DEPARTMENT OF CHEMISTRY
ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514

Programme Specific Outcomes (PSOs)

The programme enables the students to

PSO1: recognise the basic concepts of Chemistry and to provide students with the skills required to succeed in future career prospects in Chemistry

PSO2: acquire the ability to identify and describe the principles of pure and applied Chemistry

PSO3: apply the contextual knowledge of Chemistry to identify and solve problems, think significantly and to function effectively as an individual in multidiscipline

PSO4: synthesise, compare, evaluate, classify, interpret and effectively apply the basic laws, principles, process and mechanism involved in the domain of Chemistry

PSO5: impart a broad foundation in Chemistry and enable them to evaluate and analyse critically the scientific facts

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
B.Sc. Chemistry – Course Structure under CBCS

I SEMESTER				
PART	**Sub. Code**	**PAPER**	**Hrs**	**Cr**
I	22UTAL11/ 22UHNL11/ 22UFNL11	Tamil / Hindi / French	6	4
II	22UENA11 22UENB11	English through Prose & Short Story (Stream-A) English through Prose & Short Story (Stream-B)	5	4
III	22UCHC11	Core-1 General Chemistry	6	5
	22UCHP12	Core Lab-I Volumetric Estimations	3	--
	22UCHB11	Allied Chemistry-I (for Mathematics)		
	22UCHR12	Allied Chemistry Lab (for Mathematics)		
	22UCHA11 22UMAB11	Allied Biochemistry-I/ Allied Mathematics-1	3/ 5	3/ 4
	19UCHQ12	Allied Biochemistry Lab	2	--
IV	22USBE11	Skill Based Elective-1 (Computer Literacy) Office Automation & Design	1	1
	22USBP11	Office Automation & Design - Practical	2	1
	22UFCE11	FC-Personality Development	1	1
	22UCSH12	Communication Skills	1	--
V	22UNSS/NCC/ YRC/PHY.EDU. /ROT/ACF/ NCB12	Extension Activities NSS/NCC/Phy. Edn/ YRC/ROTARACT/AICUF/NATURE CLUB	--	--
	22UBRC11	Bridge Course		1
		Total	**30**	**20/21**
II SEMESTER				
I	22UTAL22/ 22UHNL22/ 22UFNL22	Tamil / Hindi / French	6	4
II	22UENA22 22UENB22	English through Prose & Poetry (Stream-A) English through Prose & Poetry (Stream-B)	5	4
III	22UCHC22	Core-2 Inorganic Chemistry-I	6	5
	22UCHP12	Core Lab-I Volumetric Estimations	3	3
	22UCHB22	Allied Chemistry-II (for Mathematics)		
	22UCHR12	Allied Chemistry Lab (for Mathematics)		
	22UCHA22 22UMAB22	Allied Biochemistry-II/ Allied Mathematics-II	3 5	3 4
	22UCHQ12	Allied Biochemistry Lab	2	2
IV	22USBE22	Skill Based Elective-2 Programming in C	1	1
	22USBP22	Programming in C Lab	2	1
	22UFCE22	FC-Social Analysis and Human Rights	1	1
V	22UNSS/NCC/	Extension Activities NSS/NCC/Phy. Edn/	---	1

	YRC/PHY.EDU. /ROT/ACF/ NCB12	YRC/ROTARACT/AICUF/NATURE CLUB		
	22UCSH12	Communication Skills	1	1
		Total	**30**	**25/26**
III SEMESTER				
I	22UTAL33/ 22UHNL33/ 22UFNL33	Tamil / Hindi / French	6	4
II	22UENG33	English through Literature-I	6	4
III	22UCHC33	Core-3 Organic Chemistry-I	6	6
	22UCHP24	Core Lab-II Inorganic Qualitative Analysis	3	---
	22UCHB13	Allied Chemistry-I (for Physics)	3	3
	22UCHR14	Allied Chemistry Lab (for Physics)	2	---
		Allied-3 Physics		
		Allied Physics Lab		
IV	22UCHN13	Basic Tamil/Advanced Tamil/Non-Major Elective-1 Chemistry in Your Life	3	2
	22UFCE33	FC-Environmental Studies	1	1
V	22UNCC/NSS/ PED/YRC/ROT / ACF/NCB24	Extension Activities NSS/NCC/Phy. Edn./YRC/ ROTARACT/AICUF/NATURE CLUB	---	---
	22UARE14	ARISE		---
			30	**20**
IV SEMESTER				
I	22UTAL44/ 22UHNL44/ 22UFNL44	Tamil / Hindi / French	6	4
II	22UENG44	English through Literature-II	6	4
	22UCHC44	Core-4 Physical Chemistry-I	6	6
III		Core Lab-II Inorganic Qualitative Analysis	3	3
	22UCHA24	Allied Chemistry-II (for Physics)		
		Allied Chemistry Lab (for Physics)		
		Allied-4 Physics	3	3
		Allied Physics Lab	2	2
IV	22UCHN24	Basic Tamil/Advanced Tamil/Non-Major Elective-2 Applied Chemistry	3	2
	22UFCH44	Bioethics, Religions and Peace Studies/ Catechism of the Catholic Church	1	1
V	22UNCC/NSS/ PED/YRC/ROT / ACF/NCB24	Extension Activities NSS/NCC/Phy. Edn./YRC/ ROTARACT/AICUF/NATURE CLUB	---	1
	22UARE14	ARISE		1
			30	**27**

V SEMESTER				
III	22UCHC55	Core-5 Organic Chemistry-II	6	6
	22UCHC65	Core-6 Inorganic Chemistry-II	6	5
	22UCHC75	Core-7 Physical Chemistry-II	5	5
	22UCHP35	Core Lab-III Organic Analysis	4	3
	22UCHP46	Core Lab-IV Organic Estimation & Preparation	4	3
	22UCHE15	Elective-1 (out of four)	4	3
	22UINT15	Internship (Holidays)		1
	22USSI16	Interview & Group Discussion Skills	1	1
			30	**27**
VI SEMESTER				
III	22UCHC86	Core-8 Organic Chemistry-III	6	5
	22UCHC96	Core-9 Inorganic Chemistry-III	5	5
	22UCHD06	Core-10 Physical Chemistry-III	6	5
	22UCHP46	Core Lab-V Gravimetry and Preparation	4	3
	22UCHP56	Core Lab-VI Physical Chemistry	4	3
	22UCHE26	Elective-2 (out of four)	4	3
	22USSI16	Leadership & Team Building Skills	1	1
			30	**25**

Core Elective-1 : Medicinal Chemistry
Analytical Chemistry
Polymer Chemistry
Soil Chemistry

Core Elective-2 : Industrial Chemistry
Pharmaceutical Chemistry
Environmental Chemistry
Nutritional Chemistry

Non-Major Elective-1 : Chemistry in Your Life
Non-Major Elective-2 : Applied Chemistry

Semester:	I	II	III	IV	V	VI	TOTAL
Credits :	20/21	25/26	20	27	27	25	144*

*** 144 credits from 2021-2022 onwards**

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
GENERAL CHEMISTRY

Class	: I B.Sc. Chemistry	Part	: III Core-1
Semester	: I	Hours	: 90
Subject Code	: 22UCHC11	Credits	: 5

Course Educational Objectives

The course enables the students to

1. state and explain the basic concepts, theories and models of atomic structure.
2. state the periodic laws and to classify and explain the periodic table.
3. describe about the basic concepts of Organic chemistry.
4. explain the basic concepts of Physical Chemistry.
5. analyse critically the titrimetric methods of analysis.

UNIT-I Atomic Structure (18 Hours)

Atomic structure – introduction – Dalton's atomic theory – Thomson's atomic model– Rutherford's atomic model– Bohr's atomic model – Sommerfeld's atomic model – postulates, merits and demerits – classification of spectral lines in hydrogen spectrum – dual nature of electrons – de Broglie's equation – derivation – Davisson and Germer experiment – Heisenberg's uncertainty principle – Compton effect – quantum numbers and their significance – concept of atomic orbital – Shapes of orbitals – Pauli's exclusion principle– Aufbau principle – Madelung's n+l rule – Hund's rule of maximum multiplicity.

UNIT-II Periodic Table & Periodic Properties (18 Hours)

Mendeleev's periodic law and Mendeleev's periodic table – Moseley's periodic law – long form of the periodic table – merits and demerits – classification into s, p, d and f-block elements – periodic properties and their periodic variations – Atomic Radii, Ionic Radii, Covalent Radii, Ionization Energy, Electronegativity, Electron Affinity – Diagonal relationship in periodic table (introductory concepts only) – general properties of groups and periods – Electronic configuration of atoms – rule of half-filled and completely filled orbitals – Effective Nuclear Charge – Screening Effect – Slater Rules.

UNIT-III Basic Concepts of Organic Chemistry (18 Hours)

Introduction – Catenation – Empirical and Molecular formula – Calculations – Classification of organic compounds – functional groups – structural formulae (fundamental ideas only) – IUPAC Nomenclature (basic idea only) – isomerism – structural and stereoisomerism – types and examples – Tautomerism – Keto-enol Tautomerism –organic reactions – types of reactions – cleavage of bonds – homolysis and heterolysis – types of reagents – electrophiles, nucleophiles and free radicals – localised and delocalised bonds – resonance – conditionsfor resonance – hyperconjugation – inductive, mesomeric,electromeric and steric effects – definition – Organic reaction intermediates – generation, stability and structure of carbocations, carbanions and free radicals.

UNIT-IV Basic Concepts of Physical Chemistry (18 Hours)

Units – fundamental units, derived units and SI units – Significant Figures – Mathematical functions (logarithmic, exponential and trigonometric function) – drawing straight line – slope and intercept – extrapolation – coordinate system – spherical polar system.

States of matter – types – properties of solids, liquids and gases – solid state – types of solids – amorphous and crystalline solids – isotropy, anisotropy – Molecular interactions – ion-ion interaction – ion-dipole interaction – dipole-dipole interaction –van der Waal's

forces– hydrogen bonding – types of hydrogen bonding – colloidal state – types of colloids– characteristics of sol – gaseous state – general characteristics of gases and gas laws – Boyle's law, Charles' law, Avogadro's law – ideal gas equation.

UNIT-V Titrimetric Analysis & Laboratory Safety measures (18 Hours)

Mole concept – Avogadro number – Concentrations of solutions – mole fraction, molarity, molality, normality, weight%, volume%, ppm and ppb.

Principle of volumetric titration – Primary and secondary standards – criteria for primary and secondary standards – preparation of standard solution – standardisation of solutions – limitations of volumetric analysis – end point and equivalence point – acid-base titrations – acid-base indicators – pH range and choice of indicators.

Storage and handling of chemicals – toxic and poisonous chemicals – waste and fume disposal – precautions and first-aid procedure – uses of different glassware – hazard symbols – laboratory safety measures.

Course Outcomes

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

1. state and explain the basic concepts, theories and models of atomic structure.
2. explain the salient features of periodic table, classify elements and explain their periodic properties.
3. classify the organic compounds and describe the nomenclature, isomerism, reaction intermediates and electronic effects.
4. apply mathematical concepts in physical chemistry and compare and contrast the properties of solids, liquids and gases.
5. explain the theoretical principles of titrimetric methods of analysis and practice lab safety measures.

Text Books

1. B. R. Puri, L. R. Sharma and K. C. Kalia, "Principles of Inorganic Chemistry", 33rd Edition, Milestone Publishers and Distributors, New Delhi, India (2020)
2. Arun Bahl, B.S. Bahl, A Text Book of Organic Chemistry, 22ndEdition, S.Chand& Co (2019).
3. B.R. Puri & L.R. Sharma & M.S. Pathania, Principles of Physical Chemistry, 48thEdition, Vishal Publishing Co (2020).
4. R. Gopalan, P.S. Subramanian and K. Rangarajan, Elements of Analytical Chemistry, Sultan Chand & Sons. Chapter (2016)

Reference Books

1. Sathya Prakash, G. D. Tuli, S. K. Basu& R. D. Madan, "Advanced Inorganic Chemistry", S. Chand & Company, New Delhi (2013)
2. Sathya Prakash, G. D. Tuli, S. K. Basu& R. D. Madan, "Advanced Inorganic Chemistry", S. Chand & Company, New Delhi (2013)
3. Robert Thornton Morrison, Robert Neilson Boyd, SaibalKanti, Organic Chemistry, 7th Edition, Pearson Publications (2016).
4. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Fundamentals of Analytical Chemistry, 10th Edition, Cengage Publisher (2021).

Mapping

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	2	2	2	2	3	2	-	-	2	2	2	2	23
	2	3	3	2	2	2	2	3	-	-	3	3	2	2	27
	3	2	2	2	3	3	2	2	-	-	2	2	2	2	24
	4	2	2	2	2	2	2	2	-	-	2	2	2	2	22
	5	2	2	2	2	2	2	2	-	-	2	2	2	2	22
Grand total of COs With PSOs & POs															118
Mean value of COs With PSOs & POs = 118/55															2.14

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.14
Observation	COs of General Chemistry is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
ALLIED BIOCHEMISTRY-I

Class	: I B.Sc. Chemistry	Part	: III Allied-1
Semester	: I	Hours	: 45
Subject Code	: 22UCHA11	Credits	: 3

Course Educational Objectives

The course enables the students to

1. recognize the scope and importance of biochemistry.
2. identify different types of carbohydrates and their metabolism.
3. predict the biological importance of lipids.
4. classify different types of amino acids, proteins and their functions.
5. analyse the integrated metabolism of carbohydrates, lipids, and proteins.

UNIT-I Introduction to Biochemistry (9 hours)

Biochemistry – definition, scope and importance–history of biochemistry – branches of biochemistry– Living organisms – characteristics and classification – concept of cell, types of cells – prokaryotic and eukaryotic cell, biomolecules – important biomolecules and their characteristics.

UNIT-II Carbohydrates (9 hours)

Carbohydrates – occurrence, classification, properties – biological importance of monosaccharides, disaccharides and polysaccharides-example – metabolism of carbohydrates, glycogenesis, glycogenolysis, glycolysis – Embden – Meyerhof Parners pathway – energetic of EMP pathway, gluconeogenesis –Kreb's cycle(citric acid cycle or TCA cycle)regulation of glucose level in blood – Glycosuria, diabetes mellitus – glucose tolerance test.

UNIT-III Lipids (9 hours)

Lipids – definition, classification, properties – biological importance of lipids – simple lipids, compound lipids, derived lipids – definition and examples – Fatty acids – Properties – acid value – iodine value – R-M value – Saponification number – Rancidity – metabolism of lipids –oxidation of glycerol, oxidation of fatty acids – β-oxidation, biosynthesis of fatty acids – metabolism of cholesterol – role of liver in lipid metabolism –role of adipose tissues in lipid metabolism – fatty liver, lipotropism and lipotropic factor.

UNIT-IV Amino acids and Proteins (9 hours)

Amino acids – definition – classification – properties – peptides – polypeptides – preparation of polypeptides – proteins – simple proteins, conjugated proteins, derived proteins – definition and example – structure of proteins – primary, secondary, tertiary and quarternary structure – C and N-terminal analysis – Protein denaturation and renaturation – biological importance of proteins – catabolism of amino acids – oxidative deamination, transamination, trans deamination, transmethylation and decarboxylation, biosynthesis of amino acids.

UNIT-V Integration of carbohydrates, lipids and protein metabolism (9 hours)

Integrated metabolism of carbohydrates, lipids and proteins – inter conversion between three different metabolism – regulation and control of metabolism.

Course Outcomes

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

1. recall the basic idea of biomolecules and biochemistry.
2. explain the classification, properties and metabolism of carbohydrates.

3. describe the types, quality parameters and metabolism of lipids.
4. illustrate the types, functions and structure of proteins.
5. integrate the metabolic pathway of carbohydrates, lipids, and proteins.

Books for Study

1. J. L. Jain, "Fundamentals of Biochemistry", 5th Edition S.Chand& Company (2001).
2. L.Veerakumari, "Biochemistry", MJP publisher (2004).

Books for Reference

1. G.R. Agarwal, Kiranagarwal and O.P. Agarwal, "Text book of Biochemistry", 10th Edition Goel Publishing House, Meerut (1999).
2. Powar and Chatwal, "Biochemistry", 4th Edition, Himalaya Publishing House, (1999).
3. Dhaka and Singha, "A Text Book of Biochemistry", Aman Publishing House (1997).
4. McKee, "Biochemistry: The Molecular Basis of Life". 3rdEdition. McGraw Hill (2004).

Mapping

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	3	2	3	2	3	2	-	-	2	2	2	2	26
	2	3	3	2	2	2	3	3	-	-	3	2	2	2	27
	3	2	2	2	2	2	3	3	-	-	2	2	2	2	24
	4	2	2	2	2	2	2	2	-	-	3	2	2	2	23
	5	2	2	2	2	2	2	2	-	-	2	2	2	2	22
Grand total of COs With PSOs & POs															122
Mean value of COs With PSOs & POs = 122/55															2.21

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.21
Observation	COs of Allied Biochemistry-I is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY

ALLIED CHEMISTRY-I

Class	: I B.Sc. Mathematics	Part	: III Allied-1
Semester	: I	Hours	: 45
Subject Code	: 22UCHB11	Credits	: 3

Course Educational Objectives

The course enables the students to

1. define and describe the electronic configuration and periodicity in properties of elements.
2. apply the various concepts of chemical bonding in inorganic compounds.
3. classify and distinguish the isomerism involved in organic acids.
4. explain the colour and constitution of dyes.
5. describe and analysethe various safety methods involved in laboratory.

Unit I Periodic Table (9 hours)

Mendeleev's table – Merits and demerits – Long form of the periodic table and its advantages – classification into s, p, d and f-block elements – Rules for writing electronic configurations.

Study of the variation of the following properties of elements in terms of their electronic configurations – Atomic radius, ionic radius, ionization potential, electron affinity, electronegativity, metallicity and their periodic variations.

Unit II Chemical Bonding (9 hours)

Covalent bond: orbital overlap – hybridization – VB theory – geometry of organic molecules – CH_4, C_2H_4 and C_2H_2, geometry of inorganic molecules – $BeCl_2$, BF_3 and SF_6 – Molecular orbital theory, bonding, antibonding and non-bonding orbitals – MO configuration of H_2, N_2, O_2, F_2. Bond order – magnetic properties – diborane: Preparation, properties and structure.

