text{O}_4^{2-}$, $\text{C}_4\text{H}_4\text{O}_6^{2-}$, CH_3COO^-	10	1
1.7	PO_4^{3-} , AsO_3^{3-} , AsO_4^{3-} and CrO_4^{2-}	10	1

Text Books for Reference

1. Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)
2. G. Svehla, Text Book of Vogel's Macro and Semi-micro Inorganic Analysis, revised, Orient Longman.

Text Books for Enrichment

1. V. V. Ramanujam, 'Inorganic Semi micro Qualitative Analysis', The National Publishing Co., Chennai,
2. W. G. Palmer 'Experimental Inorganic Chemistry', Cambridge.

SEMESTER VI				
Course Code	Title of the Course	Course Category	Hours/ week	Credits
CH1816301	Nanochemistry and Nanotechnology	Choice Based Course (Elective)	3	3
CH1816109	Inorganic Chemistry	Core Course -9	3	3
CH1816608	Qualitative Inorganic Analysis- Practical	Practical Core Course-8	3	1
CH1816110	Organic Chemistry-IV	Core Course -10	3	3
CH1816609	Organic Preparations and basic laboratory Techniques- Practical	Practical Core Course-9	2	1
CH1816111	Physical Chemistry -III	Core Course -11	3	3
CH1816610	Physical Chemistry Practical	Practical Core Course-10	3	1
CH1816112	Physical Chemistry-IV	Core Course -12	3	3
CH1816611	Gravimetric Analysis- Practical	Practical Core Course-11	2	2
CH1816802	Project (Evaluation)	Core Course	-	2
		Total	25	22

Course	Details				
Code	CH1816109				
Title	INORGANIC CHEMISTRY				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester	III/6				
Type	Core				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	<i>Expected Course Outcomes</i> <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Identify coordination compounds.	R	PSO-1
2	Classify the possible number of isomers of any given coordination compounds.	Ap	PSO-4
3	Describe the structures and hybridizations of coordination compounds.	U	PSO-4
4	Explain the nature of bonding in coordination compounds through the various bonding theories.	An	PSO-4
5	Describe various types of reaction mechanism, kinetics and thermodynamics possible in coordination chemistry.	R	PSO-5
6	Predict the cis and trans structures using Trans effect	C	PSO-5
7	Apply the principles of coordination chemistry in qualitative and quantitative analysis	Ap	PSO-2
8	Apply the principle of organometallic chemistry to analyze and identify the stability and reactivity of organometallic compounds.	Ap	PSO-4
9	Judge the structural and functional roles of metal ions in metalloproteins	E	PSO-2
10	Explain the production methods of boron and their derivatives	U	PSO-1
11	Explain types structure and reactivity of interhalogen compounds, pseudo halogens	U	PSO-6
12	Identify the properties of the noble gases.	R	PSO-1

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Coordination Chemistry	27	
1.1	Introduction of coordination compounds, Types of ligands – Anionic, cationic and neutral, IUPAC Nomenclature	2	1
1.2	Isomerism in coordination compounds – Structural isomerism and stereo isomerism, Chelates, chelate effect	2	2
1.3	Stability of complexes: Inert and labile complexes, Factors influencing stability	2	2
1.4	Review of Werner's theory and Sidgwick's concept of coordination – EAN rule.	2	3
1.5	Bonding theories: Valence bond theory, Geometries of coordination numbers 4 and 6 – Inner orbital and outer orbital complexes, Limitations of VBT	2	4
1.6	Crystal field theory - Splitting of d-orbitals in octahedral, tetrahedral, tetragonal and square planar complexes	2	4
1.7	Jahn Teller Effect – Jahn – Teller distortion in Cu(II) complexes.	2	4
1.8	Factors affecting crystal field splitting - CFSE of low spin and high spin octahedral complexes. Spectrochemical series	2	4
1.9	Explanation of geometry, magnetism and spectral properties - Merits and demerits of Crystal field theory.	2	4
1.10	Molecular orbital theory – evidence for metal ligand covalency- MO diagram for octahedral complexes (with sigma bonds only).	2	4
1.11	Spectral and magnetic properties of complexes – electronic absorption spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$, Calculation of magnetic moments – spin only formula.	2	4
1.12	Reactivity of complexes – Ligand substitution reactions- SN_1 and SN_2 substitution reactions of square planar complexes	2	5
1.13	Trans effect and its applications	1	6
1.14	Application of coordination chemistry in qualitative and quantitative analysis of metal ions such as Cu^{2+} , Zn^{2+} , Ni^{2+} and Mg^{2+} .	2	7
2.0	Organometallic Compounds	12	
2.1	Definition – Classification based on the nature of metal-carbon bond and on the basis of hapticity.	2	8
2.2	Naming of organometallic compounds. The 18- electron rule and stability	2	8
2.3	Ferrocene: Preparation, properties and bonding (VBT only). Metal-alkene complexes- – Zeise's salt.	2	8
2.4	Catalytic properties of organometallic compounds - Zeigler Natta catalyst in the polymerization of alkene and Wilkinson catalyst in the hydrogenation of alkene (mechanism not expected).	2	8
2.5	Preparation and properties of mononuclear carbonyls - Structures of $\text{Mo}(\text{CO})_6$, $\text{Fe}(\text{CO})_5$ and $\text{Ni}(\text{CO})_4$. Polynuclear carbonyls, bridged carbonyls and bonding in carbonyls – $\text{Mn}_2(\text{CO})_{10}$ and $\text{Fe}_2(\text{CO})_9$.	2	8
2.6	EAN of metals in metal carbonyls – indication of metal-metal bonding. - Quadruple bond – structure of $[\text{Re}_2\text{Cl}_8]^{2-}$.	2	8

3.0	Bioinorganic Chemistry	6	
3.1	Essential and trace elements in biological systems	1	9
3.2	Structure and functions of haemoglobin and myoglobin, Vitamin B12 (structure not expected).	1	9
3.3	Electron carriers – cytochromes. Chlorophyll and photosynthesis (mechanism not expected).	1	9
3.4	Role of alkali and alkaline earth metals in biological systems, Na/K pump. Importance of Ca and Mg	1	9
3.5	Biological functions and toxicity of metals – Fe, Cu, Zn, Cr, Mn, Ni, Co, Cd, Hg and Pb. Metalloenzymes of zinc and copper, nitrogenase	1	9
3.6	Treatment of metal toxicity by chelation therapy. Anti cancer drugs – cisplatin and carboplatin– Structure and significance.	1	9
4.0	Boron Compounds	3	
4.1	Preparation, properties and structure of diborane	1	10
4.2	Preparation, properties and structure of borazine	1	10
4.3	Preparation, properties and structure of boric acid, boron nitride.	1	10
5.0	Inter-halogen and Noble Gas Compounds	6	
5.1	Interhalogens - classification- general preparation	1	11
5.2	Structures of AB, AB ₃ , AB ₅ and AB ₇ types.	1	11
5.3	Reactivity (ClF, ICl ₃ , ClF ₃ , IF ₅ and IF ₇).	1	11
5.4	Comparison of pseudohalogens with halogens. Electropositive character of Iodine.	1	11
5.5	Separation of noble gases (charcoal adsorption method).	1	12
5.6	Compounds of noble gases.	1	12

Text Books for Reference

1. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
2. P.L. Soni and Mohan Katyal, *Textbook of Inorganic Chemistry*, 20th Edition, S. Chand and Sons, New Delhi, 2013.
3. SatyaPrakash, *Advanced Inorganic Chemistry, Volume 2*, S. Chand and Sons, New Delhi, 2005.
4. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, Oxford College Press, New Delhi 2008.
5. R. Gopalan and V. Ramalingam, *Concise Coordination Chemistry*, 1st Edition, Vikas Publishing House, New Delhi, 2001.
6. Wahid U. Malik, G D. Tuli and R.D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010 (Reprint).

Text Books for Enrichment

1. F.A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edition, Wiley India Pvt. Ltd., New Delhi, 2009 (Reprint).
2. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry– Principles of Structure and Reactivity*, 4th Edition, Pearson Education, New Delhi, 2013.
3. D.F. Shriver and P. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford College Press, New York, 2010.

Course	Details			
Code	CH1816110			
Title	ORGANIC CHEMISTRY IV			
Degree	BSc.			
Branch(s)	CHEMISTRY			
Year/Semester	III/6			
Type	CORE			
Credits	3	Hrs/Week	3	Total Hours 54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Classify various terpenoids and alkaloids	Ap	PSO-1
2	Verify the structures of coniine, nicotine and piperine.	E	PSO-1
3	Explain the classification and properties of lipids, soaps, detergents	An	PSO-1
4	Determine the saponification value, acid value, iodine value and RM value	E	PSO-2
5	Illustrate the structure classification and functions of vitamins and steroids	Ap	PSO-1
6	Describe the Structure, classification and functions of hormones and Artificial hormones	R	PSO-1
7	Classify amino acids and to explain the synthesis of polypeptides and proteins	Ap	PSO-3
8	Determine the structure of proteins	E	PSO-1
9	Explain the structure and functions of nucleic acids and biosynthesis of proteins.	An	PSO-1
10	Describe Enzyme catalysed reaction mechanism and its characteristics.	R	PSO-1
11	Explain Molecular recognition, non covalent interactions and structure organisations of bio-molecules.	U	PSO-1
12	Distinguish thermal and photochemical reactions.	U	PSO-1
13	Construct the Jablonski diagram for explaining various photo-physical processes	C	PSO-1
14	Predict the products of various photochemical reactions	C	PSO-2
15	Predict the structure of molecules by using Principle and applications of UV/Visible and IR spectroscopy	C	PSO-2
16	Determine the molecular mass and structure of a compound using the Principle and applications NMR and mass spectrometry	E	PSO-2