Unit III Isomerism (9 hours)

Symmetry – elements of symmetry – types of isomerism – structural and stereoisomerism – optical isomerism – chirality – lactic acid - tartaric acid - racemisation, resolution – definition – geometric isomerism of maleic and fumaric acids – distinguishing geometrical isomers on the basis of dipole moments.

Unit IV Colour and Constitution (9 hours)

Chromophore, auxochrome, bathochromic shift, hypsochromic shift – hyperchromic effect – hypsochromic effect – classification of dyes: azo, phthalein and triphenylmethane dyes – preparation of methyl orange, phenolphthalein and Bismarck brown. Indicators – pH range.

Unit V Safety Methods in Lab (9 hours)

Storage and handling of chemicals – toxic and poisonous chemicals – waste and fume disposal – precautions and first-aid procedure – uses of different glassware – hazard symbols – laboratory safety measures – indicators and its applications.

Course Outcomes

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

1. define and describe the electronic configuration and periodicity in properties of elements
2. apply the various concepts of chemical bonding in inorganic compounds
3. classify and distinguish the isomerism involved in organic acids

4. explain the colour and constitution of dyes
5. describe and analysethe various safety methods involved in laboratory

Books for Study

1. ArunBahl, B.S. Bahl, A Text Book of Organic Chemistry, S.Chand& Co (2011).
2. B.R. Puri, L.R. Sharma, & K.C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers (2012).
3. R. Gopalan, P.S. Subramanian and K. Rangarajan, Elements of Analytical Chemistry, Sultan Chand & Sons.

Book for Reference

1. R. D. Madan, A Text Book of Modern Inorganic Chemistry, S.Chand & Co (2008).
2. P.L. Soni, H.M. Chawla., A Text Book of Organic Chemistry, S.Chand & Co (2014).

Mapping

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	2	2	3	2	-	-	2	2	2	2	24
	2	3	2	2	2	2	2	3	-	-	2	3	2	3	26
	3	2	2	2	3	3	2	2	-	-	2	2	2	2	24
	4	2	2	2	2	2	2	2	-	-	2	2	2	2	22
	5	2	2	2	2	2	2	2	-	-	2	2	2	2	22
Grand total of COs With PSOs & POs															118
Mean value of COs With PSOs & POs = 118/55															2.14

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.14
Observation	COs of Allied Chemistry-I is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
INORGANIC CHEMISTRY-I

Class	: I B.Sc. Chemistry	Part	: III Core-2
Semester	: II	Hours	: 90
Subject Code	: 22UCHC22	Credits	: 5

Course Specific Objectives

The course enables the students to

1. state and define the basic concepts of Inorganic Chemistry
2. explain and illustrate the types of chemical bonding
3. describe and apply the theories of chemical bonding
4. describe, apply and generalise the theories of acids, bases and non-aqueous solvents
5. apply various concepts of nuclear chemistry

UNIT-I Basic Concepts of Inorganic Chemistry (18 Hours)

Mole concept and stoichiometry –Balancing chemical equations – limiting reagents – Calculations based on chemical equations – Covalency – Oxidationnumber – Rules for calculating oxidation number – Oxidation and reduction – redox reactions and half reactions – oxidizing and reducing agents – disproportionation reaction – Balancing redox equation – oxidation number and ion-electron methods –Molecular weight and equivalent weight– Equivalent weights of acids, bases, salts, oxidants and reductants – Calculations.

UNIT-II Chemical Bonding–I (18 Hours)

Types of Bonds – ionic, covalent, coordinate and metallic bonds – Properties.

Ionic compounds – illustration of the formation of ionic compound (NaCl, $CaCl_2$, MgO) – Lattice energy – Factors affecting lattice energy – Born-Lande Equation (No derivation) – Born-Haber cycle – Formation of NaCl.

Covalent compounds – Lewis Structures of homo and heteronuclear molecules (O_2, N_2, F_2, HF, CH_4 and NH_3) – Partial covalency in ionic compounds – Polarisation and Fajans' rules. Electronegativity scales – Pauling &Mulliken.

Coordinate bond – illustration in O_3, NH_4^+ and H_3O^+ ions – Hydrogen bonding in H_2O, NH_3 and HF molecules.

UNIT-III Chemical Bonding–II (18 Hours)

Theories of covalent bond – Sidgwick-Powell theory – Valance Bond theory – Postulates – Hybridisation and geometry of molecules – sp, sp^2, sp^3, sp^3d, sp^3d^2, sp^3d^3 hybridisations – VSEPR theory – Postulates – Structure of $BeCl_2$, BF_3, CH_4, NH_3, H_2O, PCl_3, PCl_5, SF_4, SF_6, IF_7, ClF_3 and BrF_5.

Molecular orbital theory – criteria of orbital overlap – types of molecular orbitals – Construction of MO diagrams – MO diagram for simple homo diatomic (H_2, He_2, B_2, C_2, N_2, O_2 and F_2) and hetero diatomic (CO and NO) molecules – Bond order and magnetic properties – stability of molecules.

Unit-IV Concepts of Acids, Bases and Non-aqueous Solvents (18 Hours)

Theories of Acids and bases – Arrhenius concept – Brönsted-Lowry concept– Conjugate acid-base pairs – Relative order of acidity of halogen acids and oxyacids – Lewis concept – Lux-Flood concept – Usanovich's concept – definition, applications and limitations – Pearson's classification as Hard and Soft Acids and Bases (HSAB) – applications and limitations.

Non-aqueous solvents – protic and aprotic solvents – Ammonia – solutions of alkali and alkaline earth metals in ammonia – Liq. SO_2 as solvent.

Unit-V Nuclear Chemistry (18 Hours)

Introduction – elementary particles – concept of nuclides – representation of isobars, isotones, isotopes with examples – Radioactivity – Stable and unstable nuclei – n/p ratio – magic numbers – mass defect and binding energy – binding energy curve – packing fraction – mass-energy relationships.

Radioactive Elements – modes of decay – Neutron, Positron Theory of α, β and γ emission – characteristics of α, β and γ particles – Theories of radioactivity – Soddy's group displacement law – half-life period – average life – radioactive disintegration series.

Nuclear reactions – Nuclear fission – atomic bomb – Nuclear fusion – stellar energy, hydrogen bomb – Nuclear reactor.

Applications of radioactivity in medicine, agriculture and industry – Radiocarbon dating.

Course Outcomes

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

1. define the basics of oxidation number and apply the concept to balance redox reactions.
2. explain and illustrate the formation of ionic and covalent compounds.
3. apply the theories of chemical bonding to predict the hybridization,structure and properties.
4. explain the theories of acids & bases and describe the properties of non-aqueous solvents.
5. discuss the concepts of nuclear chemistry and outline its applications.

Text Books

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Shoban Lal, Principles of Inorganic Chemistry, Nagin Chand and Co., New Delhi, (2018).
2. Satyaprakash, G. D. Tuli, S. K. Basu, R. D. Madan, Advanced Inorganic Chemistry, Vol. I, S. Chand & company, 5th Edition, New Delhi (2017).

Reference Books

1. John D. Lee, "Concise Inorganic Chemistry", 5th Edition, Blackwell Science, New Delhi (2018).
2. B. R. Puri, L. R. Sharma and K. C. Kalia, "Principles of Inorganic Chemistry", 31st Edition, Milestone Publishers and Distributors, New Delhi, India (2014).
3. James E. Huheey, Ellen A. Keiter, Richard L. Keiter&Okhil K. Medhi, "Inorganic Chemistry – Principles of Structure and Reactivity", 4th Edition, Pearson Education, New Delhi (2018).
4. B.Douglas, D.McDaniel, J.Alexander, Concepts and Models of Inorganic Chemistry, 3rd Edition, John Wiley (1994).

Mapping

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	2	2	2	3	-	-	2	2	2	2	24
	2	2	3	2	2	2	3	2	-	-	3	2	2	2	25
	3	3	2	2	2	2	2	2	-	-	2	3	2	2	24
	4	2	2	2	2	2	2	2	-	-	2	3	2	3	24
	5	3	2	3	2	2	2	2	-	-	2	2	2	2	24
Grand total of COs With PSOs & POs															121
Mean value of COs With PSOs & POs = 121/55															2.20

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.20
Observation	COs of Inorganic Chemistry-I is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
ALLIED BIOCHEMISTRY-II

Class	: I B.Sc. Chemistry	Part	: III Allied-2
Semester	: II	Hours	: 45
Subject Code	: 22UCHA22	Credits	: 3

Course Educational Objectives

The course enables the students to

1. state different types of enzymes and their importance
2. describe about DNA , RNA and genetic code
3. classify different types of hormones and their role on human health.
4. Analyse critically the chemistry of vitamins
5. describe the biological aspects of physiological process

Unit-I Enzymes (9 hours)

Enzymes – definition –classification – enzyme activity units – characteristic properties of enzymes – mechanism of enzyme action – lock and key hypothesis – factor affecting enzyme action – enzyme kinetics – Michaelis-Menton hypothesis - enzyme inhibition – coenzymes – mechanism of coenzyme – clinical importance of enzymes – therapeutic uses of enzymes, enzymes in food processing – enzymes in industry.

Unit-II Nucleic acids (9 hours)

Introduction – Nuclear bases – purine bases, pyrimidine bases, nucleosides and nucleotides –definition – types – biological importance – properties and structure of nucleic acid – DNA – Hydrogen bonding between nucleobases – primary, secondary and tertiary structure – RNA – types – functions – replication of DNA – mutation – distinction between DNA and RNA – genetic code and genetic code table.

Unit-III Hormones (9 hours)

Definition – properties – functions of hormones – classification of hormones based on secreting glands and chemical structure – hierarchy of hormonal function – mode of action of hormones – functions of pituitary hormones, thyroid hormones – adrenal hormones – antithyroid drug – definition, example – hypothyroidism, hyperthyroidism – goiter and iodine deficiency – insulin – diabetes.

Unit-IV Vitamins (9 hours)

Classification of vitamins – fat soluble vitamins (A,D,E,K) – metabolic function, sourcesand effects of deficiency of vitamins – water soluble vitamins – thiamine (B_1), riboflavin (B_2), pantethenic acid (B_3), niacin (B_5), pyridoxine (B_6), Biotin (B_7), Folic acid (B_9), cyanocobalamin (B_{12}), choline, p-amino benzoic acid, inositol, vitamine C, lipoic acid –metabolic function, sources and its effects of deficiency.

Unit-V Biochemical aspects of important physiological process (9 hours)

Digestion and absorption – definition, advantages – absorption of food stuffs – carbohydrates, proteins – lipids – nucleoproteins – water – vitamins – minerals – detoxification and excretion – definition – excretory organ – function of kidney – mechanism of kidney excretion – Respiration – definition, principle of respiration – liver function – nervous function – structural and functional units of nervous system – ageing – physiological changes and biochemical changes.

Course Outcomes

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

1. discuss the types, kinetics of enzymatic reactions and applications of enzymes
2. explain the types of nucleic acids and their functions
3. illustrate the types, properties and functions of hormones
4. describe sources, functions and deficiency of fat soluble and water-soluble vitamins
5. discuss the mechanism of digestion, respiration and nervous function

Books for Study

1. J. L. Jain, "Fundamentals of Biochemistry", 5th Edition S.Chand& Company (2001).
2. L.Veerakumari, Biochemistry, MJP publisher (2004)

Books for Reference

1. GR Agarwal, Kiranagarwal and O.P Agarwal, "Text book of Biochemistry", 10th Edition. Goel Publishing House, Meerut (1999).
2. Powar and Chatwal, "Biochemistry", 4th Edition, Himalaya Publishing House, (1999).
3. Dhaka and Singha, "A Text Book of Biochemistry", Aman Publishing House (1997).
4. McKee, "Biochemistry: The molecular basis of Life",3rdEdition. McGraw Hill (2004).

Mapping

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	2	2	3	2	-	-	2	2	2	2	24
	2	2	3	2	2	2	2	3	-	-	2	2	2	2	24
	3	2	2	2	3	3	2	2	-	-	2	2	2	2	24
	4	2	2	3	2	2	2	2	-	-	3	2	2	2	24
	5	3	2	2	2	2	2	2	-	-	2	2	2	3	24
Grand total of COs With PSOs & POs															120
Mean value of COs With PSOs & POs = 120/55															2.18

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.18
Observation	COs of Allied Biochemistry-II is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
ALLIED CHEMISTRY-II

Class	: I B.Sc. Mathematics	Part	: III Allied-2
Semester	: II	Hours	: 45
Subject Code	: 22UCHB22	Credits	: 3

Course Specific Objectives

The course enables the students to

1. state the principle involved in volumetric analysis.
2. define and describe the structure and bonding in co-ordination compounds.
3. describe the classification, preparation and properties of amino acids and carbohydrates.
4. analyse critically the various transitions involved in photochemical reactions
5. explain the basic concepts of electrochemistry.

Unit I Titrimetric Methods (9 hours)

General principle of titrimetric methods of analysis – requirements – expressing concentration – molarity, molality, normality, Wt%, ppm.

Standardisation of solutions – Principle of volumetric titration – primary and secondary standard – criteria – limitations of volumetric analysis – end point and equivalence point base, weak acid – weak base – indicators – choice of indicators.

Unit II Coordination Chemistry (9 hours)

Introduction – terminology – type of ligands – nomenclature – Werner's theory – Valence Bond theory – $[FeCl_6]^{4-}$, $[Fe(CN)_6]^{3-}$, $[CoCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ – polydendate ligand – chelation – examples – haemoglobin, chlorophyll and vitamin B12 – structure and functions – EDTA and its applications in analysis.

Unit III Life Chemistry (9 hours)

Amino acids – classification, preparation and properties of glycine and alanine – isoelectric point and Zwitter ion – peptide bond.

Classification of proteins by physical properties and by biological functions.

Carbohydartes – classification, preparation and properties of glucose and fructose – interconversion of glucose to fructose and vice versa.

Unit IV Fundamentals of Photochemistry (9 hours)

Comparison between thermal and photochemical reactions – Beer-Lambert's law – Grotthus-Draper Law and Stark-Einstein's Law - Quantum Efficiency – Definition – Jablonsky diagram – Radiative and non-radiative processes – chemiluminescence, fluorescence, phosphorescence – photosensitisation – bioluminescence (definitions with suitable examples)

Unit V Electrochemistry (9 hours)

Introduction – Terminology **–** Faradays law of electrolysis – Specific conductance, Equivalent conductance – Kohlraush's law – Galvanic cells – standard and single electrode potentials – Nernst equation **–** electrochemical series – e.m.f and its applications – reference electrodes – conductometric titrations – salt hydrolysis – buffer solutions.

Course Outcomes

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

1. state the principle followed in titrimetric methods of analysis
2. predict the structure and bonding in co-ordination compounds

3. classify the preparation and properties of amino acids and carbohydrates
4. analyse the transitions of photochemical reactions
5. assess the various aspects involved in electrochemistry

Books for Study

1. ArunBahl, B.S. Bahl, "A Text Book of Organic Chemistry", S. Chand & Co (2011).
2. B.R. Puri& L.R. Sharma & M.S. Pathania, "Principles of Physical Chemistry", Vishal Publishing Co (2012).
3. B.R. Puri, L.R. Sharma&K.C. Kalia, "Principles of Inorganic Chemistry", Milestone Publishers (2012).

Books for Reference

1. R. D. Madan, "A Textbook of Modern Inorganic Chemistry", S.Chand& Co (2008).
2. P.S. Subramanian and K. Rangarajan "Elements of Analytical Chemistry", R. Gopalan, Sultan Chand & Sons. (2011).

Mapping

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	2	2	2	2	-	-	2	2	2	2	23
	2	2	3	2	2	2	2	3	-	-	3	3	2	3	27
	3	2	2	2	2	2	2	2	-	-	2	2	2	2	22
	4	2	2	2	2	2	2	2	-	-	2	2	2	2	22
	5	3	2	2	2	2	2	2	-	-	2	2	2	3	24
Grand total of COs With PSOs & POs															118
Mean value of COs With PSOs & POs = 118/55															2.14

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.14
Observation	COs of Allied Chemistry-II is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY

VOLUMETRIC ESTIMATION

Class	: II B.Sc. Chemistry	Part	: III Major Practical
Semester	: I & II	Hours	: 45 (Each Semester)
Subject Code	: 22UCHP12	Credits	: 3

The course enables the students to

1. recall the principles of quantitative analysis
2. detect error in handling apparatus for volumetric estimations
3. employ in preparing solution of different concentration
4. support hands on training in volumetric titration
5. review the volumetric techniques to estimate the given solution

Calibration of volumetric apparatus: Burette, pipette and standard flasks.

Acidimetry – Alkalimetry

1. Estimation of hydrochloric acid (oxalic acid – NaOH – HCl)
2. Estimation of sulfuric acid (oxalic acid – NaOH – H_2SO_4)
3. Estimation of sodium carbonate (Na_2CO_3 – HCl – Na_2CO_3)
4. Estimation of sodium hydroxide (Na_2CO_3– HCl – NaOH)
5. Estimation of oxalic acid (oxalic acid – NaOH – oxalic acid)
6. Estimation of borax (Na_2CO_3 – HCl – borax)

Permanganometry

7. Estimation of iron (Oxalic acid – $KMnO_4$ – FAS)
8. Estimation of oxalic acid (Oxalic acid – $KMnO_4$ – Oxalic acid)
9. Estimation of ferrous sulphate (FAS – $KMnO_4$ – $FeSO_4$)
10. Estimation of calcium (Oxalic acid – $KMnO_4$ – Ca^{2+})

Iodimetry and Iodometry

11. Estimation of copper ($K_2Cr_2O_7$ – Thio – Cu^{2+})
12. Estimation of potassium dichromate (Cu^{2+} – Thio – $K_2Cr_2O_7$)

Complexometric Titrations

13. Estimation of magnesium
14. Estimation of calcium

Course Outcomes

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

1. recall the importance of calibration of apparatus to prepare standard solutions
2. describe and recognize the terminology of concentration terms
3. employ the principles ofvolumetric estimation
4. observe the end point and record the concordant values
5. develop the skills to perform volumetric estimation with high accuracy and precision.

Reference books

1. Jeyavathana Samuel, “Chemistry Practical Book”, G. G. Printers, Chennai. (2012).
2. Arthur Israel Vogel & John Mendham, “Vogel’s Textbook of Quantitative Chemical Analysis”, 6thEdition, Prentice Hall of India. (2000).
3. J.N. Gurtu and R. Kapoor, “Experimental Chemistry”, S.Chand and Co. (1987).
4. Peter McPherson, “Practical Volumetric Analysis”, Royal Society of Chemistry (2015).

Mapping

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	3	2	2	2	3	3	-	-	2	3	2	2	27
	2	2	2	2	3	3	2	2	-	-	3	3	3	3	28
	3	3	2	3	2	3	2	3	-	-	2	2	2	2	26
	4	2	2	3	2	2	3	2	-	-	2	3	3	2	26
	5	2	3	2	2	2	2	2	-	-	2	3	2	3	25
Grand total of COs With PSOs & POs															132
Mean value of COs With PSOs & POs = 132/55															2.40

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.40
Observation	COs of Volumetric Estimation is strongly related with PSOs and POs		

PATTERN OF ASSESSMENT

Internal Continuous Assessment: **Total Marks: 50** **Duration: 3 hours**

Principle and Short Procedure – 10 marks
Observation – 5 marks
Viva – 5 marks
Experiment – 30 marks

End-Semester Examination: **Total Marks: 50** **Duration: 3 hours**

Principle and Short Procedure – 10 marks
Record – 5 marks
Viva – 5 marks
Experiment – 30 marks

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY

ALLIED BIOCHEMISTRY – PRACTICAL

Class	: I B.Sc. Chemistry	Part	: III Allied Practical
Semester	: I & II	Hours	: 30 (Each Semester)
Subject Code	: 22UCHQ12	Credits	: 2

The course enables the students to

1. recall the principles of quantitative analysis
2. detect error in handling apparatus for volumetric estimations
3. employ in preparing solution of different concentration
4. support hands on training in volumetric titration
5. analyse critically the separation techniques

List of Experiments

1. Qualitative analysis for Protein
2. Qualitative analysis for Carbohydrate
3. Qualitative analysis forLipids
4. Determination of pH
5. Estimation of sugar – Benedict's method
6. Estimation of calcium
7. Estimation of vitamin C
8. Determination of % of acetic acid in vinegar
9. Isoelectric Precipitation of Proteins: Casein from Milk
10. Determination of iodine value of an oil
11. Determination of acid value of an oil
12. Determination of saponification value of an oil
13. Detection of adulterants in Turmeric and chilli powder
14. Detection of adulterants in milk
15. Detection of adulterants in oil
16. Separation of amino acids by paper chromatography (demonstration only)
17. Separation of lipids and amino acidsby TLC (demonstration only)
18. Column chromatography (demonstration only)

Book for Reference

a. Arthur Israel Vogel & John Mendham, Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, Prentice Hall of India, 2000.
b. https://vlab.amrita.edu/?sub=3&brch=63 (Virtual Lab – Amrita University)
c. Sadasivam, S. and Theymoli Balasubramanian. "Practical Manual (Undergraduate)", TamilNadu Agricultural University, Coimbatore, p. 2(1985).
d. Pavia, Lampman, Kriz and Engel,"Introduction to Organic Laboratory Techniques: A Microscale Approach", Saunders (2005).
e. Manual of Methods of Anlaysis of Foods (Milk and Milk Products); Directorate General of Health services, Ministry of Health and Family Welfare, Government of India, New Delhi (2005).

Course Outcomes

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

1. describe and recognize the terminology of concentration terms
2. interpret the principles and expressions involved in volumetric estimation

3. determine the amount of calcium and vitamin C
4. determine the presence of adulterants in foods
5. analyse the given separation techniques

Mapping

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	3	2	2	2	3	3	-	-	2	3	2	2	27
	2	2	2	2	3	3	2	2	-	-	3	2	3	3	27
	3	3	2	3	2	3	2	3	-	-	3	2	2	2	27
	4	2	2	3	3	2	3	2	-	-	2	3	3	2	27
	5	2	3	2	2	2	2	2	-	-	2	3	2	3	25
Grand total of COs With PSOs & POs															133
Mean value of COs With PSOs & POs = 133/55															2.42

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.42
Observation	COs of Allied Biochemistry Practical is strongly related with PSOs and POs		

EVALUATION

Continuous Internal Assessment (50 Marks)

S.No.	Components	Marks
1.	Observation Note book – Maintained neatly and regularly	10
2.	Results of the practical – Regular class work	20
3.	Internal Test	20
	TOTAL	**50**

End-Semester Examination (50 Marks) ***(Duration: 3 Hours)***

Examination at the end of even-semester.

S. No.	Components	Marks
1	Record Notebook	**10**
2	Procedure & Viva voce	**10**
3	Identification of the given sample with correct procedure	**10**
4	Estimation – Final result within the prescribed error limit	**20**
	TOTAL	**50**

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY

ALLIED CHEMISTRY – PRACTICAL

Class	: I B.Sc. Chemistry	Part	: III Allied Practical
Semester	: I & II	Hours	: 30 (Each Semester)
Subject Code	: 22UCHR12	Credits	: 2

The course enables the students to

1. state the principles behind volumetric analysis
2. detect error in handling apparatus for volumetric estimations
3. examine to prepare solutions of different concentration
4. identify on training in volumetric titration
5. infer the analysis of mono functional organic compound

Volumetric Analysis

1. Estimation of sodium hydroxide (Na_2CO_3– HCl – NaOH)
2. Estimation of hydrochloric acid (oxalic acid – NaOH – HCl)
3. Estimation of oxalic acid (oxalic acid – NaOH – oxalic acid)
4. Estimation of FAS (oxalic acid – $KMnO_4$ – FAS)
5. Estimation of iron (FAS – $KMnO_4$ – $FeSO_4$)
6. Estimation of sodium carbonate (Na_2CO_3 – HCl – Na_2CO_3)

Organic Analysis

1. Detection of Elements.
2. To distinguish between aliphatic and aromatic.
3. To distinguish between saturated and unsaturated.
4. Detection of Functional group tests for phenol, acid (mono), amine, monoamide, diamide, carbohydrate, aldehyde and ketone.
5. Functional groups characterized by confirmatory test.

Course Outcomes

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

1. define and identify the terminology of concentration terms
2. illustrate the basics principles and expression involved in volumetric estimation
3. determine the strength of acid by acidimetry
4. determine the strength of base by alkalimetry
5. assess the mono functional organic compounds qualitatively

Text Book

1. Venkateswaran, V. Veerasamy, R. and Kulandaivelu, A.R., “Basic Principles of Practical Chemistry”, Sultan Chand & Sons, New Delhi, 2017.

Book for Reference

1. Thomas, A.O, “B.Sc. Main Practical Chemistry”, Scientific Book Centre, Cannanore, 2003.

Mapping

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	2	2	3	2	-	-	2	3	2	2	25
	2	2	2	2	3	2	2	2	-	-	3	2	2	3	25
	3	3	2	2	2	3	2	3	-	-	2	2	2	2	25
	4	2	2	3	2	2	3	2	-	-	2	2	3	2	25
	5	2	3	2	3	2	2	2	-	-	2	3	2	2	25
Grand total of COs With PSOs & POs															125
Mean value of COs With PSOs & POs = 125/55															2.27

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.27
Observation	COs of Allied Chemistry Practical is strongly related with PSOs and POs		

EVALUATION

Continuous Internal Assessment (50 Marks)

S. No.	Components	Marks
1.	Observation Note book – Maintained neatly and regularly	10
2.	Results of the practical – Regular class work	20
3.	Internal Test	20
	TOTAL	**50**

End-Semester Examination (50 Marks) ***(Duration: 3 Hours)***

Examination at the end of even-semester.

S. No.	Components	Marks
1	Record Notebook	**10**
2	Procedure & Viva voce	**10**
3	Identification of the given sample with correct procedure	**10**
4	Estimation – Final result within the prescribed error limit	**20**
	TOTAL	**50**

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
ORGANIC CHEMISTRY-I
(For students admitted from the Academic Year 2021-2022 onwards under the OBE Pattern)

Class	: II B.Sc. Chemistry	Part	: III Core -3
Semester	: III	Hours	: 90
Subject Code	: 22UCHC33	Credits	: 6

Course Educational Objectives

The course enables the students to

1. discuss the preparation and properties of alkanes & cycloalkanes.
2. discuss the preparation, properties of alkenes, alkadienes & alkynes.
3. identify the aromatic nature of organic compounds and predict their directing properties.
4. discuss the preparation, properties of alkyl and aryl halides
5. identify the relationship between phenols, alcohols and ethers in reactions.

SYLLABUS

Unit I: Alkanes and Cycloalkanes (18 Hours)

Nomenclature of alkanes – Preparation of alkanes - Reduction of alkenes and alkynes -Wurtz reaction - Kolbe's reaction - Corey-House reaction - decarboxylation reactions. Properties of Alkanes - Physical properties - Chemical Properties – Free radical reactions, catalytic cracking, isomerization, aromatization.

Cycloalkanes – Preparation-Wurtz reaction -Dieckmann's ring closure reaction - reduction of aromatic hydrocarbons. Stability of Cycloalkanes - Baeyer's strain theory and its Limitations.

Conformations of ethane and butane – comparison of stability of various conformers - conformation of cyclohexane (chair and boat form) – axial and equatorial hydrogen.

Unit II : Alkenes, Alkadienes and Alkynes (18 Hours)

Alkenes: Nomenclature - methods of preparation – dehydration of alcohols and dehydrohalogenation of alkyl halides-dehalogenation of dihalides.Reactions of alkenes. Addition reactions – hydrogenation. Addition of halogens and hydrogen halides-Markownikov's rule and peroxide effect-Hydration – Hydroboration – ozonolysis – polymerization.

Alkadienes: Nomenclature and classification-Stability of conjugated dienes. Preparation and reactions of 1, 3-butadiene – 1,2- and 1,4-addition-Diels-Alder reaction.

Alkynes: Nomenclature-Structure of acetylene-methods of preparation-Acidity of terminal alkynes. Reactions of alkynes: addition of hydrogen, hydrogen halides and water.

Unit III: Aromatic Hydrocarbons (18 Hours)

Nomenclature of aromatic compounds (mono and di-substituted compounds) - Structure of benzene: Kekule structure-Resonance picture of benzene.

Aromaticity and Huckel's rule. Elements of aromaticity, non-aromaticity and anti-aromaticity of simple molecules.

Preparation and properties of Benzene - Electrophilic aromatic substitution reactions – General mechanism. Mechanism of Nitration, sulphonation, halogenation and Friedel-Craft's reactions (Alkylation and Acylation reactions).

Disubstitution in benzene. Directive influence – classification of substituents – o,p- and meta- directing groups. Effect of substituents in orientation and reactivity.

Unit IV: Alkyl and Aryl Halides (18 Hours)

Alkyl Halides – Nomenclature and classification. Preparation of alkyl halides -Physical and chemical properties – Substitution reactions – S_N1 and S_N2 - Mechanism and stereochemistry – Factors affecting S_N1 and S_N2 reactions – comparison between S_N1 and S_N2 reactions. Elimination reactions - E_1 and E_2 reactions (Saytzeff and Hoffman rule).

Preparation – properties of allyl chloride – allylic substation using NBS (mechanism not required) – Preparation and properties of vinyl chloride.

Aryl Halides – Preparation, properties of chlorobenzene. Mechanism of nucleophilic aromatic substitution – S_NAr mechanism – Aralkyl halides - Preparation, properties of benzyl chloride. Distinction between nuclear and side-chain halides.

Unit V: lcohols, Phenols and Ethers (18 Hours)

Alcohols: Nomenclature-Classification of alcohols- methods of preparation-chemical reactions of alcohols. Distinction between primary, secondary and tertiary alcohols – Lucas's test – oxidation method – dehydrogentation method – Victor Meyer's method.

Preparation and properties of allyl alcohol, ethylene glycol and glycerol.

Phenols: Nomenclature-Methods of preparation- Effect of substituent on the acidity of phenols. Reactions of Phenols- Lederer-Manasse reaction, Houben-Hoesch reaction, Libermann Nitroso reaction. Mechanism of Kolbe's reaction. Reimer-Tieman reaction and Gattermann reaction.

Ethers. Preparation – Dehydration of alcohols and Williamson Synthesis - Properties of ether – Formation of peroxide – Reaction with HI (hot and cold condition). Estimation of alkoxy group by Zeisel's method.

Course Outcomes

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

	Course Outcome	Knowledge Level
CO1	Explain the preparation and properties of alkanes and cycloalkanes and predict the stability of cycloalkanes	K2 & K3
CO2	Explain the preparation, properties of alkenes, alkadienes and alkynes	K1
CO3	Identify the aromatic nature of organic compounds and predict their directing properties.	K2 & K3
CO4	Compare and contrast the preparation, properties of alkyl and aryl halides and predict their mechanism	K2 & K3
CO5	Distinguish the acidity phenols, alcohols and ethers and examine their reaction	K2 & K3

Books for Study

1. B.S. Bahl and Arun Bahl, Text Book of Organic Chemistry, 22nd Edition. Chand (2017).
2. Raj K. Bansal, A Textbook of Organic Chemistry, 6th Edition, New Age International Publisher (2016).
3. P.L. Soni and H.W. Chawla, Text Book of Organic Chemistry, 21th Edition. Chand and company (2014).

Books for Reference

1. Morrison and Boyd, Organic Chemistry, 7th Edition. Prentice Hall (2010).
2. I. L. Finar, Organic Chemistry: Volume 1, 6th Edition. Pearson (2012).
3. Paula Yurkanis Bruice, Organic Chemistry, 8th Edition, Pearson (2020)

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	-	2	2	3	-	-	-	1	3	2	-	19
	2	2	2	-	2	2	3	2	-	-	3	2	2	-	20
	3	2	3	2	2	-	2	2	2	-	2	2	2	-	21
	4	2	2	2	-	-	2	2	3	-	2	2	-	-	17
	5	2	2	2	-	2	2	2	2	-	-	3	-	-	17
Grand total of COs With PSOs & POs															94
Mean value of COs With PSOs & POs = 94/43															2.25

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.25
Observation	COs of Organic Chemistry-I is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
ALLIED CHEMISTRY-I

(For students admitted from the Academic Year 2021-2022 onwards under the OBE Pattern)

Class	: II B.Sc. Physics	Part	: III Allied-3
Semester	: I	Hours	: 45
Subject Code	: 22UCHB13	Credits	: 3

Course Educational Objectives

The course aims to make the students to

- State the periodic law and explain the periodicity of elements
- Describe basic concepts in chemical bonding
- Explain the rates of chemical reactions, order and its determination
- State the principle involved in volumetric analysis
- Define the safety methods in the laboratory

SYLLABUS

Unit I Periodic Table (9 hours)

Mendeleev's periodic table - merits and demerits. Long form of the periodic table. Classification into s, p, d and f-block elements.

periodic variation-electronic configuration Atomic radius, ionic radius, ionization energy – factors affecting ionization energy, electron affinity, electronegativity-Applications of electronegativity Metallic Bond: Semiconductors – Intrinsic and Extrinsic, n and p- type super conductors.

UNIT II Chemical Bonding (9 hours)

Ionic bond, characteristics of ionic compounds-Covalent bond: Fajan's rule - concept of hybridization, geometry of molecules – CH_4, $BeCl_2$, BF_3, C_2H_2. Molecular Orbital Theory: LCAO, Bonding, anti-bonding orbital and bond order. MO diagrams of H_2, He_2, N_2, O_2 and F_2 molecules.

UNIT III Chemical Kinetics and catalysis (9 Hours)

Rate, order, molecularity, pseudo first order, determination of order. Half lifeperiod. Derivation of rate constant for first and second order reactions (same type of reactants only). Effect of temperature on the rate – Arrhenius equation. Energy of activation Catalysis: Types of catalysis – homogeneous and heterogeneous catalysis (preliminary ideas).

UNIT IV Titrimetric Methods (9 hours)

General principle of titrimetric methods of analysis – requirements – expressing concentration – molarity, molality, normality, Wt%, ppm.

Standardisation of solutions-Limitations of volumetric analysis – end point and equivalence point, weak acid – weak base – indicators – choice of indicators.

UNIT V Safety Methods in Lab (9 hours)

Storage and handling of chemicals – handling of toxic and poisonous chemicals, General precautions, first aid techniques - acid and alkali on eye - acid and alkali burn – bromine burns – cut by glasses - heat burns - Inhalation of toxic vapours – Precautions and first-aid procedure. Uses of different glassware – Hazard symbols – Laboratory safety measures – Waste and fume disposal.

Course Outcomes

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

	Course Outcome	Knowledge level
CO1	state the periodic law and explain the periodicity of elements	K2&K3
CO2	describe the basic concepts of chemical bonding	K2&K3
CO3	assess the rates of chemical reactions, order and its determination	K2&K3
CO4	state the principle followed in titrimetric methods of analysis	K2
CO5	define the safety methods in the laboratory	K2&K3

Textbooks

1. A Text Book of Physical Chemistry, Arun Bahl, B.S. Bahl., S. Chand & Co (2019).
2. Principles of Inorganic Chemistry, B.R. Puri, L.R. Sharma, & K.C. Kalia, Milestone Publishers (2017).
3. Principles of Physical Chemistry, B.R. Puri & L.R.Sharma & M.S.Pathania, Vishal Publishing Co (2018).

Books for Reference

1. R. D. Madan, "A Textbook of Modern Inorganic Chemistry", S.Chand & Co (2008).
2. Elements of Analytical Chemistry, R. Gopalan, P.S. Subramanian and K. Rangarajan, Sultan Chand & Sons. (2011).

Mapping

Objectives		PSO					PO								Sum of COs With PSOs & Pos
Outcome		1	2	3	4	5	1	2	3	4	5	6	7	8	
CO	1	3	2	2	2	-	3	2	2	2	-	2	2	-	22
	2	2	3	2	2	-	2	2	2	3	2	1	-	-	21
	3	2	2	-	2	2	2	2	3	2	2	2	-	-	21
	4	2	2	2	-	2	2	2	2	-	2	2	2	-	20
	5	2	2	2	2	-	2	2	2	2	-	2	2	-	20
Grand total of COs with PSOs & POs															101
Mean value of COs with PSOs & POs = 112/53															2.08

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.08
Observation	COs of Allied Chemistry-I is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
NON MAJOR ELECTIVE: CHEMISTRY IN YOUR LIFE
(For students admitted from the Academic Year 2021-2022 onwards under the OBE Pattern)

Class	: II B.A. History, Economics, RDS and Philosophy	Part	: IV NME-1
Semester	: III	Hours	: 45
Subject Code	: 22UCHN13	Credits	: 2

Course Educational Objectives

The course enables the students to

1. recognise the composition of air, water, and food.
2. recall composition of water
3. recognise composition of food
4. compare the properties of hair dyes
5. describe the preparation and properties of plastics

SYLLABUS

Unit I: Air (9 hours)

Composition of air – Role of various components present in air – Biological importance of oxygen – Air pollution – acid rain, ozone depletion, green house gases and green house effect.