*PSO-Program Specific Outcome; CO-Course Outcome;
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Natural Products (6 Hrs)		
1.1	Terpenoids – Classification. Isoprene rule. Structure elucidation and uses of citral and geraniol.	2	1
1.2	Natural rubber - structure, latex processing methods, vulcanisation, rubber compounding, mastication and uses.	1	1
1.3	Alkaloids Alkaloids - General methods of isolation. Classification. Physiological action and medicinal importance.	1	1
1.4	Structure elucidation and synthesis of coniine, nicotine and piperine.	2	2
2.0	Lipids (6 Hrs)		
2.1	Introduction to lipids. Classification. Oils and fats: Biological functions. Extraction and refining. Common fatty acids present in oils and fats. Omega fatty acids.	1	3
2.2	Soaps - Types of soaps. Cleansing action of soaps.	1	3
2.3	Synthetic detergents - Classification. Detergent additives. Comparison between soaps and detergents. Environmental aspects. ABS and LAS detergents.	2	3
2.4	Trans fats and their effect. Hydrogenation, Rancidity. Acid value, Saponification value, Iodine value and RM value. Biological functions of waxes, phospholipids and glycolipids.	2	4
3.0	Vitamins, Steroids and Hormones : (6 Hrs)		
3.1	Vitamins : Vitamins – Classification. Structure, biological functions and deficiency diseases of vitamins A, B1, B2, B3, B5, B6, C and D.	2	5
3.2	Steroids Steroids – Introduction. Diels' hydrocarbon. Structure and functions of cholesterol. Elementary idea of HDL and LDL.	1	5
3.3	Hormones Hormones – Introduction. Examples and biological functions of steroid hormones, peptide hormones and amine hormones (structure not required)	2	6
3.4	Artificial hormones.	1	6
4.0	Amino Acids, Peptides and Proteins (8 Hrs)		
4.1	Classification of amino acids. Synthesis, ionic properties and reactions of α -amino acids. Zwitterion structure and Isoelectric point.	1	7
	Polypeptides. Synthesis of simple peptides (upto tripeptides) by N-protecting (benzyloxycarbonyl and t-butylloxycarbonyl) & C-activating groups. DCC method.	2	7
4.2	Merrifield's solid phase peptide synthesis.	1	7
4.3	Classification of proteins. Overview of Primary,	2	8

	Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of proteins.		
4.4	Determination of N- terminal amino acid (by FDNB and Edman method) and C-terminal amino acid (by hydrazinolysis and with carboxypeptidase enzyme).	1	8
4.5	Helical and sheet structures. Denaturation of proteins.	1	8
5.0	Nucleic Acids (4 Hrs)		
5.1	Components of Nucleic acids: Adenine, guanine, cytosine, thymine and uracil (structure only), other components of nucleic acids.	1	9
5.2	Nucleosides and nucleotides (nomenclature), Structure of polynucleotides;.	1	9
5.3	Structure of DNA (Watson - Crick Model) and RNA. Biological functions of DNA and RNA - Replication and protein biosynthesis	1	9
5.4	Transcription and Translation. Genetic code.	1	9
6.0	Enzymes (3 Hrs)		
6.1	Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action, factors affecting enzyme action.	1	10
6.2	Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (Including stereospecificity).	1	10
6.3	Enzyme inhibitors and their importance. Uses of enzymes.	1	10

7.0	Supra molecular Chemistry (3 Hrs)		
7.1	Introduction. Molecular recognition. Host-guest interactions.	1	11
7.2	Types of non-covalent interactions and molecular receptors	1	11
7.3	Role of molecular recognition in biopolymer (DNA and protein) structure organisation (elementary idea only).	1	11
8.0	Organic Photochemistry (4 Hrs)		
8.1	Introduction. Photochemical versus Thermal reactions.	1	12
8.2	Electronic excitation and fate of excited molecules.	1	12
8.3	Jablonski diagram. Fluorescence and phosphorescence.	1	13
8.4	Photosensitisation. Photochemical reactions: Norrish type	1	14

	I and II reactions of acyclic ketones, Paterno-Buchi reaction and Photo-Fries reaction (with mechanisms).		
9	Organic Spectroscopy (14 Hrs)		
9.1	UV Spectroscopy: Types of electronic transitions, λ_{\max} , Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption;	2	15
9.2	Application of Woodward Rules for calculation of λ_{\max} for the following systems: α,β -unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.	3	15
9.3	IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O and N containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.	3	15
9.4	NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds.	3	16
9.5	Applications of IR, UV and NMR for identification of simple organic molecules	1	16
9.6	Mass Spectrometry: Introduction. EI ionisation. Determination of molecular mass by MS (elementary idea only – fragmentation study not required).	2	16

Text Books for Reference

1. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R.T., Boyd, R.N. & Bhattacharjee, S.K. Organic Chemistry, 7th ed., Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
3. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry, 7th ed., W. H. Freeman.
4. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.
5. Bhat S.V., Nagasampagi, B.A. & Sivakumar M. Chemistry of Natural Products, Narosa, 2005.
6. Jain, M.K. & Sharma, S.C. Modern Organic Chemistry, Vishal Publishing Co. 2010.
7. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
8. Tewari, K.S. & Vishnoi, N.K. Organic Chemistry, Vikas Publishing House, 2012.
9. Billmeyer, F.W. Textbook of Polymer Science, Wiley.

Text Books for Enrichment

1. Gowariker, V.R., Viswanathan, N.V. & Sreedhar J. Polymer Science, 2nd ed., New Age, 2015
2. Steed, J. W. & Atwood, J.L. Supramolecular Chemistry, 2nd ed., Wiley, 2009.
3. Dodziuk, H. Introduction to Supramolecular Chemistry, Springer, 2002.

Course	Details				
Code	CH1816111				
Title	Physical Chemistry III				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester	III/6				
Type	Core				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Understand the basic concepts of thermodynamic such as temperature, pressure, system, properties, process, state	U	PSO-1
2	State the Zeroth, First, Second and Third Laws of thermodynamics	U	PSO-1
3	Understand all the concepts needed to state the laws of thermodynamics, such as 'thermodynamic equilibrium', 'exact' and 'inexact' differentials and 'reversible' and 'irreversible' processes	U	PSO-1
4	Understand the distinction between real gas and ideal gas in terms of Joules-Thomson coefficient	U	PSO-1
5	Define the enthalpy H, Helmholtz function F and the Gibbs function G and state their roles in determining equilibrium under different constraints.	U	PSO-4
6	Understand the feasibility of a chemical reaction in terms of Gibbs free energy and Entropy	U	PSO-1
7	Understand the law of reversibility and irreversibility of a chemical reaction	U	PSO-1
8	Understand the concept of Equilibria in solution	U	PSO-1
9	Understand the importance of Phase Diagrams and its applications in the field of materials science and engineering.	U	PSO-1
10	Understand the concept of reaction rates and explain how reactions occur at the molecular level in terms of collision theory and transition state theory.	U	PSO-1
11	Describe catalyst its effect on reaction rates and illustrate its mechanism.	U	PSO-1

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Thermodynamics		
1.1	Basic concepts of system, surroundings, types of systems. Extensive and intensive properties, macroscopic properties.	1	1
1.2	State functions and path functions. Types of Processes, Zeroth law of thermodynamics. Definition of internal energy and enthalpy	2	2
1.3	Heat capacities at constant volume (C_v) and at constant pressure (C_p), relationship between C_p and C_v .	2	3
1.4	First law of thermodynamics, Mathematical statement of first law. Reversible process and maximum work.	2	3
1.5	Calculation of work, heat, internal energy change and enthalpy change for the expansion of an ideal gas under reversible isothermal and adiabatic condition	2	2
1.6	The Joule-Thomson effect – derivation of the expression for Joule-Thomson coefficient. Sign and magnitude of Joule-Thomson coefficient, inversion temperature. Liquefaction of gases.	2	1
1.7	Thermochemistry – standard states. Enthalpies of formation, combustion and neutralization	1	1
1.8	Integral and differential enthalpies of solution. Hess's law and its applications. Kirchoff's equation.	2	1
2.0	Thermodynamics II		
2.1	Second law: Limitations of first law – Different statements of II nd law, Thermodynamic scale of temperature	1	2
2.2	Carnot cycle and its efficiency, Carnot theorem.	2	2
2.3	Concept of entropy – Definition and physical significance. Entropy as a function of volume and temperature, Entropy as a function of pressure and temperature. Entropy as a criteria of spontaneity and equilibrium.	1	2
2.4	Gibbs and Helmholtz free energies and their significances- criteria of equilibrium and spontaneity.	2	3
2.5	Gibbs-Helmholtz equation, dependence of Gibbs free energy change on temperature, volume and pressure.	1	3
2.6	Third law of thermodynamics-statement and determination of absolute entropies of substances	1	4
3.0	Chemical Equilibria	1	
3.1	Law of mass action-equilibrium constant – Relation between K_p , K_c and K_x , Thermodynamic treatment of the law of mass action	2	5
3.2	Vant Hoff reaction isotherm – Temperature dependence of the equilibrium constant – The Van'tHoffs equation –Pressure dependence of the equilibrium constant K_p	2	
4.0	Ionic Equilibria		
4.1	Concepts of acids and bases, relative strength of acid-base pairs, influence of solvents	2	
4.2	Dissociation constants – acids, bases, and polyprotic acids. Ostwald's dilution law.	1	
4.3	Degree of ionization, factors affecting degree of ionization,	2	

	ionization constant and ionic product of water-pH. Effects of solvents on ionic strength..		
4.4	Buffer solutions – Mechanism of buffer action, Henderson equation. Hydrolysis of salts – degree of hydrolysis and hydrolysis constant, determination of degree of hydrolysis, pH of salt solutions.	2	
5.0	Phase Equilibria		
5.1	The phase rule-derivation, equilibrium between phases – conditions.	2	
5.2	One component system – water system, sulphur system	2	
5.3	Two component systems – solid-liquid equilibrium – Simple Eutectic, Lead- Silver system	2	
5.4	Formation of compounds with Congruent Melting Point; Ferric chloride–Water system. Formation of compounds with Incongruent Melting Point Sodium sulphate–Water system.11	1	
6.0	Chemical Kinetics	1	
6.1	Rate of reaction, rate equation, order and molecularity of reactions, determination of order of a reaction. Integrated rate expressions for first and second order reactions ($2A \rightarrow P$ and $A + B \rightarrow P$). Zero order reactions, pseudo-order reactions, half life.	2	10
6.1	Effect of temperature on the rate of reaction: Arrhenius equation, concept of activation energy, Collision theory	3	10,11
6.2	Transition state theory. Thermodynamic parameters for activation – Eyring equation (no derivation needed), enthalpy and entropy of activation.	2	11
6.3	Theory of unimolecular reactions – Lindemann Theory.	1	10
6.4	Kinetics of complex (composite) reactions: Opposing reactions, consecutive reactions, and parallel (simultaneous) reactions.	1	9
6.5	Chain reactions – steady state treatment, Hydrogen– Bromine reaction- derivation of rate expression	1	8
6.6	Catalysis: Homogeneous catalysis, enzyme catalysis – Michaelis–Menten equation (no derivation needed). Heterogeneous catalysis – Surface catalysis, Elementary idea about Autocatalysis.	3	11