Unit II: Water (9 hours)

Importance of water – Natural water – Sources of water – Drinking water – making water fit to drink – chlorination – Water pollution – Chemicals causing water contamination – contamination by fertilisers, soaps and detergents and their effect.

Unit III: Nutrients & Medicines (9 hours)

Important nutrients – carbohydrates, fats, proteins – their role in human health – Role of vitamins, minerals – iron, calcium, cobalt in human health – Medicines: Antibiotics, Analgesics, Antipyretics, Antidepressants – definition – few examples.

Unit IV: Fireworks & Cosmetics (9 hours)

Firework – Chinese invention – Basic ingredients and principle of firework – Colour of firework.

Perfumes – basic composition – Fragrances – Substances that give colour – Dyes – Hair dyes and hair colouring – Safety of hair dyes.

Unit V: Polymers (9 hours)

Definition – Classification – Applications – Teflon, Polythene, PVC, Polystyrene, Nylon.

Plastics – Definition – Thermo and thermosetting plastics – Bakelite and its uses

Text Book

1. Lakshmi, S. *Pharmaceutical Chemistry*, S. Chand and Sons, New Delhi, 1995.
2. A.K. De, *Environmental Chemistry*, New Age International Publishers, 2018.

Reference Books

1. Principle of Environmental Science, Cunninggham, W and Cunninggham, M.A., Tata McGraw Hill Publication, New Delhi, 2nd edition (2003)
2. P.L. Soni and H.M. Chawla, Text Book of Organic Chemistry, 28th Edition. Sultan Chand (2006)

Course Outcomes (CO)

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

	Course Outcome	Knowledge Level
CO1	Explain the composition of air and air pollution.	K2
CO2	Explain the composition of air and air pollution	K2
CO3	Discuss various uses of nutrients and medicines for human health.	K2
CO4	Narrate the basic principles of fireworks and perfumes.	K1,K2
CO5	Define and classify the various polymers & plastics and their applications.	K1 & K2

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs With PSOs & POs
		1	2	3	4	5	1	2	3	4	5	6	7	8	
CO	1	2	3	-	2	-	3	2	-	-	2	2	-	-	16
	2	3	2	-	2	-	2	3	-	-	1	2	-	-	15
	3	2	2	-	1	-	2	2	-	-	2	2	-	-	13
	4	2	2	-	2	-	2	2	-	-	1	2	-	-	13
	5	2	2	-	2	-	2	2	-	-	2	2	-	-	14
Grand total of COs With PSOs &POs															71
Mean value of COs With PSOs & POs = 71/35															2.03

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with PSOs & POs			2.03
Observation	COs of Chemistry in Your Life is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514

DEPARTMENT OF CHEMISTRY

SELF LEARNING COURSE: FORENSIC CHEMISTRY

(For students admitted from the Academic Year 2021-2022 onwards under the OBE Pattern)

Class	: II UG	Part	: Self Learning Courses
Semester	: III	Hours	:
Subject Code	: 22UCHSL3	Credits	: 3

Objectives

The course enables the students to

1. recall the various types of chemicals in chemical toxicology.
2. describe crime detection, bomb detection, metal detection and bullets.
3. identify forgery documents and signature by uv rays, fake currency notes, counterfeit coin, purity of gold and diamond.
4. describe the tool marks, paints, fibres and biological substances
5. discuss the scheduled drugs, steroid consumption, plastic surgery and metabolite.

SYLLABUS

Unit I Chemical Toxicology

Poisons. Types and classification. Diagnosis of poisons in the living and the dead. Clinical symptoms. Heavy metal contamination of sea foods. Use of neutron activation analysis in detecting arsenic in human hair.

Unit II Crime Detection

Explosives. Bomb detection. Metal detectors and other security devices. Composition of bullets and detecting powder burns.

Unit III Forgery and Counterfeiting

Documents. Different types of forged signatures. Use of UV rays. Comparison of type written letters. Checking silver line and water mark in currency notes. Alloy analysis using Atomic Absorption Spectroscopy to detect counterfeit coins. Detection of gold purity. Diamond checking.

Unit IV Tracks and Traces

Tracks and traces. Casting of foot prints. Residue prints. Tyre patterns. Glass fracture. Tool marks. Paints. Fibres. Analysis of biological substances.

Unit V Medical Aspects

Misuse of scheduled drugs. Burns and their treatment by plastic surgery. Metabolite analysis. Detecting steroid consumption among athletes.

Text Book

1. Nanda and Tewari – Forensic Science in India A Vision for the 21st Century, Select Publisher, 2001.

Reference Books

1. T. H. James, Forensic Sciences. Stanley Thames Ltd. (2000)
2. Richard, An Introduction to Forensic Science. 8th Edition, Prentice Hall, (2004).
3. Nabar B S, Forensic Science, SVP national police academy, Hyderabad.
4. Eckert G. William – Introduction to Forensic Sciences, CRC Press, Second Edition
5. Saferstein Richard, Criminalities – An Introduction to forensic science, Prentice Hall, 5th Edition.

Course Outcomes (CO)

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

	Course Outcome	Knowledge Level
CO1	List out and recognize the poisonous chemicals and detecting instruments	K1 & K2
CO2	Define and Identify the metal detector	K1 & K2
CO3	identify the testing for forgery signature	K1,K2
CO4	Compare and distinguish tool marks	K2
CO5	Identify the steroid consumption in athletles	K2

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	3	-	2	-	3	2	-	-	1	2	-	-	15
	2	3	2	-	2	-	2	2	-	-	1	2	-	-	14
	3	2	2	-	1	-	2	3	-	-	2	2	-	-	14
	4	2	2	-	2	-	2	2	-	-	2	2	-	-	14
	5	2	2	-	2	-	2	2	-	-	2	2	-	-	14
Grand total of COs With PSOs & POs															71
Mean value of COs With PSOs & POs = 71/35															2.03

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.03
Observation	COs of Forensic Chemistry is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514

DEPARTMENT OF CHEMISTRY

B.Sc. Chemistry: Core – 4

PHYSICAL CHEMISTRY-I

(For students admitted from the Academic Year 2021-2022 onwards under OBE Pattern)

Class	: II B.Sc. Chemistry	Part	: III Core -4
Semester	: IV	Hours	: 90
Subject Code	: 22UCHC44	Credits:	6

Course Educational Objectives

The course enables the students to

1. compute the molecular velocities, explain the properties of real gases and derive the expression of real gases.
2. illustrate various terminologies and concepts related to first and Zeroth law of thermodynamics and thermochemistry
3. discuss the feasibility of chemical reactions based on II law of thermodynamics
4. state and discuss third law of thermodynamics &apply the concepts of chemical equilibrium
5. derive and solve problems related to various ionic equilibrium properties along with its applications

SYLLABUS

Unit I Gaseous State (18 Hours)

The kinetic theory of gases –Maxwell distribution of molecular speeds and energies - Molecular velocities – Most probable, root mean square and average velocities - Collision parameters – mean free path – degrees of freedom of a molecule – principle of equipartition of energy - Deviations from ideal behavior – equation of states for real gases – Vander Waals equation of state – intermolecular forces - the critical phenomena – P-V isotherm of carbon dioxide – the Vander Waals equation and critical states – Principle of corresponding states.- liquefaction of gases.

Unit – II First law of thermodynamics and Thermochemistry (18 Hours)

Importance of Thermodynamics -Terminology in thermodynamics -Types of system – state variable – Thermodynamic equilibrium – Extensive and Intensive properties –First law of thermodynamics – Internal energy -State and path functions. Enthalpy – enthalpies of vaporization and fusion. Heat Capacity - Relation between C_p and C_v– Joule-Thomson effect & Joule-Thomson coefficient and its significance.

Zeroth law of thermodynamics – Absolute temperature scale.

Thermochemistry – Change in enthalpy in chemical reaction –enthalpy of neutralization – enthalpy of formation – Bond energy and heat of reaction – Variation of enthalpy of reaction with temperature – Kirchhoff equation – Hess law and its applications.

Unit – III Second law of thermodynamics (18 Hours)

Limitations of first law of thermodynamics – Formulation of second law of thermodynamics on the basis of Carnot cycle – Efficiency of a heat engine – The concept of entropy –Entropy changes in reversible and irreversible processes – Entropy of mixing – Entropy change in a chemical reaction - Work function – Gibbs free energy – Helmholtz free energy – Maxwell's relationship - Criteria of spontaneity - Gibbs-Helmholtz equation – Concept of chemical potential - Gibbs-Duhem equation - Clapeyron-Clausius equation –Integrated equation and applications.

Unit – IV Third law of Thermodynamics and Chemical Equilibrium (18 Hours)

Third law of thermodynamics: Nernst heat theorem - Formulation of third law. Determination of absolute entropy of solids.

Free energy of spontaneous reaction – Standard free energy change - Law of mass action - K_p and K_c – Relationships between K_p and K_c - Properties of equilibrium constants – Derivation of Kp and Kc for homogeneous equilibria - HI formation and Dissociation of PCl_5 – Temperature dependance of the Equilibrium constant – The van't Hoff equation – Derivation of Kp and Kc for heterogeneous equilibria - Le-Chatelier's principle – Contact Process and Haber's process.

Unit –V Ionic Equilibria (18 Hours)

Dissociation of weak acids and bases – Dissociation of water – Ionic product of water – The pH scale – Relationship between pH and pOH – Numerical problems involving pH – Common ion effect – Buffer solution – Henderson's equation – Mechanism of buffer action. Hydrolysis of salts – Salts of strong acids and strong bases – Salts of weak acids and strong bases – Salts of weak bases and strong acids – Salts of weak acids and weak bases -Degree of hydrolysis - Relation between K_h, K_a, K_b, K_w. Concept of solubility product – Solubility product of sparingly soluble salts – Applications.

Text Book

1. Puri, Sharma and Pathania, Principles of Physical Chemistry, 48th *Edition,* Vishal Publishing & CO (2020).
2. A.S. Negi, S.C. Anand, A Textbook of Physical Chemistry, 3rd Edition, New Age International Publisher (2022).
3. Arun Bahl, BS Bahl, G.D. Tuli, Essentials of Physical Chemistry, 28th Edition, S. Chand Publishers (2020).

Reference Book

1. R. Gurdeep Chatwal, Advanced Physical Chemistry, Joel publishing house (2016).

2. K.L. Kapoor, A Textbook of Physical Chemistry - Application of Thermodynamics, Vol 3, 5th Edition, McGraw Hill (2020).
3. G. Rajaram, J.C. Kuriacose, Thermodynamics, New edition, Shoban Lal Nagin Chand and Co (2006).

Course Outcomes (CO)

At the end of the course, students are enabled to

	Course Outcome	Knowledge Level
CO1	Compute the molecular velocities, explain the properties of real gases and derive the expression of real gases.	K2 & K3
CO2	Illustrate various terminologies and concepts related to first and zeroth law of thermodynamics and Thermochemistry	K1, K2 & K3
CO3	discuss the feasibility of chemical reactions based on II law of thermodynamics	K3
CO4	state and discuss third law of thermodynamics &apply the concepts of chemical equilibrium	K1 & K2
CO5	Derive and solve problems related to various ionic equilibrium properties along with its applications	K2 & K3

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs With PSOs & Pos
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	2	2	3	2	-	-	-	2	2	2	21
	2	2	2	3	3	2	2	2	-	-	-	2	2	2	20
	3	2	2	2	2	2	2	2	-	-	-	2	2	2	20
	4	3	2	2	2	2	2	2	-	-	-	2	2	2	21
	5	3	3	2	2	2	3	2	-	-	-	2	2	2	23
Grand total of COs with PSOs & POs															105
Mean value of COs with PSOs & POs = 105/50															2.1

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
			2.1
Observation	COs of Physical Chemistry-I is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
B.Sc. Chemistry: Allied-2
ALLIED CHEMISTRY-II

(For students admitted from the Academic Year 2021-2022 onwards under the OBE Pattern)

Class	: II B.Sc. Physics	Part	: III Allied-4
Semester	: IV	Hours	: 45
Subject Code	: 22UCHA24	Credits	: 3

Course Educational Objectives

The course enables the students to

1. state the theory of photochemical processes
2. identify Structure and bonding in coordination compounds
3. explain the preparation and reactions of amino acids and carbohydrates
4. describe the principles of chemical energetics, relation between heat and work and the concept of free energy
5. explain the electrolytic conductance and electrochemical cells

SYLLABUS

Unit I Fundamentals of Photochemistry (9 hours)

Definition- Grothus Draper Law and Einstein's Law, Beer-lamberts law Quantum Efficiency (High and Low). Jablonski diagram. Comparison between thermal and photochemical reactions. Chemiluminescence, Fluorescence, Phosphorescence. Bioluminescence, Photosensitisation (Definitions with suitable examples)

Unit II Coordination Chemistry (9 hours)

Double salts – complex compounds – complex ion and coordination number Ligands and their classification. Werner's theory. Chelation- EDTA and its applications in analysis.

Valence Bond Theory and its applications (Tetrahedral and Octahedral). Limitations of VBT.

Isomerism: ionization, hydrate, ligand, linkage, coordination, position, geometrical and optical isomerisms.

Unit III Basic concepts in Organic Chemistry (9 hours)

General Introduction- Functional groups-Structural Formulae (Fundamental ideas only). Isomerism- – Structural and stereoisomerism – types and examples. Cleavage of bonds- Homolysis and Heterolysis. Types of reagents –Electrophiles, nucleophiles and free radicals– definition and examples. Organic reactions – Types of reactions (addition, elimination, substitution, rearrangement)

Unit IV Thermodynamics (9 hours)

Energetics – Definition of first law thermodynamics – Types of systems – types of equilibrium Reversible, irreversible, Isothermal and adiabatic processes. Joule-Thomson effect. Enthalpy – enthalpy of fusion – enthalpy of vaporization- Need for the second law – Entropy and its significance – Free energy change in a chemical reaction – bond energy – Spontaneous processes – Criteria of spontaneity of chemical reaction.

Unit V Electrochemistry (9 hours)

Faraday's Law of electrolysis, specific, molar and equivalent conductance and its variation with dilution. Kohlrausch's law- Daniel cells- reference electrodes. Electrochemical series and its applications – pH determination. Conductometric titrations – Buffer and its action.

Course Outcomes

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

	Course Outcome	Knowledge Level
CO1	explain the theories of photochemistry and describe Jablonski diagram	K1 & K2
CO2	define the basic concepts and theories of coordination chemistry	K1
CO3	classify and explain the properties as well as the importance of carbohydrates, proteins, aminoacids	K2
CO4	illustrate the principles, applications of thermodynamics	K2
CO5	depict the basics of electrochemistry	K2

Textbook

1. A Text Book of Organic Chemistry, Arun Bahl, B.S. Bahl., S.Chand & Co, 22nd Edition, (2019).

Books for Reference

1. Principles of Inorganic Chemistry, B.R.Puri, L.R.Sharma, & K.C. Kalia. Vishal Publishing Co (2020).
2. Principles of Physical Chemistry, B.R. Puri & L.R. Sharma & M.S. Pathania. Vishal Publishing Co (2021).

Mapping

Objectives		PSO					PO								Sum of COs With PSOs & POs
Outcome		1	2	3	4	5	1	2	3	4	5	6	7	8	
CO	1	3	2	2	2	-	3	2	2	-	2	2	2	2	24
	2	2	2	2	-	2	3	2	2	2	-	2	2	2	23
	3	3	2	2	-	2	2	2	-	2	2	-	2	2	21
	4	2	3	2	-	2	2	2	2	-	2	2	2	2	23
	5	2	2	2	2	-	2	3	2	-	-	2	2	2	21
Grand total of COs with PSOs & POs															112
Mean value of COs with PSOs & Pos = 112/53															2.11

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.11
Observation	COs of Allied Chemistry-II is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
NON-MAJOR ELECTIVE: APPLIED CHEMISTRY
(For students admitted from the Academic Year 2021-2022 onwards under OBE Pattern)

Class	: II B.Sc. RDS, Mathematics & Physics	Part	: NME-2
Semester	: IV	Hours	: 45
Subject Code	: 22UCHN24	Credits	: 2

Course Educational Objectives

The course enables the students to

1. Recognize the nutrients and medicine for good health
2. Determine the role of nucleic acid and hormones in human.
3. List out the important polymers and their uses.
4. Discuss the cosmetic products
5. List out the important of chemical aspects of soil

SYLLABUS

Unit I: Nutrients & Medicines (9 hours)

Important nutrients – carbohydrates, fats, proteins – their role in human health – Role of vitamins, minerals – iron, calcium, cobalt in human health – Medicines – Antibiotics, Analgesics, Antipyretics, Antidepressants- definition - few examples.

Unit II: Nucleic acids (9 hours)

Nucleic acids – Elementary idea on the structure of DNA and RNA – their role – Hormones in our body – Functions and deficiency symptoms.

Unit III: Polymers (9 hours)

Definition. Classification – Applications – Teflon, Polythene, PVC, Polystyrene, Nylon. Plastics – Definition – Thermo and thermosetting plastics – Bakelite and its uses.

Unit IV: Cosmetics (9 hours)

Shampoos – principal constituents – thickeners and foam stabilizers – perfumes – preservatives – conditioning agents – antidandruff shampoos. Hair cream – composition – hair dyes – types – constituents – dye removals.

Unit V: Chemistry of soil & Plant Nutrients (9 hours)

Composition of soil - Organic and Inorganic constituents. - Chemical aspects of soil - acid, alkali and saline soil. Plant nutrients - Sources and roles of macro and micro nutrients in plant growth – Nutritional deficiency in plants - symptoms, corrective measures.