*PSO-Program Specific outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Text Books for Reference

6. P. Atkins and J Paula, *The elements of Physical chemistry*, 7th edn., Oxford College Press
7. K. J. Laidler, *Chemical kinetics*, 3rd edn, Pearson education, 2004

Text Books for Enrichment

1. F. A. Alberty and R. J .Silby, *Physical Chemistry*, John Wile
2. D. A. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books Pvt. Ltd.

Course	Details				
Code	CH1816112				
Title	PHYSICAL CHEMISTRY – IV				
Degree	B.Sc				
Branch(s)	Chemistry				
Year/Semester	III/6				
Type	Core				
Credits	3	Hrs/Week	3	Total Hours	54

CO No	Expected Outcomes	CI	PSO No
1	Understand Raoult's law, the behaviour of binary liquid mixtures, Separation techniques of liquid-liquid systems, Henry's law and Nernst distribution law	U	PSO-1
2	Explain Partial molar quantities – Chemical potential – Gibbs–Duhem equation	U	PSO-1
3	Perform calculations involving colligative properties of solutions,	Ap	PSO-1
4	Understand Osmotic pressure, Reverse osmosis, Abnormal molecular masses and van't Hoff factor	U	PSO-1
5	Understand electrolytic conductance, equivalent conductance, Faraday;s laws electrolysis, , Kohlrausch's law, ionic mobility and perform calculations based on these	U	PSO-1 PSO-4
6	Understand the experimental determination of transport number	U	PSO-4
7	Explain Debye Huckel theory, Debye-Hückel limiting law, Debye- Hückel-Onsager equation	An	PSO-1 PSO-4
8	Perform conductometric titrations	Ap	PSO-1
9	Understand basis of Electrochemical cells, concentration cells, Irreversible electrode processes and perform calculations involving thermodynamic properties of Electrochemical cells	U	PSO-1 PSO-4
10	Determine pH from emf measurements and perform potentiometric titrations	E	PSO-1 PSO-4
11	Understand Laws of photochemistry, Jablonsky diagram, fluorescence, phosphorescence, non-radiative processes, chemiluminescence, bioluminescence and photochemical reactions	U	PSO-1 PSO-4
12	Understand Symmetry, symmetry elements, point groups and construct character tables	C	PSO-1 PSO-4

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Solutions	12	
1.1	Introduction – Binary liquid solutions – Raoult’s law- ideal and non-ideal solutions– G_{mix} , V_{mix} , and S_{mix} for ideal solutions. Vapour pressure – composition and temperature– composition curves of ideal and non-ideal binary liquid solutions	2	1
1.2	Fractional distillation of binary liquid-liquid solutions – distillation of immiscible liquids, partially miscible liquid-liquid systems. Critical solution temperature (CST).	2	1
1.3	Solubility of gases in liquids – Henry’s law. Distribution of a solute between two solvents– Nernst distribution law.	2	1
1.4	Partial molar quantities – Chemical potential – Gibbs–Duhem equation	2	2
1.5	Colligative properties of dilute solutions – vapour pressure lowering, Boiling point elevation and freezing point depression (thermodynamic derivation). Molar mass determination-related problems	2	3
1.6	Osmotic pressure – laws of osmotic pressure – Reverse osmosis – purification of sea water.	1	4
1.7	Abnormal molecular masses – van’t Hoff factor – Degree of association and Degree of dissociation.	1	4
2	Electrical Conductance	12	
2.1	Introduction- Faraday’s laws of electrolysis, electrochemical equivalent & chemical equivalent. Electrolytic conductivity, molar conductivity – Variation of molar conductivity with concentration. Kohlrausch’s law – Applications.	2	5
2.2	Ionic mobility – relation with ion conductivity, influence of temperature on ion conductivity, ion conductivity and viscosity – Walden’s rule. Abnormal ion conductivity of hydrogen and hydroxyl ions.	2	5
2.3	Transference number and its experimental determination using Hittorf and Moving boundary methods	2	6
2.4	Debye-Hückel theory of strong electrolytes – the concept of ionic atmosphere, Activity, mean ionic activity and mean ionic activity coefficients of electrolytes. Ionic strength of a solution, Debye-Hückel limiting law (no derivation). Asymmetry and electrophoretic effect, Debye- Hückel-Onsager equation (no derivation).	4	7
2.5	Applications of conductance measurements – Determinations of degree of dissociation of weak electrolytes, determination of solubility and solubility products of sparingly soluble salts, conductometric titrations involving strong acid- strong base, weak acid- strong base, mixture of a strong acid and weak acid against strong base and precipitation titrations.	2	8
3	Electromotive Force	15	

3.1	Introduction –Electrochemical cells and electrolytic cells, Galvanic cells, characteristics of reversible cells. Reversible electrodes – Different types, Reference electrodes – Standard Hydrogen Electrode, Calomel electrode, Electrode potential – Electrochemical series. Representation of cells, Electrode reactions and cell reactions	4	9
3.2	Derivation of Nernst equation for electrode potential and cell potential, Gibb’s Helmholtz equation and EMF of a cell, calculation of G, H and S from EMF data. Calculation of equilibrium constant from EMF data	2	9
3.3	Concentration cells – Electrode concentration cell and electrolyte concentration cells. Types of electrolyte concentration cells – with transference and without transference, liquid junction potential and salt bridge.	3	9
3.4	Irreversible electrode processes – overvoltage, Fuel cells – the hydrogen-oxygen fuel cell	2	9
3.5	Corrosion of metals – forms of corrosion, corrosion monitoring and prevention methods.	1	9
3.6	Applications of emf measurements – determination of solubility product, determination of pH using hydrogen electrode, quinhydrone electrode and glass electrode. Potentiometric titrations of acid-base and redox reaction, oxidation reduction indicators.	3	10
4	Photochemistry	6	
4.1	Laws of photochemistry-Grothus-Draper law, Stark-Einstein law. Quantum yield, examples of low and high quantum yields,	2	11
4.2	Jablonsky diagram-qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing). Quenching of fluorescence.	2	11
4.3	Photochemical reactions (decomposition of HBr, isomerisation of maleic acid to fumaric acid), photosensitised reactions (photosynthesis, isomerization of 2-butene), chemiluminescence, bioluminescence	2	11
5	Group Theory	9	
5.1	Elements of symmetry – Proper and improper axis of symmetry, plane of symmetry, centre of symmetry and identity element.	3	12
5.2	Combination of symmetry elements, Schoenflies symbol	2	12
5.3	Point groups, C _{2v} , C _{3v} and D _{3h} , Group multiplication table of C _{2v} , Determination of point groups of simple molecules like H ₂ O, NH ₃ and BF ₃ .	4	12

References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Elements of Physical chemistry*, VishalPub. Co. Jalandhar.
2. K. L. Kapoor, *A Textbook of Physical chemistry, Volume 4*, Macmillan India Ltd.
3. Barrow, G.M. *Physical Chemistry*, Tata McGraw -Hill (2007).
4. Castellan, G.W. *Physical Chemistry*, 4th Ed. Narosa (2004).
5. Kotz, J.C., Treichel, P.M. & Townsend, J.R., *General Chemistry*, Cengage Learning India Pvt. Ltd. New Delhi (2009).
6. Mahan, B.H. *College Chemistry*, 3rd Ed. Narosa (1998).
7. K. L. Kapoor, *A Textbook of Physical chemistry, Volumes 1*, Macmillan India Ltd,
8. Glasstone S, *An Introduction to Electrochemistry*, East-West Press (Pvt.) Ltd. (2006).
9. Gurdeep Raj, *Advanced Physical Chemistry*, Goel publishing house.
10. Glasstone and Lewis, *Elements of Physical Chemistry*, Macmillan
11. K. L. Kapoor, *A Textbook of Physical chemistry, Volumes 3*, Macmillan IndiaLtd.
12. I.N. Levine, *Physical Chemistry*, Tata McGraw Hill
13. F A Alberty and R J Silby, *Physical Chemistry*, John Wiley.
14. P. W. Atkins, *The elements of Physical chemistry*, 8th edn, Oxford CollegePress.
15. D. A. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books Pvt.Ltd.

Text Books for Enrichment

1. S. H. Marron and J. B. Lando, *Fundamentals of Physical Chemistry*, MacmillanLtd.
2. G. K. Vemulapalli, *Physical Chemistry*, Prentice-Hall of India Pvt. Ltd. (1997) V Ramakrishnan and M S Gopinathan, “*Group Theory in Chemistry*”, Vishal Publishing.