Text Books

1. P. L. Soni, H.M. Chawla, Textbook of Organic Chemistry, Sultan Chand & Sons, (2014)
2. Modern Technology of Cosmetics, Asia Pacific Business Press Inc., New Delhi, (2014)

Reference Books

1. B. R. Puri, L. R. Sharma & K. C. Kalia, Principles of Inorganic Chemistry, Vishal Publishing Co. (2020)
2. Jayashree Ghosh, A Textbook of Pharmaceutical Chemistry, S. Chand Publishing, (2010)
3. H. Kaur, Environmental Chemistry, Pragati Prakashan Publishers, Meerut (2016)
4. S. S. Dara & D. D. Mishra, A Text Book of Environmental Chemistry and Pollution Control, S. Chand & Company, New Delhi (2011)

Course Outcomes (CO)

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

No.	Course Outcome	Knowledge Level
CO 1	discuss the various uses of nutrients and medicines for human health.	K2
CO 2	interpret the role of nucleic acid and hormones in human body	K2
CO 3	define and classify the various polymers and its applications.	K1
CO 4	discuss various use of shampoos and hair dyes	K2
CO 5	define and analyse the chemistry of soil	K1 & K2

Mapping

Outcomes		PSO					PO								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	-	2	-	2	3	-	-	2	2	-	-	16
	2	2	3	-	2	-	3	2	-	-	2	2	-	-	16
	3	2	1	-	2	-	3	2	-	-	2	2	-	-	14
	4	2	2	-	1	-	2	3	-	-	2	2	-	-	14
	5	1	2	-	2	-	2	2	-	-	2	1	-	-	12
Grand total of COs With PSOs & POs															
Mean value of Cos With PSOs & POs = 72/35															2.06

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.06
Observation	COs of Applied Chemistry is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514

DEPARTMENT OF CHEMISTRY

SELF LEARNING COURSE: FOOD CHEMISTRY

(For students admitted from the Academic Year 2021-2022 onwards under the OBE Pattern)

Class	: II UG	Part	: Self Learning Courses
Semester	: IV	Hours	:
Subject Code	: 22UCHSL4	Credits	: 03

Course Educational Objectives

The course enables the students to

1. define the information food and food sources
2. illustrate about the food additives
3. describe awareness on food adulteration
4. explain the importance of quality of food
5. identify the recent food technology process

SYLLABUS

Unit-I Food and Food Sources

Food: Definition - Classification based on nutritional values, nutritive values of cereals and nuts - oil seeds. Milk - composition of milk, water present in milk, milk protein and milk sugar. Food Sources, biological functions, deficiency diseases and Recommended Dietary Allowance (RDA) of carbohydrates, protein and fats.

Unit-II Food Additives

Artificial sweeteners – saccharin, cyclomate, asparatame – food flavours – esters, aldehydes and heterocyclic compounds. Antioxidants.Foodcolors– changes in cooking. Restricted use. Baking powder – Yeast – Taste enhancers – MSG - vinegar**.** Beverages: Soft drinks, soda, fruit juices and alcoholic beverages (Types and content of alcohol). Composition of soft drinks. Illness of soft drinks (urinary bladder stones).

Unit- III Food Adulteration

Types of adulterants- intentional, incidental and metallic. Common adulterants in different foods – milk and milk products, vegetableoils and fats, spices and condiments, cereals, pulses, sweetening agents and beverages.

Unit- IV Food Preservation

Food Preservation: principle and importance - methods of preservation, freezing, canning, pickling, salting, smoking, bottling, sterilization, refrigeration, dehydration, heating, radiation and preservative agents – Quality control: Specifications and standards: PFA, FPO, FDA, drug license, WHO standards, ISI specifications.

Unit- V Food Technology

Introduction to food technology and future foods – Biotechnology in food. Nutraceuticals. Organic foods. Low-cost nutrient supplements. Space foods.

Course Outcomes

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

	Course Outcome	**Knowledge Level**
CO1	categorize the major components of foods in the environment	K2
CO2	summarize food additives, pigments, flavoring agents and preservatives	K2
CO3	explain the awareness on food adulteration	K2
CO4	define the importance of quality of food	K1
CO5	Demonstrate the recent food technology process	K2

Text Books

1. Dr. M. Swaminathan, Handbook of food and Nutrition. The Bangalore Printing and Publishing Co.,5th Edition (2007)
2. B. Srilakshmi, Food Science. New Age International Publishers (2005)

Reference Books

1. H.K. Chopra and P.S. Panesar, *Food Chemistry*, Narosa Publisher, New Delhi (2010)
2. Jayashree Ghosh, *Fundamental concepts of Applied Chemistry*, S. Chand & Co. Publisheres (2006)
3. Partrasarathy, A. (Editor), *Chemistry of spices,* CAB International, Oxford shire, UK, (2008)

Mapping

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	-	2	-	2	3	-	-	2	2	-	-	16
	2	2	3	-	2	-	2	2	-	-	2	2	-	-	15
	3	2	1	-	2	-	3	2	-	-	2	2	-	-	14
	4	2	2	-	1	-	2	3	-	-	2	2	-	-	14
	5	1	2	-	2	-	2	2	-	-	2	1	-	-	12
Grand total of COs With PSOs & POs															71
Mean value of Cos With PSOs & POs = 72/35															2.03

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.03
Observation	COs of Food Chemistry is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514

DEPARTMENT OF CHEMISTRY

B.Sc. Chemistry

INORGANIC QUALITATIVE ANALYSIS

(For students admitted from the academic year 2021-2022 onwards under the OBE pattern)

Class	: II B.Sc. Chemistry	Part	: Core Lab-2
Semester	: III & IV	Hours	: 45
Subject Code	: 22UCHP24	Credits: 3	

Course Educational Objectives

The course enables the students to

1. recall the principles of qualitative analysis
2. recognize the chemical reactions of acid and basic radicals
3. classify and find acid and basic radicals
4. analyze the inorganic salt mixture
5. separate and identify the cations into various groups

SYLLABUS

Semimicro Qualitative Analysis

1. Analysis of inorganic salt mixture containing interfering and non-interfering anions.
2. Simple anions: carbonate, nitrate, sulphate and bromide.
3. Interfering anions: borate, fluoride, oxalate and phosphate.
4. Elimination of interfering anions and intergroup separation of cations
5. Cations:

Group I	:	Lead
Group II	:	Copper, Cadmium, Bismuth
Group III	:	Aluminum, Iron, Chromium
Group IV	:	Cobalt, Nickel, Manganese, Zinc
Group V	:	Barium, Strontium, Calcium
Group VI	:	Magnesium
Zero group	:	Ammonium

Books for Study

1. Practical Chemistry by A.O. Thomas, Scientific Book Centre, Cannanore, 2003.
2. Venkateswaran, V. Veerasamy, R. and Kulandaivelu, A.R., *Basic Principles of Practical Chemistry*, Sultan Chand & Sons, New Delhi, 2017.

Books for Reference

1. V.V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd edn., The National Publishing Company, Chennai, 1974.
2. G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th edn., Pearson education, Chennai, 2012.
3. Jeyavarthana Samuel, Chemistry Practical Book, S.S. Printers, Chennai, 2018.
4. G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th edn., Pearson education, Chennai, 2002.

Course Outcomes

Course Outcome		Knowledge Level
CO1	recognize the methods of inorganic salt analysis	K1
CO2	explain the reactions involved in the salt analysis	K2
CO3	identify the tests for various anions and cations	K2
CO4	compare the properties of various group cations	K3
CO5	establish and conclude the importance of physical concepts (pH, solubility product, etc) in inorganic qualitative analysis	K3 & K4

MappingCourse outcome with

Outcomes		PSO					PO								Sum of COs With PSOs & POs
		1	2	3	4	5	1	2	3	4	5	6	7	8	
CO	1	3	2	2	-	2	3	2	-	-	3	3	2	2	24
	2	2	3	3	-	2	2	2	-	-	2	3	2	3	24
	3	2	2	3	-	-	2	3	-	-	3	3	2	2	22
	4	2	-	2	3	-	2	2	-	-	2	3	2	2	20
	5	3	3	-	2	3	2	2	-	-	2	2	2	3	24
Grand total of COs with PSOs & POs															114
Mean value of COs with PSOs & POs = 114/48															2.38

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.38
Observation	COs of Inorganic Qualitative Analysis is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
B.Sc. Chemistry: Allied Practical–2

ORGANIC QUALITATIVE ANALYSIS & VOLUMETRIC ESTIMATIONS

(For students admitted from the Academic Year 2021-2022 onwards under the OBE Pattern)

Class	: II B.Sc. Physics	Part	: III Allied Practical
Semester	: III/IV	Hours	: 30
Subject Code	: 22UCHR14	Credits: 2	

Course Educational Objectives

The course enables the students to

1. state the principles behind volumetric analysis.
2. detect error in handling apparatus for volumetric estimations
3. examine to prepare solutions of different concentration
4. identify on training in volumetric titration
5. infer the analysis of mono functional organic compound

SYLLABUS

I. VOLUMETRIC ANALYSIS:

15. Estimation of HCl (Oxalic acid – NaOH – HCl).
16. Estimation of Na_2CO_3 (NaOH – HCl – Na_2CO_3).
17. Estimation of NaOH (Na_2CO_3– HCl – NaOH).
18. Estimation of Oxalic acid (HCl – NaOH – Oxalic acid).
19. Estimation of FAS (Oxalic acid – $KMnO_4$ – FAS).
20. Estimation of Fe^{2+} ion (FAS – $KMnO_4$ – $FeSO_4$).
21. Estimation of Copper ($K_2Cr_2O_7$ – Thio – Cu^{2+})

II. ORGANIC ANALYSIS:

1. Detection of Elements.
2. To distinguish between aliphatic and Aromatic.
3. To distinguish between saturated and unsaturated.
4. Functional group tests for phenol, acid (mono), amine, monoamide, diamide, carbohydrate, aldehyde and ketone
5. Functional groups characterized by confirmatory test.

Course Outcomes

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

	Course Outcome	Knowledge Level
CO1	define and identify the terminology of concentration terms	K1 & K2
CO2	illustrate the basics principles and expression involved in volumetric estimation	K2
CO3	find the strength of acid by acidimetry	K3
CO4	find the strength of base by alkalimetry	K3
CO5	assess the mono functional organic compounds qualitatively	K3

Textbook

1. Venkateswaran, V. Veerasamy, R. and Kulandaivelu, A.R., *Basic Principles of Practical Chemistry*, Sultan Chand & Sons, New Delhi, 2017.

Book for Reference

1. Thomas, A.O, *B.Sc. Main Practical Chemistry*, Scientific Book Centre, Cannanore, 2003.

Mapping

Objectives		**PSO**					**PO**								Sum of COs With PSOs & Pos
Outcome		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	-	2	2	3	3	-	-	-	2	3	2	22
	2	3	2	3	2	2	2	2	-	-	-	2	2	3	23
	3	2	3	-	2	2	3	2	-	-	-	3	2	2	21
	4	2	3	2	3	2	2	3	-	-	-	2	2	2	23
	5	2	2	3	2	2	2	2	-	-	-	3	2	3	23
Grand total of Cos with PSOs & POs															112
Mean value of COs with PSOs & POs = 112/48															2.33

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.33
Observation	COs of Allied Chemistry practical is strongly related with PSOs and POs		

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514
DEPARTMENT OF CHEMISTRY
B.Sc. CHEMISTRY
CBCS STRUCTURE (from the academic year 2019-2020 onwards)

PART	Sub. Code	PAPER	Hrs	Cr
V SEMESTER				
III	19UCHC55	Core-5 Organic Chemistry-II	6	6
	19UCHC65	Core-6 Inorganic Chemistry-II	6	5
	19UCHC75	Core-7 Physical Chemistry-II	5	5
	19UCHP35	Core Lab-III Organic Analysis and Estimation	4	4
	19UCHP46	Core Lab-IV Gravimetry and Preparation	4	--
	19UCHE15	Elective-1 Medicinal Chemistry	4	3
IV	19USSI16	Soft Skills	-	1
	19UINT15	Internship	1	---
			30	**24**
VI SEMESTER				
III	19UCHC86	Core-8 Organic Chemistry-III	6	5
	19UCHC96	Core-9 Inorganic Chemistry-III	5	5
	19UCHD06	Core-10 Physical Chemistry-III	6	5
	19UCHP46	Core Lab-IV Gravimetry and Preparation	4	4
	19UCHP56	Core Lab-V Physical Chemistry	4	4
	19UCHE26	Elective-2 Industrial Chemistry	4	3
IV	19USSI16	Soft Skills	1	1
			30	**27**

Non-Major Elective-1 : Chemistry in Your Life
Non-Major Elective-2 : Chemicals for Life and Living

Semester:	I	II	III	IV	V	VI	TOTAL
Credits :	20/21	26/25	20	27	24	27	144*

*** 144 credits from 2019-2020 onwards**

Self-Learning Courses

19UCHSL3 Third Semester : Forensic Chemistry
19UCHSL4 Fourth Semester : Food Chemistry
19UCHSL5 Fifth Semester : Fuel Chemistry
19UCHSL6 Sixth Semester : Chemistry for Competitive Exams

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514

Programme Specific Outcomes (PSO)

The programme enables the students to

1. recognise the basic concepts of Chemistry and to provide students with the skills required to succeed in future career prospects in Chemistry
2. acquire the ability to identify and describe the principles of pure and applied Chemistry
3. apply the contextual knowledge of Chemistry to identify and solve problems, think significantly and to function effectively as an individual in multidiscipline
4. synthesise, compare, evaluate, classify, interpret and effectively apply the basic laws, principles, process and mechanism involved in the domain of Chemistry
5. impart a broad foundation in Chemistry and enable them to evaluate and analyse critically the scientific facts

Course Code & Title	19UCHC55 Organic Chemistry-II		Hours	90
			Credit	6
Class	III B.Sc. Chemistry	Semester	V	
Cognitive Levels	K1, K2, K3			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • explain the preparation and properties of aldehydes and ketones and predict their stability of mechanisms (K2, K3) • explain the preparation, properties of saturated and unsaturated carboxylic acids and their reaction mechanisms (K2, K3) • identify the nature of polycyclic hydrocarbons and the effect Carcinogenic hydrocarbons (K1, K2) • compare and contrast the preparation, reactions of aromatic nitrogen compounds, amines and diazocompounds (K2, K3) • classify the principles of organic synthesis and to study the synthetic applications organometallics (K2, K3)			

UNIT	Contents	No. of Hours
I	**Carbonyl Compounds** Nomenclature. Structure of carbonyl group. General methods of preparation and properties of aliphatic aldehydes and ketones- Acidity of α-hydrogen. Chemical reactions- Haloform reaction. Nucleophilic addition reactions. Addition of ammonia derivatives. Condensation reactions- Mechanism of Aldol and Cannizarro reactions. Oxidation – Reaction with Tollen's and Fehling's reagents. Baeyer-Villiger oxidation of ketones. Reduction by MPV, Clemmensen, Wolff-Kishner and Metal Hydrides ($LiAlH_4$ Vs. $NaBH_4$). Aromatic Aldehydes: Benzaldehyde – Preparation and properties – Claisen, Perkin, Benzoin and Knoevenagel reactions. Aromatic Ketones: Preparation, properties and reactions of Acetophenone, Benzophenone and p-Benzoquinone.	18
II	**Carboxylic acids and their Derivatives** Preparation and reactions. Acidity of carboxylic acid. Effect of substituents on the acidity. Conversion to functional derivatives. Reduction. HVZ reaction. Preparation and reactions of Acrylic acid, Benzoic acid and Cinnamic acid. Substituted acids: Preparation and reactions of Glycolic acid, Lactic acid, Salicylic acid, Anthranilic acid. Action of heat on α, β- and γ- hydroxy- and amino acids. Saturated dicarboxylic acids: Preparation and reactions of Oxalic, Malonic, and Succinic acids. Action of heat on dicarboxylic acids. Phthalic acid, Phthalic anhydride and Phthalimide.	18

	Unsaturated dicarboxylic acids: Preparation and reactions of Maleic and Fumaric acids.	
III	**Polycyclic Hydrocarbons** Isolated Systems: Diphenyl and Diphenylmethane. Preparation and reactions Fused ring systems: Preparation and reactions of Naphthalene, Anthracene and Phenanthrene. Structural elucidation of Naphthalene and Anthracene. Preparation and reactions of Naphthols, Naphthylamines and Anthraquinone. Carcinogenic hydrocarbons. Preparation and properties of Methylcholanthrene.	18
IV	**Nitrogen Compounds** Aromatic Nitro compounds – Nitrobenzene. Preparation and reactions. Reduction products of Nitrobenzene. Amines: Classification. Preparation and reactions. Basicity of amines. Separation of a mixture of primary, secondary and tertiary amines. Basicity of aliphatic amines. Effect of substituents on the basicity of aromatic amines. Aliphatic diazo compounds: Diazomethane, Diazoacetic ester. Preparation and reactions. Benzenediazonium chloride: Preparation and reactions.	18
V	**Organic Synthesis** Carbon-Carbon bond forming reactions**:** alkylation of active methylene compounds-Ethyl acetoacetate and Malonic ester. Synthetic applications of Ethylacetoacetate and Malonic ester. Fittig reaction, Claisen reaction, Claisen-Schmidt and Michael addition. Diels-Alder reactions- Synthesis using organometallic compounds. Organomagnesium compounds: Grignard reagents. Preparation, structure and chemical reactions. Organozinc compounds – Preparation and reactions. Reformatsky reaction. Organolithium compounds – Preparation and reactions of Phenyllithium.	18
References	***Text Books*** 1. B. S. Bahl & Arun Bahl. Advanced Organic Chemistry. S. Chand. 22nd Edition (2019). 2. P.L. Soni and H.W. Chawla, Text Book of Organic Chemistry, 21th Edition. Chand and company (2014). 3. S.N Sanyal, Reactions, Rearrangements & Reagents. Revised Edition, Bharati and Bhawan Publishers and Distributors (2013). ***Reference Books*** 1. Morrison Boyd & Bhattacharjee. Organic Chemistry. Pearson Education. 7th Edition (2010). 2. Y. R. Sharma, Elementary Organic Spectroscopy. S. Chand. Revised Edition (2013). 3. I. L. Finar, Organic Chemistry: Volume 1, 6th edition. Pearson (2012).	

Course Outcomes (COs)	**On completion of the course, students will be able to** CO1: explain the preparation and properties of aldehydes and ketones and predict their stability of mechanisms. CO2: explain the preparation and properties of saturated and unsaturated carboxylic acids and their reaction mechanisms. CO3: identify the nature of polycyclic hydrocarbons and the effect carcinogenic hydrocarbons. CO4: compare and contrast the preparation, reactions of aromatic nitrogen compounds, amines and diazo compounds. CO5: classify the principles of organic synthesis and to study the synthetic applications organometallics.

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	2	2	2	2	3	2	-	-	3	2	2	-	22
	2	2	2	2	3	2	2	2	-	-	2	2	2	-	21
	3	2	2	1	1	2	1	2	-	-	3	2	2	-	18
	4	2	2	2	2	2	2	2	-	-	2	2	2	-	20
	5	3	2	2	2	2	2	3	-	-	2	3	2	-	23
Grand total of COs With PSOs & POs															104
Mean value of COs With PSOs & POs = 104/50															2.08

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.08
Observation	COs of Organic Chemistry-II strongly related with PSOs and POs		

Course Code & Title	19UCHC65 Inorganic Chemistry-II		Hours	90
			Credit	5
Class	III B.Sc. Chemistry	Semester	V	
Cognitive Levels	K2, K3, K4			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • outline the nomenclature and to classify coordination compounds (K2, K3) • define and describe the bonding and properties of coordination compounds (K2, K3) • describe the chemistry of metal carbonyls and nitrosyls (K3) • explain and illustrate the reaction mechanism in coordination compounds (K3, K4) • predict and explain the role of metal complexes in biological systems (K3)			

UNIT	Contents	No. of Hours
I	**Coordination Compounds** Double salts- complex compounds- complex ion and coordination number (2, 3, 4, 5 and 6). Nomenclature. Types of ligands- Chelation - chelate effect. Factors affecting Chelation. Structure of EDTA and DMG. Isomerism in coordination compounds: Structural Isomerism - ionization, hydration, linkage, coordination, ligand, polymerization. Stereo Isomerism - geometrical and optical isomerism. Stability of Complexes. Thermodynamic and kinetic stability (no derivation).	18
II	**Bonding in Coordination Compounds** Theories: Werner's theory. Sidgwick's electronic interpretation. EAN concept. Valence Bond Theory (VBT). Inner sphere and outer sphere complexes. Hybridisation of metal complexes. Applications of VBT to octahedral, tetrahedral and square planar complexes. Magnetic properties of complexes. Limitations of VBT. Crystal Field Theory (CFT) – postulates – crystal field splitting in Octahedral, Tetrahedral and Square planar complexes. High and low spin octahedral complexes. Factors influencing crystal field splitting. Calculation of CFSE. Uses and limitations of CFT. Jahn-Teller distortion in octahedral complexes. Magnetic properties. Spectrochemical series.	18

III	**Metal Carbonyls and Nitrosyls** Metal Carbonyls. EAN rule and its application to the carbonyls of Cr, Mn, Fe, Co and Ni. Bonding in metal carbonyls – molecular orbitals of CO. General methods of preparation of carbonyls – direct combination and reductive carbonylation. Structure and discussion of $Ni(CO)_4$, $Fe(CO)_5$, and $Mn_2(CO)_{10}$ using IR. Metal Nitrosyls – Preparation and structure of sodium nitroprusside. EAN rule applied to $[Co(CO)_3(NO)]$	18
IV	**Reaction Mechanism in Coordination Compounds** Lability and inertness. Stability of Complexes. Thermodynamic and kinetic stability (no derivation). Substitution reactions of octahedral complexes – S_N1, S_N2. Acid and Base hydrolysis of Octahedral complexes. Substitution reactions of square-planar complexes – Trans effect (theories included). Mechanism of Electron Transfer Reactions in Solution Phase – Outer Sphere and Inner Sphere Mechanisms. Two-electron Transfer Reactions.	18
V	**Bioinorganic Chemistry** Introduction. Metal complexes in biological systems – chlorophyll, cyanocobalamine. Iron containing oxygen carriers – Introduction. Myoglobin and hemoglobin. Structure of the prosthetic group. Mechanism of binding of oxygen and CO to myoglobin and hemoglobin. Copper containing enzyme – Structure and functions of superoxide dismutase (SOD). Zinc containing enzyme – Structure and functions of carbonic anhydrase.	18
References	***Text Books*** 1. R. Gopalan, V. Ramalingam, Concise Coordination Chemistry, 1st Edition, Vikas Publishing House (2001) 2. Modern Inorganic Chemistry, 4th Edition. R. D. Madan. S. Chand (2006) ***Reference Books*** 1. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry – Principles of Structure and Reactivity, 4th Edition, Pearson Education (2008). 2. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, 33rd Edition, Milestone Publishers & Distributors (2016). 3. R. M. Roat-Malone, Bioinorganic Chemistry – A Short Course, John Wiley & Sons (2013).	
Course Outcomes (COs)	**On completion of the course, students will be able to** CO1: outline the nomenclature and classification of coordination compounds CO2: define and describe the bonding and properties of coordination compounds CO3: describe the chemistry of metal carbonyls and nitrosyls CO4: explain and illustrate the reaction mechanism in coordination compounds CO5: predict and explain the role of metal complexes in biological systems	

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	3	3	2	3	3	-	-	3	2	2	2	28
	2	2	3	3	2	2	2	2	-	-	2	2	2	2	24
	3	2	2	2	2	2	2	2	-	-	1	2	2	2	21
	4	3	2	2	2	2	2	1	-	-	2	2	2	2	22
	5	2	2	2	2	2	3	2	-	-	2	1	2	2	22
Grand total of COs With PSOs & POs															117
Mean value of COs With PSOs & POs = 114/55															2.13

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.13
Observation	COs of Inorganic Chemistry-II strongly related with PSOs and POs		

Course Code & Title	19UCHC75 Physical Chemistry-II		Hours	75
			Credit	5
Class	III B.Sc. Chemistry	Semester	V	
Cognitive Levels	K2, K3, K4			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • derive and to apply the physical aspects of Chemical kinetics (K2, K3) • apply and analyse basic principle of classical and quantum mechanics (K3, K4) • apply the principles of photochemistry (K3, K4) • discuss and to apply phase rule concept in Heterogeneous equilibrium • explain principle of solution of non-electrolyte (K2, K4)			

UNIT	Contents	No. of Hours
I	**Phase Rule** Phase rule. Concepts of phase, component and degrees of freedom. Gibbs phase rule- derivation. Clapeyron and Clausius-Clapeyron equation and their applications to equilibria in phase transitions (solid-liquid, liquid-vapour, soild-vapour). One component system: Water and Sulphur systems. Two component systems: i) Simple eutectic- Lead-Silver system ii) Formation of compound with congruent and incongruent melting point $FeCl_3$-H_2O and Na_2SO_4-H_2O systems	15
II	**Chemical Kinetics** Introduction. Rate of reaction. Rate law and rate constants. Order and molecularity of reactions. Derivation of rate constant and half life period for first and second order reactions. Examples for first and second order reactions. Third order reactions. (No Derivation). Methods of determining the order of a reaction. Complex reactions- consecutive, parallel and reversible reactions-Elementary idea. Influence of temperature on the rate of a reaction. Arrhenius rate equation and its significance. Bimolecular collision theory. Theory of absolute reaction rates. Lindemann's hypothesis.	15

III	**Solutions of Non-Electrolytes** Ideal solutions. Vapour pressure-composition diagram of solution. Raoult's law. Positive and negative deviations from the law. Principle of fractional distillation. Steam distillation. Binary systems. Azeotropic distillation. Partially miscible binary liquid systems. Critical Solution Temperature. –UCST, LCST, both UCST and LCST. Effect of addition of solute on CST. Solubility of gases in liquids. Henry's law. Distribution law: Thermodynamic derivation. Limitation of the law. Application of studying association, dissociation and solvation. Study of formation of complex ions. Solvent extraction. Efficiency of extraction.	15
IV	**Quantum Chemistry** Dual nature of electrons -De Brogliesparticle-waveduality. Davisson-Germer experiment -Heisenberg's uncertainty principle. Probability concept of electron. Schrodinger wave equation. Interpretation of wave function. Eigen Equation, Eigen values and Eigen function. Operator-Commuting,Hermitian. Solution of wave equation for particle in a one dimensional. Schrodinger equation for hydrogen atom. Probability densities of orbitals.	15
V	**Photochemistry** Comparison of thermal and photochemical reactions. Laws of Photochemistry. Beer-Lambert law. Grothus-Draper law. Stark-Einstein law. Quantum efficiency and its determination, reason for low and high efficiency. Consequences of light absorption by atoms and molecules. Jablonski energy level diagram. Primary and secondary photo physical processes- Radiationless transition-internal conversion and intersystem crossing. Fluorescence and Phosphorescence – Applications. Experimental study of photochemical reactions. Qualitative aspect of photochemical H_2-Cl_2 and H_2-Br_2 reactions. Basic concepts of photosensitized reactions. Flash photolysis and Chemiluminescence. Bioluminescence.	15
References	***Text Books*** 1. Text Book of Physical Chemistry. M. V. Sankaranarayanan and V. Mahadevan. Universities Press (2011) 2. Principles of Physical Chemistry. B. R. Puri, Sharma and L. R. Pathania. Vishal Publishing (2003) ***Reference Books*** 1. K. J. Laidler, Chemical Kinetics,2nd edition, Tata McGraw Hill (1975) 2. A. Frost and R. G. Pearson, Kinetics and Mechanisms, John Wiley & Sons (1953) 3. J. C. Kuriacose and J. Rajaram, Kinetics and Mechanisms Transformations, MacMillan & Co., (1993)	

Course Outcomes (COs)	**On completion of the course, students will be able to** CO1: derive and to apply the physical aspects of Chemical kinetics CO2: apply and analyse basic principle of classical and quantum mechanics CO3: apply the principles of photochemistry CO4: discuss and to apply phase rule concept in heterogeneous equilibrium CO5: explain the principle of solution of non-electrolyte

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	2	3	2	2	3	3	-	-	2	3	2	2	26
	2	3	2	1	2	2	2	3	-	-	2	2	3	2	24
	3	2	1	2	3	2	2	1	-	-	3	2	2	2	22
	4	3	3	1	2	2	3	2	-	-	2	2	2	2	24
	5	2	2	1	2	2	2	2	-	-	2	3	3	2	23
Grand total of COs With PSOs & POs															119
Mean value of COs With PSOs & POs = 119/55															2.16

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.16
Observation	COs of Physical Chemistry-II strongly related with PSOs and POs		

Course Code & Title	19UCHP35 Organic Analysis & Estimation		Hours	60
			Credit	4
Class	III B.Sc. Chemistry	Semester	V	
Cognitive Levels	K1, K2, K3, K4			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • recognize the methods of organic compound analysis (K2) • explain the reactions involved in the organic analysis (K2) • find the functional group and to prepare a suitable derivative (K3, K4) • compare the properties of various functional groups (K3) • estimate the amount of given organic compounds quantitatively (K3, K4)			

UNIT	Contents	No. of Hours
I	Test for aliphatic & aromatic and saturation and unsaturation nature of compounds	60
II	Detection of elements – N, S and halogens	
III	***Identification of functional groups*** Carboxylic acids – mono & di (saturated and unsaturated), Phenols, Aldehydes, Ketones, Reducing sugars, Primary Amines, Amides – mono, di.	
IV	Preparation of Derivatives	
V	Estimation of Phenol & Aniline	
References	***Text Books*** 1. V. Venkateswaran, R. Veerasamy, and A. R. Kulandaivelu, "Basic Principles of Practical Chemistry", Sultan Chand & Sons (2017) 2. N. S. Gnanpragasam , Prof. G. Ramamurthy "Organic Chemistry: Lab Manual", S. Viswanathan Co Printers & Publishers Pvt Ltd (2009) ***Reference Books*** 1. Thomas, A.O, *B.Sc. Main Practical Chemistry*, Scientific Book Centre (2003) 2. Furniss And Brian S And Hannaford And Antony J, "Vogel's Textbook of Practical Organic Chemistry" Pearson India, 5th Edition (2016)	
Course Outcomes (COs)	**On completion of the course, students will be able to** CO1: recognize the methods of organic compound analysis CO2: explain the reactions involved in the organic analysis CO3: identify the functional group and to prepare a suitable derivative CO4: compare the properties of various functional groups CO5: estimate the amount of given organic compounds quantitatively	

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	3	3	2	2	2	2	-	-	3	3	2	-	25
	2	3	3	2	2	2	3	2	-	-	3	3	2	-	25
	3	3	2	2	2	2	3	2	-	-	3	3	2	-	24
	4	3	3	3	3	2	3	2	-	-	3	3	2	-	27
	5	3	3	3	3	3	3	2	-	-	3	3	2	-	28
Grand total of COs With PSOs & POs															129
Mean value of COs With PSOs & POs = 129/50															2.58

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.58
Observation	COs of Organic Analysis & Estimation strongly related with PSOs and POs		

Continuous Internal Assessment (50 Marks)

S. No.	Components	Marks
1.	Observation Note book & Viva Voce	10
2.	Reports of the regular practical - Analysis	10
3.	Results of the regular practical - Estimation	10
4.	Internal Test-I	10
5.	Internal Test-II	10
	TOTAL	**50**

End-Semester Examination (50 Marks)

S. No.	Components	Marks
1.	Record Note book & Viva Voce	10
2.	Procedure – Analysis & Estimation	10
3.	Organic Analysis-I (Preliminary)	10
4.	Organic Analysis-II (Functional group & derivative preparation)	10
5.	Result of the estimation within prescribed limit	10
	TOTAL	**50**

Course Code & Title	19UCHE15 Medicinal Chemistry		Hours	60
			Credit	3
Class	III B.Sc. Chemistry	Semester	V	
Cognitive Levels	K2, K3, K4			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • outline and to discuss the basic principles medicine sytems and drug activity (K2, K3) • justify and explain the new drug synthesis and structural activity relationship (K2, K3) • identify the different class of drugs (K3) • list out and recognize chemotherapy and antibiotics (K3, K4) • investigate the role of blood composition and relevant agents (K4)			

UNIT	Contents	No. of Hours
I	**Introduction of Medicinal Chemistry and Drug Action** Introduction to the different systems of medicine - ayurveda, Siddha, homeopathy and allopathy. History of medicinal chemistry. Discovery of drugs - an introduction. Nature and sources of drugs. Terminology. Classification of Drugs. Mechanism of drug action and metabolism of drugs - Biotransformation.	12
II	**Drug Design and SAR** Principles of drug discovery and synthesis. The concept of lead compounds. Synthetic considerations. Use of computers in drug design. Relationship between chemical structure and pharmacological activity.	12
III	**Analgesics and Anxiety Drugs** Analgesics, antipyretics and anti-inflammatory Agents: Definition and Classification based on structure. Salicylates. Paracetamol. Opioid analgesics- morphine and its analogues. NSAIDS-Important drugs. Antidepressant Drugs- Definition. Anxiety. Classification. Benzodiazepines and barbiturates.	12
IV	**Chemotherapy and Antibiotics** Chemotherapy-Basic principles of chemotherapy. The molecular basis of chemotherapy. Antibacterials- sulphonamides. Antibiotics- beta-lactam antibiotics, tetracyclins, chloramphenicol, aminoglycosides, macrolides and flouroquinolones. Antimalarials.	12
V	**Blood Composition and Cardiovascular drugs** Blood- Composition-grouping-Rh factor- buffers in blood. Functions of plasma proteins – clotting mechanism – blood	12

	pressure. Coagulants and anticoagulants- definition and examples. Antianemic drugs. Cardiovascular drugs- definition and names of drugs used for each of the following –antiarrythmic agents, antihypertensives – antianginals, vasodilators – lipid lowering agents.	
References	***Text Books*** 1. Jayashree Ghosh. A Textbook of Pharmaceutical Chemistry. S. Chand (2014) 2. Bentley and Driver, "Textbook of Pharmaceutical Chemistry", Eight Edition, Oxford (2020) ***Reference Books*** 1. H. P. Rang, J.M. Ritter, R.J. Flower, and G. Henderson. Rang & Dale's Pharmacology, 8th Edition. Elsevier (2015) 2. V.K. Ahluwalia, & Madhu Chopra, Text book of Medicinal Chemistry, First Edition, Anne Books Pvt. Ltd. (2008). 3. Ashutosh Kar, Medicinal Chemistry Paperback – 1 Nov 2018, Seventh edition, New Age International Publishers (2018)	
Course Outcomes (COs)	**On completion of the course, students will be able to** CO1: outline and to discuss the basic principles medicine systems and drug activity CO2: justify and explain the new drug synthesis and structural activity relationship CO3: identify the different class of drugs CO4: list out and recognize chemotherapy and antibiotics CO5: investigate the role of blood composition and relevant agents	

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	1	2	2	2	3	2	-	-	2	2	2	2	22
	2	3	3	2	2	2	2	3	-	-	3	3	2	2	27
	3	2	2	1	2	3	2	2	-	-	1	2	2	2	21
	4	2	1	2	2	2	2	1	-	-	2	2	2	3	21
	5	1	2	2	2	2	2	2	-	-	2	1	2	2	20
Grand total of COs With PSOs & POs															111
Mean value of COs With PSOs & POs = 111/55															2.02

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.02
Observation	COs of Medicinal Chemistry strongly related with PSOs and POs		

Course Code & Title	19UCHSL5 Fuel Chemistry		Hours	-
			Credit	3
Class	III B.Sc. Chemistry	Semester	V	
Cognitive Levels	K2, K3, K4			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • outline and to discuss the classification and calorific value of fuels (K2, K3) • identify and to explain the role, composition and the preparation of fuels (K2, K3) • explain the role, components and preparation of fuels (K3) • analyze the advantages and to apply the fuels (K3) • to investigate the usage of alternative fuels (K3, K4)			