Course	Details				
Code	CH1816608				
Title	Qualitative Inorganic Analysis				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester	III/6				
Type	Core Practicals				
Credits	1	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Identify various ions present in a given inorganic sample	U	PSO-2
2	Discuss and participate in the qualitative identification of ions present in water and soil	A	PSO-4
3	Describe confirmatory and spot tests for ions	R	PSO-1
4	Prepare reagents for qualitative inorganic analysis	U	PSO-1
5	Show techniques like precipitation and centrifugation	A	PSO-3
6	Identify and eliminate interfering anions in a given sample	An	PSO-3
7	Test and interpret the solubility of inorganic salts	An	PSO-3
8	Give a standard laboratory report	E	PSO-4
9	Work in as laboratory technician	C	PSO-4

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
2.0	Qualitative inorganic analysis of Mixtures	54	
2.1	Systematic qualitative analysis of mixtures containing two acid and two basic radicals from the above list without interfering radical by Semi-micro method only.	22	8
2.2	Systematic qualitative analysis of mixtures containing two acid and two basic radicals from the above list with one interfering radical by Semi-micro method only	32	9

Text Books for Reference

- Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)
- G. Svehla, Text Book of Vogel's Macro and Semi-micro Inorganic Analysis, revised, Orient Longman.

Text Books for Enrichment

- V. V. Ramanujam, 'Inorganic Semi micro Qualitative Analysis', The National Publishing Co., Chennai,
- W. G. Palmer 'Experimental Inorganic Chemistry', Cambridge.

Course	Details				
Code	CH1816609				
Title	ORGANIC PREPARATIONS AND LABORATORY TECHNIQUES				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester	III/ 6				
Type	Core				
Credits	1	Hrs/Week	2	Total Hours	36

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Devise new synthetic methodologies	C	PSO-4
2	Assess their idea about mechanisms to predict the outcome of reaction	E	PSO-1
3	Distinguish the category to which the reaction belong to	An	PSO-1

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Organic Preparations		
1.1	Oxidation (benzaldehyde to benzoic acid)	4	3,4,5
1.2	Hydrolysis (methyl salicylate or ethyl benzoate to the acid).	4	3,4,5
1.3	Nitration (<i>m</i> -dinitrobenzene and picric acid).	4	3,4,5
1.4	Halogenation (<i>p</i> -bromoacetanilide from acetanilide).	4	3,4,5
1.5	Acylation (Benzoylation of aniline, phenol, β -naphthol)	4	3,4,5
1.6	Esterification (benzoic acid ester)	4	3,4,5
1.7	Iodoform from acetone or ethyl methyl ketone.	4	3,4,5
1.8	Side chain oxidation (benzyl chloride to benzoic acid)	4	3,4,5
1.9	Claisen – Schmidt reaction: Dibenzal acetone from benzaldehyde	4	3,4,5

References

1. Furniss, B.S.; Hannaford, A.J.; Rogers, V. Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry*, 5th ed., Pearson Education, 2005.
2. Mann, F.G.; Saunders, B.C. *Practical Organic Chemistry*, 4th ed., Pearson Education, 2009.
3. Ahluwalia, V.K.; Aggarwal, R. *Comprehensive Practical Organic Chemistry – Preparation and Quantitative Analysis*, Universities Press, 2000.
4. Vishnoi, N.K. *Advanced Practical Organic Chemistry*, 3rd ed., Vikas Publishing House, New Delhi, 2010.

Course	Details				
Code	CH1816610				
Title	PHYSICAL CHEMISTRY PRACTICALS				
Degree	BSc				
Branch(s)	CHEMISTRY				
Year/Semester	III/6				
Type	CORE				
Credits	1	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Investigate the effect of electrolytes on Critical Solution Temperature	An	PSO-2
2	Determine the molecular mass of the solute by Rast method	E	PSO-2
3	Predict the rate constant of ester hydrolysis	C	PSO-3
4	Determine the concentration of analytes using potentiometric titrations	E	PSO-5

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Critical Solution Temperature Experiments		
1.1	Critical solution temperature of phenol-water system.	6	6
1.2	Effect of electrolytes on the CST of phenol-water system (KCl or NaCl)	6	6
2.0	Cryoscopic Experiments		
2.1	Molecular weight determination by Rast's method.(using naphthalene as solvent and p-dichlorobenzene as solute.)	6	7
2.2	Molecular weight determination by Rast's method.(using camphor or biphenyl as solvent and acetanilide, as solute.)	6	7
3.0	Kinetics		
3.1	Kinetics of simple reactions eg. Acid hydrolysis of methyl acetate.	6	8
3.2	Data analysis of kinetic experiments using spreadsheet program (determination of rate constant)	6	8
4.0	Potentiometric Titrations		
4.1	Potentiometric titration – Fe ²⁺ vs. Cr ₂ O ₇ ²⁻	6	9
4.2	Potentiometric titration – I ⁻ vs. MnO ₄ ⁻	6	9
4.3	Determination of equivalence point of potentiometric and conductometric titrations using spreadsheet program.	6	9

Text Books for Reference

1. W. G. Palmer: 'Experimental physical chemistry', Cambridge University Press.
2. J.B. Yadav: Advanced Practical Physical Chemistry Goel Publishing House.
3. R.C. Das and B. Behra; 'Experiments in Physical Chemistry', Tata McGraw hill.
4. K.K. Sharma : 'An Introduction of Practical Chemistry': Vikas Publishing House, New Delhi.

Text Books for Enrichment

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

Course	Details				
Code	CH1816611				
Title	GRAVIMETRIC ANALYSIS				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester	V/6				
Type	Practicals				
Credits	2	Hrs/Week	2	Total Hours	36

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Quantitative analysis of substances through measurement of mass	An	PSO-4
2	Compare masses of two compounds	U	PSO-5
3	Demonstrate techniques like precipitation and filtration	An	PSO-6
4	Show drying and incineration process	Ap	PSO-6
5	Calculate mass of a substance in the given solution	Ap	PSO-5
6	Estimate the mass of an ion in the given solution	E	PSO-5
7	Work as laboratory technician	C	PSO-4

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Experiments	36	
1.1	Estimation of Barium as barium sulphate	8	1,2,3,4,5,6,7
1.2	Estimation of iron as Fe ₂ O ₃	8	1,2,3,4,5,6,7
1.3	Estimation of sulphate as barium sulphate	8	1,2,3,4,5,6,7
1.4	Estimation of copper as cuprous thiocyanate	6	1,2,3,4,5,6,7
1.5	Estimation of nickel as nickel dimethyl glyoxime.	6	1,2,3,4,5,6,7

Text Books for Reference

1. T J. Mendham, R.C. Denney, J.D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.

Text Books for Enrichment

1. G. D. Christian, *Analytical Chemistry*, JohnWiley and Sons.
2. R. D. Day, A. L. Uderwood, *Quantitative analysis*

Course	Details				
Code	CH1816301				
Title	Polymer Chemistry				
Degree	Bachelor of Science				
Branch(s)	Chemistry				
Year/Semester	III/6				
Type	Choice Based Course				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	<i>Expected Course Outcomes</i> Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Recall the basic principles and concepts of contemporary polymer chemistry	R	PSO-1
2	Interpret the mechanisms of the main methods of polymer synthesis and define the basic concepts of polymer synthesis.	U	PSO-1
3	Establish the relationship between the polymerization method and the resulting molecular characteristics	Ap	PSO-1
4	Outline the different experimental techniques used in the characterization of polymers	U	PSO-1
5	Describe the morphology of a polymer at different scales, and state how this morphology controls the properties of the material	Ap	PSO-1
6	Illustrate the role of crystallinity, molecular masses and glass transition temperature of polymer to its properties.	An	PSO-1
7	Elucidate the basic reactions in polymer chemistry.	Ap	PSO-1
8	Judge the polymer molecular structure and method of preparation to the properties of the polymer materials	E	PSO-1

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Introduction and History of Polymeric Materials	4	
1.1	History of polymers	1	1
1.2	Terminology of polymers	1	1
1.3	Different schemes of classification of polymers. Polymer nomenclature.	2	1
2.0	Mechanisms of Polymerization	6	
2.1	Classification of polymerization processes.	1	1,2
2.2	Mechanism of step growth, radical chain growth, ionic chain and coordination polymerizations.	2	2
2.3	Mechanism of copolymerization. Mechanism of ring opening and group transfer polymerisations.	3	2
3.0	Polymerisation Techniques and Processing	8	

3.1	Polymerisation techniques (Bulk, solution, suspension, emulsion, melt, solution and interfacial polycondensation).	4	2,3
3.2	Polymer processing techniques (Compression moulding, Injection moulding, Blow moulding, Extrusion moulding, Thermoforming, Die casting, Film casting, Rotational casting, Calendering and Spinning)	4	2,3
4.0	Physical and Chemical Properties of Polymers	22	
4.1	Structure-Property relationships of polymers.	2	8
4.2	Crystallization and Crystallinity: Determination of crystalline melting point and degree of crystallinity.	4	6
4.3	Morphology of crystalline polymers, Factors affecting crystalline melting point.	3	5
4.4	Molecular weight of polymers: 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.	4	6
4.5	Glass Transition Temperature (Tg): Definition. Factors influencing glass transition temperature (Tg). Tg and molecular weight. Tg and melting point. Importance of Tg.	4	6
4.6	Hydrolysis, hydrogenation, addition, substitution, cross linking, vulcanisation and cyclisation reactions.	3	7
4.7	Types of degradation. Thermal, mechanical, photo and oxidative degradations of polymers.	2	1,7
5.0	Chemistry of Commercial and Speciality Polymers	14	
5.1	Brief introduction to the preparation, structure, properties and applications of the following polymers: polyolefins (LDPE, HDPE and PP), poly(vinyl chloride), polystyrene, poly(vinyl acetate), acrylic polymers (PAN and PMMA), fluoro polymers (PTFE), aliphatic polyamides (Nylon 6,6 and Nylon 6), aromatic polyamides (Kevlar), polyesters (PET), formaldehyde resins (PF, UF and MF), polyurethanes, polycarbonates, epoxy resins.	7	3,8
5.2	High temperature resistant and flame retardant polymers.	1	1
5.3	Biomedical applications of polymers.	1	1
5.4	Controlled drug delivery systems.	1	1
5.5	Conducting polymers - polyacetylene, polyaniline, poly(p-phenylene sulphide), polypyrrole, polythiophene. Conduction mechanism and applications.	3	1,8
5.6	Carbon nanotubes. Synthesis and applications	1	1

Text Books for Reference

1. Carraher, C.E. *Seymour/Carraher's Polymer Chemistry*, 6th ed., Marcel Dekker, New York, 2003.
2. Odian, G. *Principles of Polymerization*, 4th ed., Wiley, 2004.
3. Billmeyer, F.W. *Textbook of Polymer Science*, 3rd ed., Wiley-Blackwell, 1984.
4. Gowariker, V.R., Viswanathan, N.V.; Sreedhar J. *Polymer Science*, 2nd ed., New Age, 2015.