UNIT	Contents	No. of Hours
I	**Classification and Calorific Value of Fuels** Fuels and Combustion - Introduction - Classification of Fuels – Calorific Value – Theoretical Calculation of Calorific Value of a Fuel Gross calorific value and net calorific value – Characteristics of a Good Fuel - Solid fuels - Wood. Coal - Classification of Coal by Rank - Selection of Coal - Analysis of Coal and its significance.	-
II	**Role, Components and Preparation of Fuels** Types of cooking - Types of Carbonization of Coal - Role of Sulphur in Coal - Role of Ash in Coal. Gaseous fuels - Producer Gas - Water Gas - Natural Gas – Oil Gas - Biogas - Components - composition - preparation – advantages - disadvantages and applications of Coal gas - Gobar gas – LPG	-
III	**Quality Analysis of Fuels** Liquid fuels - Petroleum- Cracking - Advantages of catalytic cracking over thermal cracking - Synthetic Petrol. Refining of Gasoline – Reforming - Knocking - Octane number of Gasoline - Diesel Engine Fuels - Diesel - Octane number of Diesel Oil - Diesel index.	-
IV	**Applications of Fuels** Residual fuel oils - Asphalt - Aviation fuel- advantages -Kerosene as a fuel. Analysis and testing of liquid and gaseous fuels - Utilization of fuels - Solar power.	-
V	**Alternative Fuels** Other sources of energy – Electricity Power - Modern Concept of Fuel - Fuels for Metallurgy. Power Alcohol - Recent Advances in Fuel Technology. Alternative Fuels – Alcohols – Promising Biofuel : An Alternative Source to Diesel and Gasoline - Control of Pollution in Refineries.	-

References	***Text Books*** 1. B.K. Sharma. Industrial Chemistry. Goel Publishing House (2016) ***Reference Books*** 1. Jayashree Ghosh. Fundamental Concepts of Applied Chemistry. S. Chand (2010) 2. K. Bagavathi Sundari. Applied Chemistry. MJP Publishers (2006)
Course Outcomes (COs)	**On completion of the course, students will be able to** CO1: outline and to discuss the classification and calorific value of fuels CO2: identify and to explain the role, composition and the preparation of fuels CO3: explain the role, components and preparation of fuels CO4: analyze the advantages and to apply the fuels CO5: to investigate the usage of alternative fuels

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	1	2	2	2	3	2	-	-	2	2	2	2	22
	2	2	3	2	2	2	2	2	-	-	2	2	2	2	23
	3	2	2	2	2	3	2	2	-	-	2	2	2	2	23
	4	2	1	3	2	2	2	2	-	-	2	2	3	2	23
	5	1	2	2	2	2	2	2	-	-	2	1	2	3	21
Grand total of COs With PSOs & POs															112
Mean value of COs With PSOs & POs = 112/55															2.04

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.04
Observation	COs of Fuel Chemistry strongly related with PSOs and POs		

Course Code & Title	19UCHC86 Organic Chemistry-III		Hours	90
			Credit	5
Class	III B.Sc. Chemistry	Semester	VI	
Cognitive Levels	K2, K3, K4			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • explain the preparation and reactions of heterocycles and to classify dyes and discuss its preparation (K2, K3) • classify carbohydrates and explain its reactions (K3, K4) • elucidate the structural determination of alkaloids and terpenoids (K4) • discuss and explain various rearrangements with examples (K3, K4) • explain the fundamentals and applications of UV-Visible Spectroscopy, IR Spectroscopy and NMR spectroscopy (K4)			

UNIT	Contents	No. of Hours
I	**Heterocyclic Compounds and Dyes** Nomenclature. Preparation, properties and reactions of Pyrrole, Furan, Thiophen, Pyridine, Indole, Quinoline and Isoquinoline. Dyes- Theories of colour and constitution. Classification according to structure and applications. Preparation and uses of Methyl orange, Bismarck brown, Malachite green, Phenolphthalein, Fluorescein, Indigo and Alizarin	18
II	**Carbohydrates** Carbohydrates: Classification. Monosaccharides -Properties and reactions. Structural elucidation of Glucose and Fructose. Epimerisation and Mutarotation. Ring structure and conformation. Descending, Ascending and inter-conversions of monosaccharides. Determination of ring size. Disaccharides – Sucrose, maltose and lactose – Structure and properties. (No structural elucidation). Polysaccharides- Starch and Cellulose. Properties and Uses.	18
III	**Alkaloids and Terpenes** Alkaloids: General methods of isolation. General structure determination. Structural elucidation of Coniine, Piperine and Nicotine. Terpenes: Classification. Occurrence. Isolation. General properties. Isoprene rule. Structural elucidation of Citral and Geraniol. Preparation and properties of Menthol and α-pinene.	18
IV	**Molecular Rearrangements** Molecular rearrangements: Anionotropic and Cationotropic rearrangements. Intramolecular and intermolecular rearrangements. Mechanism of the following reactions – Pinacol-Pinacolone, Beckmann, Benzidine, Hoffman, Curtius,	18

	Benzilic acid, Claisen, Fries and Wagner-Meerwein rearrangements.	
V	**Spectrometric Identification of Organic Compounds** UV-Visible Spectroscopy: Types of electronic transition. Chromophore, Auxochrome. Bathochromic, Hypsochromic, Hyperchromic and Hypochromic shifts. UV spectrum of conjugated dienes. Carbonyl compounds. Woodward-Fieser rules applied to conjugated dienes and α,β-unsaturated carbonyl compounds. Simple examples. IR Spectroscopy: Molecular Vibrations. Fingerprint region. Characteristic absorption of functional groups. Interpretation of IR spectra of simple molecules. NMR Spectrum: Fundamental concepts. Chemical shift. Shielding and de-shielding. Area of signals. Spin-Spin splitting. Coupling constants. Interpretation of PMR spectra of Ethyl bromide, Ethanol, Acetaldehyde.	18
References	***Text Books*** 1. B. S. Bahl & Arun Bahl. Advanced Organic Chemistry. Revised Edition S. Chand. (2010) 2. P. S. Kalsi. Spectroscopy of Organic compounds. New Age International, (2007) 3. P.Y. Bruce. Organic Chemistry. Seventh Edition, Pearson. (2014) ***Reference Books*** 1. Morrison Boyd & Bhattacharjee. Organic Chemistry. 7th Edition. Pearson Education. (2010) 2. William Kemp. Organic Spectroscopy. Third Edition. Sixth Reprint. Palgrave (2002)	
Course Outcomes (COs)	**On completion of the course, students will be able to** CO1: explain the preparation and reactions of heterocycles and to classify dyes and discuss its preparation CO2: classify carbohydrates and explain its reactions CO3: elucidate the structural determination of alkaloids and terpenoids CO4: discuss and explain various rearrangements with examples CO5: explain the fundamentals and applications of UV-Visible Spectroscopy, IR Spectroscopy and NMR spectroscopy	

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	2	2	2	2	-	-	3	2	2	2	24
	2	3	2	2	2	2	2	3	-	-	2	2	2	-	22
	3	2	2	3	2	2	2	2	-	-	2	2	2	-	21
	4	2	2	2	2	2	3	1	-	-	3	2	2	-	21
	5	2	3	3	2	2	2	2	-	-	2	2	2	2	24

Grand total of COs With PSOs & POs	112
Mean value of COs With PSOs & POs = 112/52	2.15

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.15
Observation	COs of Organic Chemistry-III strongly related with PSOs and POs		

Course Code & Title	19UCHC96 Inorganic Chemistry-III		Hours	75
			Credit	5
Class	III B.Sc. Chemistry	Semester	VI	
Cognitive Levels	K2, K3, K4			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • describe and explain the general methods for extracting elements from their ores and their refining methods (K2, K3) • comprehend and discuss the properties and compounds of s-block metals (K2, K3) • explain and illustrate the general properties and compounds of group 13, 14 and 15 of p-block elements. (K3, K4) • explain and illustrate the general properties and compounds of group 16, 17 and 18 of p-block elements. (K2, K3) • discuss the metallurgy of Ti, Cr, Co, Ni and to predict and explain the electronic structure, oxidation states, magnetic and spectral properties of inner-transition elements. (K2, K3, K4)			

UNIT	Contents	No. of Hours
I	**General Methods of Extraction of metals** Occurrence of metals- ore and mineral. Metallurgy – definition. Ore dressing – froth floatation, gravity, magnetic and chemical separation. Conversion of concentrated ore into metallic oxide – calcination and roasting. Isolation of the metal – electrolytic, chemical and auto reduction. Metal displacement. Complex formation followed by metal displacement. Refining of metals – physical and chemical methods. Electrolysis. van Arkel process and zone refining.	15
II	**Representative Elements – I (s-Block elements)** Alkali metals – Comparative study. Anomalous behaviour of lithium. Diagonal relationship of lithium with magnesium. Extraction of lithium. Uses. Compounds of alkali metals – sodium borohydride – preparation and uses. Alkaline earths – Group discussion. Beryllium - extraction and uses. Diagonal relationship of beryllium with aluminum. Comparison of beryllium with other elements of the group.	15

III	**Representative Elements – II (p-Block elements-I)** Group 13 elements: General properties. Boron hydrides – diborane – preparation and structure. Boric acid and borates. Borazole – preparation and structure. Group 14 elements: General properties. Carbon-catenation, allotropes. Silicon-hydrides, silicates and silicones. Group 15 elements: General properties. Nitrogen-oxides, oxoacids. Phosphorus-allotropes, oxoacids.	15
IV	**Representative Elements – III (p-Block elements-II)** Group 16 elements: General properties, Oxygen-anomalous behaviour, hydrogen bonding. Sulphur-allotropes, oxoacids. Group 17 elements: General properties. Oxoacids of halogens. Inter-halogen compounds – XY and XY_3 types. Pseudohalogens. Group 18 elements: General properties. Isolation of rare gases. Preparation and structure of Xenon compounds – XeF_2, XeF_4, XeF_6, XeO_3, XeO_2F_2 and $XeOF_4$.	15
V	**Transition & Inner Transition Elements** First, second and third transition series. General characteristics. Occurrence, extraction, properties and uses of Titanium, Chromium, Cobalt, Nickel. Lanthanides - Electronic Structure & Oxidation States. Magnetic Properties. Spectral Properties. Lanthanide contraction. Actinides - Electronic Structure & Oxidation States. Magnetic Properties. Actinide contraction. Comparison of Lanthanides and Actinides.	15
References	***Text Books*** 1. R. D. Madan. "Modern Inorganic Chemistry", 4th Edition. S. Chand (2006) 2. B. R. Puri, L. R. Sharma, K. C. Kalia. "Principles of Inorganic Chemistry". Milestone Publishers & Distributers (2016) ***Reference Books*** 1. Concise Inorganic Chemistry, 5th edition, John D. Lee. Wiley Publications (2014) 2. Advanced Inorganic Chemistry, 19th edition, Satya Prakash, G. D. Tuli, S. K. Basu, R. D. Madan, S.Chand (2008) 3. Inorganic Chemistry 5th Edition, Gary Miessler, Paul Fischer, Donald Tarr, Pearson Education (2014)	
Course Outcomes (COs)	**On completion of the course, students will be able to** CO1: describe and explain the general methods for extracting elements from their ores and their refining methods. CO2: comprehend and discuss the properties and compounds of s-block metals.	

	CO3: explain and illustrate the general properties and compounds of group 13, 14 and 15 of p-block elements. CO4: explain and illustrate the general properties and compounds of group 16, 17 and 18 of p-block elements. CO5: discuss the metallurgy of Ti, Cr, Co, Ni and to predict and explain the electronic structure, oxidation states, magnetic and spectral properties of inner-transition elements.

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	2	2	3	2	2	3	-	-	3	2	2	-	23
	2	3	2	3	2	2	3	2	-	-	2	2	2	-	23
	3	2	3	3	2	2	2	2	-	-	2	2	2	-	22
	4	3	3	2	2	2	3	2	-	-	2	3	2	-	24
	5	2	2	1	2	2	2	2	-	-	2	3	2	-	22
Grand total of COs With PSOs & POs															114
Mean value of COs With PSOs & POs = 114/55															2.07

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.07
Observation	COs of Inorganic Chemistry-III strongly related with PSOs and POs		

Course Code & Title	19UCHD06 Physical Chemistry-III		Hours	90
			Credit	5
Class	III B.Sc. Chemistry	Semester	VI	
Cognitive Levels	K2, K3, K4			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • identify the various electrolytes, electrolytic conductance and determination of ionic mobilities (K2, K3) • state and derive ionic equilibria, explain the principles of pH, buffer solutions and salt hydrolysis. (K2, K3) • define and to describe the basics of electrodes, electrode potential and electrochemical cells and to calculate the pH using various electrodes. (K2, K3) • discuss and to apply the principles of instrumentation of spectroscopic techniques- Microwave, IR, Raman, NMR and ESR (K2, K3) • state the basic concepts of Group Theory and construct the group multiplication table. (K2, K4)			

UNIT	Contents	No. of Hours
I	**Electrolytes – Electrolytic Conductance** Electrolytic conduction. Faradays law of electrolysis. Specific equivalent and molar conductance. Variation of conductance with dilution. Strong and weak electrolytes. Ionic mobility. Determination of ionic mobilities. Transport number. Determination of transport number by Hittorf and moving boundary method. Kohlrausch's law. Applications of Kohlrausch's law. Applications of conductance measurements - conductometric titrations. Ostwald's dilution law. Theory of strong electrolytes – Debye-Huckel theory. Onsager equation and its significance.	18
II	**Ionic Equilibria** Ionic product of water. pH of acids and bases. Common ion effect. solubility product of sparingly soluble salts. Derivation of Hendersen equation. Hydrolysis of salts, Degree of hydrolysis, Hydrolysis constant- Salt of weak acid and strong base, salt of strong acid and weak base, salt of weak acid and weak base. Relationship between K_h,K_a,K_b and K_w.	18

III	**Electrochemical Cells** Galvanic cells. Reversible and irreversible cells. Emf and its measurements. Standard cells. Electrode reactions. Measurement of electrode potentials. Standard electrode potentials. Sign convention. Reference electrodes – Standard hydrogen, Calomel and Quinhydrone electrodes. Electrochemical series and its significance. Concentration cells with and without transference. Liquid junction potentials. Derivation of Nernst equation for emf of cells. Applications of emf measurements. Determination of pH using Hydrogen, Quinhydrone and Glass electrodes. Potentiometric titrations. Applications of concentration cells. Overvoltage.	18
IV	**Spectroscopy** Introduction. Molecular Spectroscopy: Introduction. Regions of the electromagnetic spectrum. Microwave spectroscopy: Rotation of molecules. Rotational spectrum of simple diatomic molecules. IR Spectroscopy: Vibration of diatomic molecules. Simple harmonic and anharmonic vibrations. Characteristic group vibrations. Raman Spectroscopy: Introduction. Molecular polarisability. Selection rules. Mutual exclusion principle. Magnetic resonance: Theory of PMR spectroscopy. Instrumentation. Chemical shift and Spin-Spin coupling. CMR - Introduction. EPR Spectroscopy: Basic Idea. Hyperfine splitting. Applications-hydrogen atom, methyl radical.	18
V	**Group Theory** Molecular symmetry- Types of Symmetry elements - symmetry operations - Products of symmetry operations. Similarity transformation. Properties of group-classes and subgroups. Point groups – Cnv, Cnh, Dnh. Construction of Group Multiplication table – NH_3 and H_2O molecules.	18
References	***Text Books*** 1. Puri, Sharma & Pathania. "Principles of Physical Chemistry". 1st edition, Vishal Publishing & Co (2018). 2. Arun Bahl & B. S. Bahl, "Essentials of Physical Chemistry, 28th edition, S. Chand Publishing (2020). 3. K. V. Raman," Group Theory and its Applications to Chemistry" Tata McGraw-Hill Publishing Company, 3rd edition (1990) ***Reference Books*** 1. S. K. Dogra & S. Dogra. "Physical Chemistry through Problems", 2nd Edition. New Age International (2015). 3. Colin N. Banwell, Elaine M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, McGraw Hill Publications (2017). 4. R. Gurdeep Chatwall, Advanced Physical Chemistry, Goel publishing (2016). 5. K. Veera Reddy, "Symmetry And Spectroscopy Of Molecules", New Age International (1998)	

Course Outcomes (COs)	**On completion of the course, students will be able to** CO1:identify the various electrolytes, electrolytic conductance and determination of ionic mobilities. CO2:state and derive ionic equilibria, explain the principles of pH, buffer solutions and salt hydrolysis. CO3:define and to describe the basics of electrodes, electrode potential and electrochemical cells and to calculate the pH using various electrodes. CO4:discuss and to apply the principles of instrumentation of spectroscopic techniques - Microwave, IR, Raman, NMR and ESR. CO5:state the basic concepts of Group Theory and construct the group multiplication table.