Text Books for Enrichment

1. Ghosh, P. *Polymer Science & Technology*, 2nd ed., Tata McGraw-Hill, New Delhi, 2002.
2. Lenz, R.W. *Organic Chemistry of Synthetic High Polymers*. Interscience Publishers, New York, 1967.
3. Bahadur, R., Sastry, N.V. *Principles of Polymer Science*, Narosa, New Delhi, 2003

Course	Details				
Code	CH1816301				
Title	Nanochemistry and Nanotechnology				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester	III/6				
Type	Choice Based course				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Understand about nanoparticles and various Nanostructures	U	PSO-1
2	Discuss electrical and Optical properties of Nanomaterials	R	PSO-1
3	Describe and use different approaches in Nanoparticle synthesis	A	PSO-4
4	Characterize materials in Nanometre dimension	E	PSO-3
5	Explain synthesis and properties of CNTs	R	PSO-4
6	Discuss and correlate nanotechnological aspects in the field of health care, and electronics	C	PSO-4
7	Determine the use of Nanomaterials in medical field	An	PSO-5
8	Recognize the destructive applications of Nanomaterials in war	U	PSO-5
9	Work in interdisciplinary research groups	C	PSO-3

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Introduction to Nanomaterials	15	
1.1	History-Feynman's hypothesis- scales of nanosystems- Moore's law	2	1
1.2	Classification of nanomaterials based on dimensions -quantum dots	3	1
1.3	Different types of nanomaterials.	3	1
1.4	Synthesis, properties and applications of fullerenes, carbon nanotubes and quantum dots.	3	4
1.5	Various approaches in nanoparticle synthesis : CVD, Laser ablation and Arc discharge	2	3
1.6	self-assembled monoayers, monolayer protected metal nanoparticles	2	1
2.0	Characterization of Nanomaterials		
2.1	Important methods for the characterization of nanomaterials – electron microscopy (SEM), transmission electron microscopy (TEM)	5	9
2.2	Scanning tunneling electron microscopy (STEM)	2	4
2.3	Transmission electron microscopy (TEM)	1	4
2.4	Scanning probe electron microscopy (SPL)	2	4
2.5	Secondary ion mass spectrometry (SIMS)	2	4
2.6	Photoelectron spectroscopy (UPES and XPES)	3	4

3.0	Electrical and Optical Properties of Nanomaterials	12	
3.1	Electrical and optical properties of metal nanoparticles	3	2
3.2	Electrical and optical properties of carbon nanotubes.	2	5
3.3	Nanocrystals	2	1
3.4	nanolithography	2	3
3.5	Optoelectronic devices- photodetectors.	3	2
4.0	Applications of Nanomaterials	12	
4.1	Nanocatalysis	2	6
4.2	Nanomedicines - immunogold labeling- applications in medical diagnosis-nanobased drug delivery	3	7
4.3	Applications in biotechnology	3	6
4.4	Nanosensors- self-assembly, nanosensor based on quantum size effects- nanobiosensors	2	6
4.5	Destructive applications of nanomaterials.	2	8

Text Books for Reference

1. T. Pradeep, Nano: The Essentials, Mc Graw Hill Publishing Company, New Delhi (2007).
2. V. S. Muraleedharan and A. Subramania, Nanoscience and nanotechnology, Ane Books Pvt. Ltd. New Delhi, 2009.
3. C. N. R. Rao and A. Govindraj, Nanotubes and Nanowires, Royal Society of Chemistry (2005).
4. J. M. M. Duart, R. J. M. Palma and F.A. Rueda, Nanotechnology and microelectronics and optoelectronics, Elsevier (2002).

Text Books for Enrichment

1. R. Booker and , E. Boysen, Nanotechnology, Wiley India Pvt Ltd, 2008.
2. K. J. Klabunde, Nanoscale materials in chemistry, John Wiley and Sons.
3. C. P. Poole Jr and F J Owens, Introduction to nanotechnology, Wiley India Pvt Ltd 2009.

COMPLEMENTARY COURSES

Course	Details				
Code	CH1811201				
Title	Basic Theoretical & Analytical Chemistry				
Degree	Bachelor of Science				
Branch(s)	(For students who have opted Life Sciences and Family & Community Science as core)				
Year/Semester	1/I				
Type	Complementary				
Credits	2	Hrs/Week	2	Total Hours	36

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Define the concept of atom	R	BY – 6, HSC – 7, ZY-7
2	Discuss the theories substantiate for the concept	U	BY – 6, HSC – 7, ZY-7
3	Describe the type of bonds in molecules and the concept of hybridisation	U	BY – 6, HSC – 7, ZY-7
4	Discuss about the electronic arrangements in atoms and periodic properties	U	BY – 6, HSC – 7, ZY-7
5	Calculate the concentration of a solution in terms of normality, molarity, molality & parts per million	Ap	BY – 6, HSC – 7, ZY-7
6	Define the concept of acids & bases with various theories and introduce the term pH	R	BY – 6, HSC – 7, ZY-7
7	predict the solubility of a compound in solution in terms of solubility product and ionic product	U	BY – 6, HSC – 7, ZY-7
8	Apply the analytical techniques in a chemistry lab	Ap	BY – 6, HSC – 7, ZY-7
9	Explain the types of chromatography for the separation of compounds	U	BY – 6, HSC – 7, ZY-7

*PSO-Program Specific Outcome; CO-Course Outcome;
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Atomic Structure and Chemical Bonding	9	
1.1	Bohr atom model and its limitations, Dual nature of matter and radiation. Photoelectric effect, de Broglie equation, Heisenberg's uncertainty principle	3	1
1.2	Concept of orbital, Quantum numbers, shapes of orbitals (<i>s</i> , <i>p</i> , <i>d</i>), Electronic configuration of atoms - Aufbau principle, Hund's rule of maximum multiplicity, Pauli's exclusion principle.	3	2
1.3	Introduction – Type of bonds. Ionic bond: Factors favouring the formation of ionic bonds - Lattice energy of ionic compounds and its applications. Covalent bond: Lewis theory - Valence bond theory – Coordinate bond. VSEPR theory and examples.	2	3
1.4	Hybridisation: - sp^3 , sp^2 and sp (ethane, ethene, ethyne). Intermolecular forces - Hydrogen bonding in H ₂ O - Dipole-dipole interactions.	1	3
2.0	Fundamental Concepts in Chemistry	9	
2.1	<i>Periodic Properties</i> : Modern periodic law – Long form of periodic table. Periodicity in properties: Atomic radii, ionic radii, ionization enthalpy, electron affinity (electron gain enthalpy) and electronegativity (Pauling scale).	3	4
2.2	Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Oxidation number and valency - Equivalent mass. Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, ppm and millimoles.	1	5
2.3	<i>Concept of Equilibrium</i> : Acids and Bases - Arrhenius, Lowry-Bronsted and Lewis theories. Ionic product of water - pH and pOH, Strengths of acids and bases - K_a and K_b , pK_a and pK_b . Buffer solution. Preparation of buffer solution having a known pH.	4	6
2.4	Solvation, solubility, solubility product, common ion effect and their applications.	1	7
3.0	Basic Principles of Analytical Chemistry	9	
3.1	<i>Laboratory Operations (Non-evaluative)</i> : Laboratory safety and first aid. Use of different glassware like pipette, burette, standard measuring flask, distillation apparatus; heating methods, filtration techniques, weighing principle in chemical balance, weighing in electronic balance	1	8
3.2	<i>Methods of Analysis</i> : Volumetric method of analysis - General principles. Primary and secondary standards, criteria for primary standards, preparation of standard solutions, standardization of solutions, end point. Acid base, redox and complexometric titrations and corresponding indicators. Double burette method of	4	8

	titration: Principle and advantages. Microanalysis and its advantages. Gravimetric method of analysis: General principles.		
3.3	<i>Reporting of Analytical Data</i> : Units, significant digits, rounding, scientific and prefix notation, graphing of data - Precision and accuracy – Types of errors – Ways of expressing precision – Methods to reduce systematic errors.	2	8
4	Chromatographic Techniques	9	
4.1	Chromatography - Principle of differential migration. Classification of chromatographic methods.	1	9
4.2	Basic principle and uses of Thin layer chromatography (TLC), Paper chromatography (PC), R_f value,	2	9
4.3	Column chromatography, Gas chromatography(GC)	3	9
4.4	High performance Liquid chromatography (HPLC), Ion Exchange chromatography (IEC).	3	9

Text Books for Reference

1. B. R. Puri, L. R. Sharma, M.S. Pathania, *Elements of Physical Chemistry*, 3rd edn.
2. Manas Chanda, *Atomic Structure and Molecular Spectroscopy*
3. R. A. Day Junior, A.L. Underwood, *Quantitative Analysis*, 5th edn
4. R. Gopalan, *Analytical Chemistry*, S. Chand and Co., New Delhi.

Text Book for Enrichment

1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th edn.

Course	Details				
Code	CH1811701				
Title	VOLUMETRIC ANALYSIS				
Degree	B.Sc				
Branch(s)	Common to Physical sciences, Life sciences, Geology and Family & Community sciences				
Year/Semester	I / I				
Type					
Credits	1	Hrs/Week	2	Total Hours	36

CO No.	<i>Expected Course Outcomes</i> Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1.	Prepare standard solutions	U	PSO-1
2.	To find the concentrations of unknown solutions using Acidimetry and Alkalimetry	Ap	PSO-1
3.	To use redox reactions in volumetric titrations	Ap	PSO-1
4.	To Use acidified Potassium permanganate as an oxidising agent in redox titrations	R	PSO-1

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Acidimetry and Alkalimetry	18	
1.1	Standardization of HCl with standard Na ₂ CO ₃ solution	3	1
1.2	Standardization of NaOH with standard oxalic acid solution	3	1
1.3	Estimation of any acid using standard NaOH	6	2
1.4	Estimation of any alkali using standard HCl	6	2
2.0	Permanganometry	18	
2.1	Standardization of KMnO ₄ using oxalic acid	3	3
2.2	Standardization of KMnO ₄ using Mohr's salt	3	3
2.3	Estimation of Fe ²⁺ in Mohr's salt using standard KMnO ₄	6	4
2.4	Estimation of crystalline Ferrous Sulphate in Mohr's salt using standard KMnO ₄	6	4

References

1. D. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry* 8th edn, Brooks/Cole Nelson
2. *Vogel's Textbook of Quantitative Chemical Analysis* 6th edn., Pearson Education. Ltd.
3. G. D. Christian, *Analytical Chemistry*, JohnWiley and Sons
4. R.D Day, A.L. Underwood, *Quantitative Analysis*, 6th Edn., Prentice Hall of India Pvt. Ltd.

Course	Details				
Code	CH1812202				
Title	BASIC ORGANIC CHEMISTRY				
Degree	B.Sc				
Branch(s)	Botany,Zoology and Family and Community Science				
Year/Semester	I/2				
Type	Complimentary				
Credits	2	Hrs/Week	2	Total Hours	36

CO No.	<i>Expected Course Outcomes</i> <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Explain the basic concepts of organic chemistry	U	BY – 6, HSC – 7, ZY-7
2	Identify how stereochemistry affects a chemical reaction	Ap	BY – 6, HSC – 7, ZY-7
3	Describe nucleophiles and electrophiles	R	BY – 6, HSC – 7, ZY-7
4	Assess their idea about mechanisms to predict the outcome of reaction	E	BY – 6, HSC – 7, ZY-7
5	Analyse various polymers	An	BY – 6, HSC – 7, ZY-77
6	Predict the category to which the reaction belong	C	BY – 6, HSC – 7, ZY-7
7	Define the synthesis of alkanes, alkenes etc	R	BY – 6, HSC – 7, ZY-7
8	Understand the concept of isomerism and classification of molecules accordingly	Ap	BY – 6, HSC – 7, ZY-7
9	Classify the polymers	Ap	BY – 6, HSC – 7, ZY-7
10	Create awareness among public about the environmental hazards of polymers.	C	BY – 6, HSC – 7, ZY-7

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Fundamental Concepts of Organic Chemistry	9	
1.1	Origin of organic chemistry – Uniqueness of carbon – Homologous series	1	1
1.2	IUPAC nomenclature of alkyl halides, alcohols, aldehydes, ketones, carboxylic acids and amines.	2	1
1.3	Structural isomerism: Chain isomerism, position isomerism, functional isomerism, metamerism and tautomerism	1	1
1.4	. Arrow formalism in organic chemistry. Bond fission - homolytic and heterolytic fission	1	1
1.5	Reaction Intermediates: Carbocations, carbanions and free radicals (preparation, structure, hybridization and stability).	2	1
1.6	<i>Types of organic reactions:</i> Addition, elimination, substitution, rearrangement and redox reactions (definition and one example each).	2	4,6
2.0	Mechanisms of Organic Reactions	9	
2.1	Meaning of reaction mechanism. Polarity of bonds.	1	1,4
2.2	Electron Displacement Effects: Inductive effect - Definition - Characteristics - +I and -I groups. Applications: Explanation of substituent effect on the acidity of aliphatic carboxylic acids.	2	1,4
2.3	Mesomeric effect: Definition –Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene, nitrobenzene and phenol.	2	1,4
2.4	Hyperconjugation: Definition – Characteristics. Applications: Baker-Nathan effect, Comparison of stability of 2-methyl-1-butene & 2-methyl-2-butene. Steric effect (causes and simple examples).	2	1,4
2.5	<i>Substitution reactions:</i> nucleophilic substitution of alkyl halides- S _N 1 and S _N 2 mechanisms. Electrophilic substitutions in benzene - reaction mechanism. Addition reactions: electrophilic addition to alkenes and alkynes - Markwonikoff's rule, Peroxide effect. Elimination reactions: E1 and E2 mechanisms.		1,6,4
3	Stereochemistry of Organic compounds	9	
3.1	<i>Stereoisomerism</i> – definition, classification	1	2,8
3.2	<i>Geometrical Isomerism:</i> Definition – Condition – Geometrical isomerism in but-2-ene and but-2-ene-1,4-dioic acid. cis and trans, <i>E</i> and <i>Z</i> configurations.	1	1,8
3.3	Methods of distinguishing and interconversion of geometrical isomers.	1	1,8
3.4	<i>Optical Isomerism:</i> Optical activity – Chirality – Enantiomers - Meso compounds - Diastereoisomers	2	1,8
3.5	Optical isomerism in lactic acid and tartaric acid - Racemisation and resolution (elementary idea only).	1	1,8
3.5	<i>Conformations:</i> Newman projection, Saw-horse projection. Conformations of ethane, n-butane, and cyclohexane - Relative stability and energy diagrams. Conformation of	3	8

	methyl cyclohexane		
4.0	Natural and Synthetic Polymers	9	
4.1	Introduction. Classification of polymers: Natural, synthetic; linear, cross-linked and network	1	9
4.2	plastics, elastomers, fibres; homopolymers and copolymers	1	9
4.3	Polymerization reactions. Typical examples: Polyethylene, polypropylene, PVC, phenol-formaldehyde and melamine-formaldehyde resins, polyamides (nylons) and polyesters.	4	9
4.4	Natural rubber: structure, latex processing methods, vulcanization and uses.	1	9
4.5	Synthetic rubbers: SBR, nitrile rubber and neoprene.	1	9
4.6	Biodegradability of polymers, environmental hazards. Recycling of plastics.	1	10

References

1. I. L. Finar, Organic Chemistry Vol. I , 6th edn. Pearson.
2. M.K. Jain, S.C. Sharma, *Modern Organic Chemistry*, Vishal Publishing Co. 2010.
3. S. M. Mukherji, S. P Singh, R. P Kapoor, Organic Chemistry Vol.1, New Age International Pvt. Ltd, 2006.
4. S. Sengupta, *Basic Stereochemistry of Organic Molecules*, 2014.
5. E. L. Eliel, S.H. Wilen, *Stereochemistry of Organic Compounds*, Wiley, 1994.
6. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th edn. Orient Longman, 1988.

Text Books for Enrichment

1. S. M. Mukherji, S.P Singh, *Reaction Mechanism in Organic Chemistry*, Macmillan, 3rd edn., 2003.
2. V.R. Gowarikar, N.V. Viswanathan, J. Sreedhar, *Polymer Science*, 2nd edn., New Age International Pvt. Ltd., 2015.

Course	Details				
Code	CH1812702				
Title	VOLUMETRIC ANALYSIS				
Degree	B.Sc				
Branch(s)	Common to Physical sciences, Life sciences, Geology and Family & Community sciences				
Year/Semester	I/2				
Type	Complementary				
Credits	1	Hrs/Week	2	Total Hours	36

CO No.	Expected Course Outcomes	Cognitive Level
	<i>Upon completion of this course, the students will be able to:</i>	
1.	Prepare standard solutions	U
2.	To use acidified potassium dichromate in redox titrations	R
3.	To use Iodine as an oxidising agent.	R

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO. No.
1.0	Dichrometry	18	
1.1	Estimation of Ferrous ions (external indicator)	6	3,5
1.2	Estimation of Ferrous ions (external indicator)	6	3,5
1.3	Estimation of FeSO ₄ · 7 H ₂ O (external indicator)	6	3,5
2.0	Iodimetry and Iodometry	18	
2.1	Standardization of Iodine solution	4	
2.2	Standardization of Sodium thiosulphate	4	
2.3	Estimation of KMnO ₄	4	
2.4	Estimation of Copper	6	

References

1. D. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry* 8th edn, Brooks/Cole Nelson
2. *Vogel's Textbook of Quantitative Chemical Analysis* 6th edn., Pearson Education. Ltd.
3. G. D. Christian, *Analytical Chemistry*, JohnWiley and Sons
4. R.D Day, A.L. Underwood, *Quantitative Analysis*, 6th Edn., Prentice Hall of India Pvt. Ltd.

Course	Details				
Code	CH1813203				
Title	Advanced Inorganic and Organic Chemistry				
Degree	BSc				
Branch(s)	Botany, Zoology and Home Science (Complementary Chemistry)				
Year/Semester	II/III				
Type	Complementary				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	<i>Expected Course Outcomes</i> <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Understand the basics of nuclear chemistry and heterocyclic compounds	U	BY – 6, HSC – 7, ZY-7
2	Recognize various types of food additives.	R	BY – 6, HSC – 7, ZY-7
3	Identify the formulations of various drugs used in the treatment of diseases.	An	BY – 6, HSC – 7, ZY-7
4	Choose different fertilizers and pesticides for their specific agricultural purposes.	E	BY – 6, HSC – 7, ZY-7
5	Analyse the detrimental effects of drug addiction and abuse.	An	BY – 6, HSC – 7, ZY-7
6	Plan events for creating awareness among public (especially youth) for the prevention of drug addiction.	C	BY – 6, HSC – 7, ZY-7
7	Solve problems in nuclear chemistry.	Ap	BY – 6, HSC – 7, ZY-7
8	Explain the chemical side of biological processes such as photosynthesis and respiration.	U	BY – 6, HSC – 7, ZY-7
9	Describe different biologically important molecules and their general functions.	U	BY – 6, HSC – 7, ZY-7
10	Create awareness among the public about the toxicity and environmental hazards of synthetic pesticides and insecticides.	C	BY – 6, HSC – 7, ZY-7
11	Understand the composition of cosmetics.	U	BY – 6, HSC – 7, ZY-7
12	Create awareness among the public about the health effects of fast foods, junk foods and soft drinks	C	BY – 6, HSC – 7, ZY-7

*PSO-Program Specific Outcome; CO-Course Outcome;
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Nuclear Chemistry	12	
1.1	Nuclear Stability - Mass defect, Binding energy, Nuclear forces	1	1
1.2	Magic number, Packing fraction, n/p ratio	1	1
1.3	Natural and induced radioactivity, radioactivity – detection, Units of radioactivity	1	1
1.4	Modes of decay – Group displacement law.	1	1, 7
1.5	Isotopes, isobars and isotones with examples.	1	1
1.6	Nuclear fission - Atom bomb	1	1
1.7	Nuclear fusion – Hydrogen bomb	1	1
1.8	Nuclear reactors - Nuclear reactors in India	1	1
1.9	Application of radioactive isotopes	1	1
1.10	¹⁴ C dating – Rock dating	1	1
1.11	Isotopes as tracers	1	1
2.0	Bio-inorganic Chemistry	6	
2.1	Thermodynamics of Living cell- Exergonic and endergonic reactions, coupled reactions.	1	8
2.2	Metal ions in biological systems - Biochemistry of iron – Metalloporphyrins - Haemoglobin and myoglobin	1	9
2.3	pH of blood, cytochromes, Ferredoxine - Mechanism of O ₂ and CO ₂ transportation	1	9
2.4	Chlorophyll and photosynthesis (mechanism not expected) elementary idea of photophosphorylation	1	8
2.5	Photosynthesis and respiration – comparison	1	8
2.6	Elementary idea of structure and mechanism of action of sodium potassium pump. Biochemistry of zinc and cobalt.	1	8
3.0	Chemistry and agriculture	12	
3.1	Fertilizers: NPK, superphosphates	1	4
3.2	triple super phosphate, uses of mixed fertilizers	1	4
3.3	micronutrients and their role, bio-fertilizers	1	4
3.4	plant growth hormones.	1	4
3.5	Pesticides: Classifications with simple examples	1	4
3.6	Biopesticides	1	4
3.7	Insecticides – stomach poisons, contact insecticides, fumigants	1	4
3.8	Method of preparation and use of DDT, BHC, pyrethrin	1	4
3.9	Herbicides - structure and function of 2, 4,-D and 2,4,5 –T	1	4
3.10	Fungicides- inorganic and organic	1	4
3.11	Bordeaux mixture	1	4
3.12	Excessive use of pesticides – environmental hazards.	1	10
4.0	Heterocyclic Compounds	12	
4.1	Aromaticity	1	1
4.2	Huckel's rule	1	1
4.3	preparation (any one method) and properties of furan.	1	1
4.4	preparation (any one method) and properties of pyrrole	1	1

4.5	structure and aromaticity of furan and pyrrole	1	1
4.6	preparation (any one method) and properties of pyridine	1	1
4.7	structure and aromaticity of pyridine	1	1
4.8	preparation (any one method) and properties of indole	1	1
4.9	structure and aromaticity of indole	1	1
4.10	Pyrimidines & purines - adenine	1	1
4.11	Guanine, thymine	1	1
4.12	cytosine, uracil	1	1
5.0	Drugs, Food Additives and Cosmetics	12	
5.1	DRUGS: Classification of drugs.	1	3
5.2	Structure, therapeutic uses and mode of action (synthesis not required) of Antibiotics: Ampicillin,	1	3
5.3	Sulpha drugs: Sulphanilamide, Antipyretics: Paracetamol	1	3
5.4	Analgesics: Aspirin, Antacids: Ranitidine, Antimalarials: Chloroquine and Anti-cancer drugs: Chlorambucil	1	3
5.5	Psychotropic drugs: Tranquilizers, antidepressants and stimulants with examples	1	3
5.6	Drug addiction and abuse. Prevention and treatment.	1	5,6
5.7	Food Additives: Food preservatives, artificial sweeteners, flavours	1	2
5.8	emulsifying agents, antioxidants, leavening agents and flavour enhancers (definition and examples, structures not required)	1	2
5.9	Structure of BHT, BHA and MSG - Commonly used permitted and non-permitted food colours (structures not required)	1	2
5.10	Fast foods and junk foods & their health effects – Soft drinks and their health effects.	1	12
5.11	Cosmetics: Introduction, classification. Dental cosmetics, Shampoos, Hair dyes, Skin products,	1	11
5.12	Shaving cream, Talcum powder, Perfumes and Deodorants (composition and health effects).	1	11

References

1. H.J. Arnika, *Essentials of Nuclear Chemistry* (Revised IV edn.), New Age, 1995.
2. B. R. Puri, L. R. Sharma, M.S. Pathania, *Elements of Physical Chemistry*, 3rd edn. Vishal Pub Co., 2008.
3. I. L. Finar, *Organic Chemistry* Vol. 1 & 2, 6th edn., Pearson, 2002.
4. C.N. R. Rao, *College General Chemistry*, Macmillan 2009.
5. B. R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers New Delhi. 2013.
6. G. R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
7. J. Ghosh, *A Textbook of Pharmaceutical Chemistry*, S. Chand & Co Ltd., 1997
8. B. Sreelakshmi, *Food Science*, New Age International Pvt. Ltd, New Delhi, 2015.
9. J.W. Hill, T.W. McCreary, D.K. Kolb, *Chemistry for Changing Times*, Prentice Hall, 12th edn., 2010.

Course	Details				
Code	CH1813703				
Title	PRACTICALS-II ORGANIC ANALYSIS				
Degree	B.Sc				
Branch(s)	Common to Physical sciences, Life sciences, Geology and Family & Community sciences				
Year/Semester	II/3				
Type	Complementary				
Credits	1	Hrs/Week	2	Total Hours	36

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level
1.	Find the elements present in a given organic compound	R
2.	Determination of the physical constants of a compound given.	U
3.	Test for various functional groups and express them with suitable chemical equations.	R
4.	Identify the functional groups and Distinguish between a set of compounds	An

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Detection of Elements	12	
1.1	Preparation of Lassaigne's extract and detection of Nitrogen, halogens and sulphur.	12	1
2.0	Determination of physical constants	6	
2.1	To determine the physical constants of a given organic compound	6	2
3.0	Tests for functional groups	18	
3.1	Reactions of Hydrocarbons	1	3
3.2	Reactions of organic halogen compounds	1	3
3.3	Reactions of alcohols	2	3
3.4	Reactions of phenols	2	3
3.5	Reactions of aldehydes and ketones	2	3
3.6	Reactions of Carboxylic acids	2	3
3.7	Reactions of Esters	2	3
3.8	Reactions of Amines	2	3
3.9	Reactions of Carbohydrates	2	3
3.10	Reactions of Amides	2	3

References:

- 1 Vogel, *A Text Book of Practical Organic Chemistry*, Longman.
- 2 F. G. Mann and B.C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education.
- 3 V. K. Ahluwalia and S. Dhingra, *Comprehensive Practical Organic Chemistry*, Universities Press.

Course	Details				
Code	CH1814204				
Title	Advanced Bio-Organic Chemistry				
Degree	Bachelor of Science				
Branch(s)	(For students who have opted Life Sciences and Family & Community Science as core)				
Year/Semester	II/IV				
Type	Complementary				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	<i>Expected Course Outcomes</i> <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Recall the classification and properties of oils, fats, lipids, carbohydrates, amino acids, peptides, proteins, amino acids, terpenoids and alkaloids.	R	BY – 6, HSC – 7, ZY-7
2	Understand the biological functions of oils, fats, lipids, carbohydrates, amino acids, peptides, proteins, amino acids, terpenoids and alkaloids.	U	BY – 6, HSC – 7, ZY-7
3	Analyse the chemical structure and biological function of terpenoids, alkaloids, proteins, nucleic acids and energy rich molecules	An	BY – 6, HSC – 7, ZY-7
4	Use the results of physical measurements to predict chemical properties such as acid value, saponification value, iodine value	Ap	BY – 6, HSC – 7, ZY-7
5	Analyse numerical data to explain biological functions	An	BY – 6, HSC – 7, ZY-7
6	Formulate the synthesis, regulation, transport of vitamins, steroids and hormones.	C	BY – 6, HSC – 7, ZY-7
7	Identify nucleic acid structure	An	BY – 6, HSC – 7, ZY-7
8	Analyse the mechanism of regulation of serum cholesterol by statins	An	BY – 6, HSC – 7, ZY-7

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Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO. No.
1.0	Natural Products	6	
1.1	Classification of Terpenoids	1	1
1.2	Isoprene rule		1
1.3	Isolation of essential oils by steam distillation	1	1,2
1.4	Uses of lemongrass oil, eucalyptus oil and sandalwood oil	1	1,2
1.5	Source, structure and uses of citral and geraniol.	1	1
1.6	Alkaloids: Classification, Isolation, general properties.	1	1
1.7	Source, structure and physiological activity of nicotine, coniine and piperine.	1	1,3
2.0	Lipids	6	
2.1	Classification and structure of oils, fats and waxes.	1	2
2.2	Biological functions of lipids.	1	2
2.3	Hydrogenation and Rancidity		2,4
2.4	Acid value, Saponification value and Iodine value	1	4,5
2.5	Biological functions of phospholipids and glycolipids	1	5
2.6	Types and action of soaps.		2
2.7	Classification of synthetic detergents.	1	2
2.8	Comparison between soaps and detergents	1	2
2.9	Environmental aspects of soaps and detergents		2
3.0	Amino Acids, Proteins, Nucleic Acids and Enzymes	21	
3.1	Classification of Amino acids.	2	1,2
3.2	Zwitter ion formation and isoelectric point	1	1
3.3	Synthesis of glycine, alanine, and phenyl alanine	1	1
3.4	Peptide bond. Synthesis of peptides	1	1
3.5	Classification of proteins – Primary, secondary and tertiary structure of proteins	2	1,2
3.6	Denaturation of proteins	1	1
3.7	Tests for proteins.	1	1
3.8	Nomenclature, classification and characteristics of Enzymes.	1	1,2
3.9	Mechanism of enzyme action. Theory of enzyme catalysis	1	1,4
3.10	Michaelis-Menten theory.	1	1
3.11	Cofactors and coenzymes. Enzyme inhibitors. Uses of enzymes.	1	1
3.12	Nucleic acids: Structure of pentose sugar, nitrogenous base, nucleoside and nucleotide.	2	1,7
3.13	Double-helical structure of DNA	1	1
3.14	Differences between DNA and RNA.	1	1,7
3.15	Biological Functions – Replication and protein biosynthesis.	1	5
3.16	Transcription and Translation. Genetic code	1	1
3.17	Energy rich molecules: Elementary structure of ATP, ADP and AMP	1	1
4	Carbohydrates	12	
4.1	Classification of Carbohydrates	2	1,2
4.2	Preparation and properties of glucose, fructose and sucrose.	2	1,2
4.3	Cyclic structures and Haworth projections of glucose, fructose, maltose and sucrose	3	1,2
4.4	Mutarotation. Conversion of glucose to fructose and vice versa.	2	1,2

4.5	Structure of starch and cellulose.	2	2
4.6	Industrial applications of cellulose.	1	1
5	Vitamins, Steroids and Hormones	9	
5.1	Classification. Structure, biological functions and deficiency diseases of vitamins A, B ₁ , B ₂ , B ₃ , B ₅ , B ₆ , B ₁₂ , C and D.	4	1
5.2	Introduction. Structure and functions of cholesterol.	2	1,6
5.3	Elementary idea of HDL and LDL. Bile acids. Steroid hormones, peptide hormones, amine hormones and artificial hormones.	3	1,8

*PSO-Program Specific outcome; CO-Course Outcome;
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate;
C- Create.

Text Books for Reference

1. Maya Shankar Singh, L.G.Wade, *Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
2. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
3. I.L. Finar, *Organic Chemistry Vol. I & II*, 5th Edition, Pearson Education, New Delhi, 2013.
4. M.K. Jain, S.C. Sharma, *Modern Organic Chemistry*, Vishal Publishing Co. 2010.
5. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition,
6. Vikas Publishing House (P) Ltd., New Delhi, 2004.
7. A. Bahl and B.S. Bahl, *Advanced Organic Chemistry*, 1st Multicolour Edition, S. Chand & Company, New Delhi, 2010.

Text Books for Enrichment

1. A.C. Deb, *Fundamentals of Biochemistry*, 9th Edn. New Central Book Agency, 2001.
2. Rastogi, *Biochemistry*, Tata McGraw –Hill Publication, 1996.
3. Bhat S.V., Nagasampagi, B.A. & Sivakumar M. *Chemistry of Natural Products*, Narosa, 2005.

Course	Details			
Code	CH1814704			
Title	PRACTICALS-II ORGANIC ANALYSIS			
Degree	B.Sc			
Branch(s)	Common to Physical sciences, Life sciences, Geology and Family & Community sciences			
Year/Semester	II/4			
Type	Complementary			
Credits	1	Hrs/Week	2	Total Hours 36

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level
1	Test for various functional groups and express them with suitable chemical equations.	R
2	Identify the functional groups and Distinguish between a set of compounds	An
3	Prepare derivatives of organic compounds.	C
4	Isolate an organic compound from a natural source.	Ap

*PSO-Program Specific Outcome; CO-Course Outcome;

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Identify the functional groups and characterise the given organic compound	20	
1.1	Distinguish between naphthalene and anthracene	2	4
1.2	Distinguish between chlorobenzene, benzyl chloride and p-dichlorobenzene	2	4
1.3	Distinguish between benzyl alcohol, phenol, o-, m- and p- cresols, α -naphthol, β -naphthol, resorcinol	4	4
1.4	Distinguish between benzaldehyde, acetophenone, benzophenone	2	4
1.5	Distinguish between benzoic acid, phthalic acid, cinnamic acid, salicylic acid	2	4
1.6	Distinguish between ethyl benzoate, methyl salicylate	2	4
1.7	Distinguish between benzamide, urea	2	4
1.8	Distinguish between aniline, dimethyl aniline	2	4
1.9	Distinguish between glucose and starch	2	4
2.0	Preparation of derivatives of organic compounds	14	
2.1	Organic preparation involving halogenation	2	5
2.2	Organic preparation involving nitration	2	5
2.3	Organic preparation involving oxidation and reduction	2	5
2.4	Organic preparation involving acetylation	2	5
2.5	Organic preparation involving benzylation	2	5
2.6	Organic preparation involving hydrolysis	2	5
2.7	Organic preparation involving diazotization	2	5
3.0	Isolation of an organic compound	2	
3.1	To isolate an organic compound from a natural source.	2	6

References:

1. A. I Vogel, *A Text Book of Practical Organic Chemistry*, Longman.
2. F. G. Mann and B.C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education.
3. V. K. Ahluwalia and S. Dhingra, *Comprehensive Practical Organic Chemistry*, Universities Press.

ADD ON COURSE

Course	Details				
Code					
Title	Computational Molecular Modeling				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester					
Type	Add on Course				
Credits	2	Hrs/Week	2	Total Hours	36

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Discuss how quantum mechanical models can be used to describe molecules	U	PSO1
2	Explain Born-Oppenheimer approximation	U	PSO1
3	Explain the concept of potential energy surface	U	PSO1
4	Discuss the various methods in solving schrodingers equation	U	PSO1
5	Demonstrate GaussView and Gaussian software	U	PSO4
6	Apply GaussView and Gaussian Software in finding the global minima of various molecules.	Ap	PSO4
7	Apply GaussView and Gaussian Software in calculating the potential energy surface of various molecules.	Ap	PSO4
8	Apply GaussView and Gaussian Software in finding the IR, Raman, NMR and UV spectra of various molecules.	Ap	PSO4
9	Compare the IR spectra obtained for different molecules	An	PSO4

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Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO.No.
1.0	Introduction to Computational chemistry	2	1
1.1	Schrodingers Equation of Hydrogen	6	1
1.2	Born-Oppenheimer approximation	3	2
1.3	Potential energy surfaces	4	3
1.4	Solving electronic strodingers equation with different techniques	3	4
2.0	Introduction to GaussView visualization software	3	5
2.1	Introduction to Gaussian09 Quantum chemistry program	3	5
2.2	Geometry optimization using Gaussian09	3	6
2.3	Potential enegy surface generation using Gaussian09	3	7
2.4	Vibrational frequency analysis using Gaussian09	3	8
2.5	Computing IR, Raman, UV and NMR spectra using Gaussian09	3	8,9

Text Books for Reference

- J. B. Foresman and Æ Frisch, *Exploring Chemistry with Electronic Structure Methods*, 3rd ed., Gaussian, Inc.: Wallingford, CT, 2015.

Text Books for Enrichment

- Donald A. MacQuarie, *Quantum Chemistry*, 2nd ed., Viva 2011

EXTRA CREDIT COURSE

Course	Details				
Code					
Title	NUMERICAL COMPUTATION AND DATA ANALYSIS				
Degree	BSc				
Branch(s)	Chemistry				
Year/Semester					
Type	Extra Credit Course				
Credits	2	Hrs/Week	2	Total Hours	36

CO No.	<i>Expected Course Outcomes</i> <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Apply standard techniques to analyze key properties of numerical algorithms, such as stability and convergence	Ap	PSO-1 PSO-4
2	Apply a range of numerical algorithms efficiently in a modern scientific computing programming language	Ap	PSO-1 PSO-4
3	Understand and analyze common pitfalls in numerical computing such as ill-conditioning and instability	U	PSO-1 PSO-4
4	Apply data analysis techniques efficiently and accurately using data fitting methods	U	PSO-1 PSO-4
5	Derive and analyze numerical methods for ODEs and PDEs.	An	PSO-1 PSO-4
6	Apply optimization using well-established algorithms.	Ap	PSO-1 PSO-4

Module	Course Description	Hrs	CO.No.
1.0	Data Fitting	2	2
1.1	Polynomial interpolation, Linear least squares fitting, Nonlinear least squares	6	1,2,4
2.0	Numerical Linear Algebra	3	1
2.1	LU and Cholesky factorizations, QR factorization, singular value decomposition	4	2
3.0	Numerical Calculus and Differential Equations	3	3,5
3.1	Numerical differentiation, numerical integration, ODEs, forward/backward Euler, Runge–Kutta schemes, Lax equivalence theorem, stability regions for ODE solvers, Boundary value problems, PDEs, finite difference method	6	5
4.0	Nonlinear Equations and Optimization	3	5

4.1	Root finding, univariate and multivariate cases, Necessary conditions for optimality, Survey of optimization algorithms	3	6
5.0	Eigenvalue problems	3	5
5.1	QR algorithm, Power method, inverse iteration, Lanczos algorithm, Arnoldi algorithm	3	5

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Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Text Books for Reference

1. Greenbaum and T. P. Chartier. Numerical Methods: Design, Analysis and Computer Implementation of Algorithms. Princeton University Press, 2012.
2. W. H. Press, S. A. Teukolsky, W. T. Vetterling, B. P. Flannery. Numerical Recipes: The Art of Scientific Computing. Cambridge University Press, 2007.
3. L. R. Scott. Numerical Analysis. Princeton University Press, 2011.
4. E. Suli, D. F. Mayers. An Introduction to Numerical Analysis. Cambridge University Press, 2003.

Text Books for Enrichment

1. C. Moler. Numerical Computing with MATLAB. SIAM, 2004. • L. N. Trefethen and D. Bau. Numerical Linear Algebra. SIAM, 1997.