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	2	3	3	2	3	3	-	-	3	2	2	-	25
	2	2	2	2	2	2	3	2	-	-	2	2	2	-	21
	3	2	2	2	2	2	2	3	-	-	2	2	2	-	21
	4	2	2	2	3	2	2	2	-	-	3	3	3	-	24
	5	3	3	3	2	2	2	2	-	-	2	2	2	-	23
Grand total of COs With PSOs & POs															114
Mean value of COs With PSOs & POs = 114/55															2.07

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.07
Observation	COs of Physical Chemistry-III strongly related with PSOs and POs		

Course Code & Title	19UCHE26 Industrial Chemistry		Hours	60
			Credit	3
Class	III B.Sc. Chemistry	Semester	VI	
Cognitive Levels	K2, K3, K4			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • describe the basic process involved in petrochemical industries (K2, K3) • explain the process involved in manufacturing of sugar in sugar industry (K2, K3) • define and classify various ingredients in fertilizers and pesticides (K2, K3) • explain the process of water treatment methods (K2, K3) • illustrate the principle and applications of green chemistry (K3, K4)			

UNIT	Contents	No. of Hours
I	**Petrochemicals** Crude oil. Constitution and distillation. Composition of different distillates. Ignition point, flash point and octane number. Cracking. Manufacture of synthetic petrol. Dergius and Fischer-Tropsch processes/ Manufacture of petrochemicals – ethanol, ethyleneglycol, glycerine, phenol, cumene, linear alkyl benzenes.	12
II	**Sugar Industry** Sugar Industry in India. Sugar cane and sugar beet – manufacture of cane sugar. Extraction of juice – concentration – separation of crystals – sulphitation and carbonation – testing and estimation of sugar. Bagasse – use of Bagasse for the manufacture of paper and electricity.	12
III	**Fertilisers and Pesticides** Classification of fertlisers – urea, super phosphate and potassium nitrate. Mixed fertliser – fertliser industry in India Insecticides and pesticides – Definition. Classification. Inorganic pesticides. Lead arsenate, Paris Green, Lime, sulphur, hydrocyanic acid. Organic pesticides – Natural and synthetic. Fungicuides – Repellants.	12
IV	**Water Treatment** Introduction: Hardness of Water – temporary and permanent hardness – units of hardness – disadvantageous of hardness. Estimation of hardness – EDTA method. Water softening methods: sedimentation, coagulation, filtration -removal of microorganisms – chlorination, UV irradiation andozonation. Ion exchange – demineralization – deionization process. Reverse Osmosis.	12

V	**Principles of Green Chemistry** Definition. Need for Green chemistry. Difference between Green Chemistry and Environmental Chemistry. Waste minimization techniques. 12 principles of green chemistry. One example illustrating each principle.	12
To visit to the above industries and to submit the report of the same.		
References	***Text Books*** 1. B. K. Sharma, "Industrial Chemistry" Goel Publishing House (2019) 2. H. L. White, "Introduction to Industrial Chemistry". John Wiley (2015) ***Reference Books*** 1. Schreve, "Chemical Process Industries", McGraw Hill (2015) 2. V. K. Ahluwalia, "Green Chemistry", Narosa Publishing House (2012)	
Course Outcomes (COs)	**On completion of the course, students will be able to** CO1: describe the basic process involved in petrochemical industries CO2: explain the process involved in manufacturing of sugar in sugar industry CO3: define and classify various ingredients in fertilizers and pesticides CO4: explain the process of water treatment methods CO5: illustrate the principle and applications of green chemistry	

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	3	2	2	2	3	2	3	-	2	2	2	-	25
	2	2	3	2	1	2	2	2	2	-	2	3	2	-	23
	3	3	2	2	2	2	2	3	2	-	2	3	2	-	25
	4	2	2	2	3	2	2	2	2	-	2	2	2	-	23
	5	3	2	3	2	2	3	3	3	-	2	2	2	-	27
Grand total of COs with PSOs & POs															123
Mean value of COs with PSOs & POs = 123/55															2.24

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.24
Observation	COs of Industrial Chemistry strongly related with PSOs and POs		

Course Code & Title	19UCHP46 Gravimetry and Preparation		Hours	60
			Credit	4
Class	III B.Sc. Chemistry	Semester	VI	
Cognitive Levels	K3, K4			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • estimate the metals lead and barium as their salts gravimetrically (K4) • estimate the metals calcium and copper as their salts gravimetrically (K4) • prepare and to recrystallise simple organic compounds by hydrolysis, acetylation and oxidation processes (K3, K4) • prepare and to recrystallise simple inorganic compounds (K3, K4)			

UNIT	Contents	No. of Hours
I	**Gravimetry-I** Estimation of lead as lead chromate Estimation of barium as barium chromate	60
II	**Gravimetry-II** Estimation of calcium as calcium oxalate monohydrate Estimation of copper as CuSCN	
III	**Organic preparations** Hydrolysis - Acid from an ester/amide Acetylation - Acetanilide from aniline Oxidation - Benzoic acid from benzaldehyde	
IV	**Inorganic preparations** Potash alum (or) Chrome alum Prussian blue Tetraamminecopper(II) sulphate	
References	***Text Books*** 1. Jeyavarthana Samuel, Chemistry Practical Book, S.S. Printers (2018)	
Course Outcomes (COs)	**On completion of the course, students will be able to** CO1: identify the suitable precipitating agent and methodology for the quantitative estimate of metal ions gravimetrically CO2: estimate the amount of various metals like lead, barium, calcium and copper in real samples. CO3: synthesize and recrystallise simple organic compounds by hydrolysis, acetylation and oxidation processes CO4: prepare and recrystallise simple inorganic compounds	

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	3	3	3	3	3	-	-	3	3	3	2	31
	2	3	3	3	3	2	3	3	-	-	2	3	3	2	30
	3	3	3	2	3	3	3	2	-	-	3	3	3	2	30
	4	3	3	3	2	3	3	3	-	-	3	2	3	2	30
Grand total of COs with PSOs & POs															121
Mean value of COs with PSOs & POs = 121/44															2.75

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.75
Observation	COs of Gravimetry and Preparation strongly related with PSOs and POs		

EVALUATION

Continuous Internal Assessment (50 Marks)

S. No.	Components	Marks
1.	Regular practical Observation & Viva	10
2.	Results of the regular practical - Gravimetry	10
3.	Results of the regular practical - Preparation	10
4.	Internal Test-I	10
5.	Internal Test-II	10
	TOTAL	**50**

End-Semester Examination (50 Marks)

S. No.	Components	Marks
1.	Record Notebook & Viva	10
2.	Procedure - Gravimetry & Preparation	10
3.	Experiment –Final Result within the prescribed error limit	20
4.	Preparation – Final result	10
	TOTAL	**50**

Course Code & Title	19UCHP56 Physical Chemistry Practical		Hours	60
			Credit	4
Class	III B.Sc. Chemistry	Semester	VI	
Cognitive Levels	K3, K4			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • determine molecular weight of the unknown solute by Transition temperature and Rast's method (K3, K4) • comprehend and calculate critical solution temperature (CST) of phenol –water system and how impurities influence CST (K3, K4) • calculate the rate constant of hydrolysis of ester by mineral acids and also their relative strength of the acids (K3, K4) • calculate the strength of the base or acid by Conductrometric Titration (K3, K4) • calculate the strength of the acid or base by Potentiometric Titration (K3, K4)			

UNIT	Contents	No. of Hours
I	**Determination of molecular weights** (a) Transition temperature method – Using sodium thiosulphate pentahydrate as the solvent. (b) Cryoscopic method – Rast's method using Naphthalene as the solvent	60
II	**Phase equilibria** (a) Determination of CST of phenol-water system (b) Estimation of NaCl by studying the CST of phenol-water system (c) Construction of phase diagrams – Two component systems (i) Simple eutectic (ii) compound formation	
III	**Chemical kinetics** Determination of rate constant of hydrolysis of methyl/ethyl acetate by an acid. (Ester Hydrolysis)	
IV	**Electrochemistry** ***Conductometric titration*** Strong Acid Vs Strong Base (HCl Vs NaOH) ***Potentiometric titrations***: Strong Acid Vs Strong Base (HCl Vs NaOH)	
V	**Partition & Adsorption experiments** (i) Determination of association of benzoic acid in benzene. (ii) Adsorption of benzoic acid over activated carbon.	
References	***Text Books*** 1. Jeyavarthana Samuel, Chemistry Practical Book, S.S. Printers (2018) 2. D. N. Bajpai, O. P. Pandey & S. Giri "Practical Chemistry" S.Chand Publishing (2013)	

Course Outcomes (COs)	**On completion of the course, students will be able to** CO1: Describe and explain the theory and underlying concepts of physical chemistry CO2: Apply knowledge of physical chemistry to select the appropriate technique for the determination of physical parameters CO3: Examine the procedures and instrumental methods applied in analytical and practical tasks of physical chemistry CO4: Analyze, interpret and predict data to solve conceptual and theoretical problems, including those from experimental work CO5: Critically evaluate data, maintain a detailed scientific notebook and summarize findings in writing in a clear and concise manner

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	3	3	3	3	3	3	-	-	3	3	3	2	32
	2	3	2	2	3	3	3	3	-	-	3	3	3	2	29
	3	2	2	3	3	3	3	3	-	-	3	3	3	2	29
	4	3	3	3	3	3	3	3	-	-	3	3	3	2	32
	5	2	3	3	3	3	3	3	-	-	3	3	3	2	31
Grand total of COs with PSOs & POs															153
Mean value of COs with PSOs & POs = 153/55															2.78

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.78
Observation	COs of Physical Chemistry Practical strongly related with PSOs and POs		

Continuous Internal Assessment (50 Marks)

S. No.	**Components**	**Marks**
1.	Regular practical Observation & Viva	10
2.	Results of the regular practical	20
4.	Internal Test-I	10
5.	Internal Test-II	10
	TOTAL	**50**

End-Semester Examination (50 Marks)

S. No.	Components	Marks
1.	Record Notebook & Viva	10
2.	Procedure	10
3.	Calculation and Graph	10
4.	Experiment –Final Result within the prescribed error limit	20
	TOTAL	**50**

Course Code & Title	19UCHSL6 Chemistry for Competitive Exams		Hours	-
			Credit	3
Class	III B.Sc. Chemistry	Semester	VI	
Cognitive Levels	K3, K4			
Course Educational Objectives (CEOs)	**The course aims to make the students to** • Justify, reason-out and apply the concepts in General Chemistry (K3, K4) • justify, reason-out and apply the concepts in Inorganic Chemistry (K3, K4) • justify, reason-out and apply the concepts in Organic Chemistry (K3, K4) • justify, reason-out and apply the concepts in Physical Chemistry (K3, K4) • justify, reason-out and apply the concepts in Analytical Chemistry (K3, K4)			

UNIT	Contents	No. of Hours
I	Short answer and Multiple choice questions in Atomic structure, Classification of periodic table, Periodic properties, Chemical Bonding	-
II	Short answer and Multiple choice questions in Acids & Bases, Representative, transition and inner-transition elements, Coordination Chemistry	-
III	Short answer and Multiple choice questions in Stereochemistry, Name reactions, Reaction Mechanisms, Spectroscopy	
IV	Short answer and Multiple choice questions in Solid state, Thermodynamics, Chemical kinetics, Electrochemistry, Phase rule	-
V	Short answer and Multiple choice questions in Applied and Analytical Chemistry	-
References	***Reference Books*** 1. T. S. Rao & T. Sampurna, "Chemistry for Competitive Exams". CBS Publishers & Distributors, New Delhi 2. IIT Objective Chemistry-Arul Syamal – Atlantic Publishers & Distributors Pvt (Ltd) 3. Objective Question Bank in Chemistry – B.K.Sharma 4. Objective Chemistry- K.L.Chugh – Kalyani Publishers, New Delhi.	
Course Outcomes (COs)	**On completion of the course, students will be able to** CO1: Justify, reason-out and apply the concepts in General Chemistry CO2: justify, reason-out and apply the concepts in Inorganic Chemistry CO3: justify, reason-out and apply the concepts in Organic Chemistry CO4: justify, reason-out and apply the concepts in Physical Chemistry CO5: justify, reason-out and apply the concepts in Analytical Chemistry	

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	2	2	2	3	2	2	-	-	2	2	2	2	23
	2	2	2	2	3	2	2	2	-	-	2	2	2	2	23
	3	2	2	3	2	2	2	2	-	-	2	2	2	2	23
	4	3	2	2	2	2	2	2	-	-	2	2	2	2	23
	5	2	3	2	2	2	2	2	-	-	2	2	2	2	23
Grand total of COs with PSOs & POs															115
Mean value of COs with PSOs & POs = 115/55															2.09

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.09
Observation	COs of Chemistry for Competitive Exams strongly related with PSOs and POs		

<table>
<tr><td>Course Code & Title</td><td colspan="2">Internship
(for those who joined in June 2019 onwards)</td><td>Part</td><td>IV</td></tr>
<tr><td></td><td colspan="2"></td><td>Duration</td><td>25 days</td></tr>
<tr><td>Class</td><td>III B.Sc. Chemistry</td><td>Semester</td><td colspan="2">VI</td></tr>
<tr><td>Objectives</td><td colspan="4">The course aims to make the students to
• provide a different kind of learning experience
• gain laboratory/ industry/ research experience
• acquire employability skills related to Chemistry</td></tr>
<tr><td>Outline</td><td colspan="4">➢ The students shall undertake their internship from IV semester holidays and must submit the report and attendance certificate before the external examinations of VI semester.

➢ The students must periodically report their progress and status to their respective Faculty-in-charge/ supervisor.

➢ The students must complete their internship of 25 days by undertaking anyone of the following ways.
• The students shall work as an intern in any of the related forums of their feasibility such as laboratory/ industry/ research centres/ institutions.
• The students shall participate in the Internship Programmes offered by other Institutions/ Colleges/ Universities.
• The students shall work under faculty of other colleges and acquire exposure to any of the topics in Chemistry.</td></tr>
<tr><td>Evaluation</td><td colspan="4">➢ Internal – 50 Marks
• Progress Report & Viva-voce
➢ External – 50 Marks
• Competent person of the laboratory/ industry/ research centres/ institutions
Total – 100 Marks</td></tr>
</table>

DEPARTMENT OF CHEMISTRY
ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR – 625 514

Programme Specific Outcomes (PSO) – M.Sc. Chemistry

The programme enables the students to

PSO1: describe the scientific principles of Chemistry, develop an insight into a specialized subject and pursue higher studies

PSO2: employ critical thinking and scientific knowledge to design chemical reactions, carry out, assess, analyze, interpret and draw conclusions from them

PSO3: develop analytical skills and problem-solving skills required to develop new applications of chemistry and transform the learned skills to qualify competitive examinations

PSO4: assess and interpret qualitative and quantitative data and empower themselves in recent and advanced developments in chemistry to undertake research and to get placements

PSO5: create an awareness of the impact of chemistry on the environment, society, and development outside the scientific community.

ARUL ANANDAR COLLEGE (AUTONOMOUS), KARUMATHUR

DEPARTMENT OF CHEMISTRY

M.Sc. Chemistry – Course Structure under CBCS

S.No.	Course	Code	Title of the Paper	Hours/Week	Credit
SEMESTER-I					
1	Core	22PCHC11	Organic Reaction Mechanism & Stereochemistry	5	4
2	Core	22PCHC21	Chemical Bonding & Solid-State Chemistry	5	4
3	Core	22PCHC31	Quantum Chemistry and Group Theory	6	5
4	Elective-1	22PCHE11	Chemistry of Materials/ Industrial Waste Management	6	4
5	Core	22PCHP11	Organic Chemistry Practical – I	4	3
6	Core	22PCHP21	Inorganic Chemistry Practical – I	4	3
TOTAL				**30**	**23**
SEMESTER-II					
7	Core	22PCHC42	Conformational Analysis, Reagents and Organic Synthesis	5	4
8	Core	22PCHC52	Coordination, Organometallics and Bioinorganic Chemistry	5	4
9	Core	22PCHC62	Principles of Molecular Spectroscopy	6	5
11	NME	22PCHN12	Environmental Chemistry	4	3
12			Life Skills	2 (+2)	3
13	Core	22PCHP32	Organic Chemistry Practical - II	4	3
14	Core	22PCHP42	Physical Chemistry Practical – I	4	3
			Self-Learning (MOOC, NPTEL)		
TOTAL				**30**	**25**
SEMESTER-III					
15	Core	22PCHC73	Natural Products	6	5
16	Core	22PCHC83	Chemical Thermodynamics, Equilibria and Electrochemistry	6	5
17	Core	22PCHC93	Applications of Spectroscopy	5	4

17	Core Elective	22PCHE23	Research Methodology/Polymer Chemistry	5	3
18	Core	22PCHP53	Physical Chemistry Practical-II	4	3
19	Core	22PCHP63	Inorganic Chemistry Practical-II	4	3
TOTAL				**30**	**23**
SEMESTER-IV					
19	Core	22PCHD04	Analytical Chemistry	4	3
20	Core	22PCHD14	Photochemistry, Pericyclic reactions and Supramolecular Chemistry	5	4
21	Core	22PCHD24	Chemical Kinetics, Surface and Polymer Chemistry	5	4
22	Elective-4	22PCHE34	Biochemistry & Medicinal Chemistry / Green Chemistry	4	3
23	Core		Project Work	12	7
TOTAL				**30**	**21**

Semester	**I**	**II**	**III**	**IV**	**Total**
Credit	**23**	**25**	**23**	**21**	**92**

ORGANIC REACTION MECHANISM AND STEREOCHEMISTRY

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: I M.Sc. Chemistry	Part	: Core-1
Semester	: I	Hours	: 75
Code	: 22PCHC11	Credits	: 4

Course Educational Objectives

The course aims to make the students to

1. explain the acid-base concept, examine the intermediates including identify the non-classical carbocations/ transition state of a reaction and methods of determining the reaction mechanism
2. identify the various projection formulas, predict and assign the R, S/ E, Z configuration of a chiral molecule
3. illustrate the mechanism of a nucleophilic/ electrophilic substitution reaction, and justify the formation of products based on the above concepts
4. explain the mechanism of aromatic electrophilic/nucleophilic substitution reactions and correlate the structure and reactivity of an aromatic compound
5. explain the mechanism of elimination and addition reactions and design an elimination or a substitution reaction based on the above concepts

Unit – I Introduction to Reaction Mechanism (15 hours)

Theory of Acids and bases – Arrhenius, Brönsted and Lewis concepts of acids and bases – Energy changes – Reaction Intermediates – classical and non-classical carbocation – carbanion – carbenes – nitrene – free radical – formation and stability – Intermediates Vs transition states – Hammond postulate – Principle of microscopic reversibility.

Methods of determining reaction mechanism – Non kinetic methods – isotopic labelling, identification and isolation of intermediates and effects due to structural changes – Kinetic methods – kinetic isotope effect.

Unit – II Introduction to Stereochemistry (15 hours)

Molecular Symmetry – Chirality – necessary and sufficient conditions – Optical activity – ORD and CD – Cotton effect.

Projection formulas of stereoisomers – Interconversion of Flying Wedge, Fischer, Sawhorse and Newman projections – Absolute Configuration – Cahn Ingold and Prelog or R, S designation of compounds having chiral centres – Absolute configuration of compounds having chiral axis –Atropisomerism – Allenes, Spiranes, Biphenyls and ANSA compounds – E-Z nomenclature –Erythro and Threo nomenclature – Prostereoisomerism and Topicity.

Unit – III Aliphatic Substitution Reactions (15 hours)

Nucleophilic substitution: S_N2, S_N1, S_Ni Mechanism – classical, ion pair mechanism – Energetics, stereochemistry and distinction of S_N2 and $S_N1$reactions – Factors influencing nucleophilic substitution reactions – effect of substrate – nature of nucleophile – solvent polarity – leaving group ability on the course of the reaction – Neighbouring group participation by σ and π bonds – Allylic and Vinylic substitution.

Electrophilic substitution– S_E1, S_E2 and S_Ei reactions.

Unit – IV Aromatic Substitution Reactions (15 hours)

Aromatic Electrophilic Substitutions: General Mechanism– Characteristics – reactivity and orientation, relative rates of substitutions–ortho, para ratio– ipso substitutions–Mechanism of nitration, Sulphonation – Reactions with carbon electrophiles – Friedel Crafts Alkylation and Acylation–Vilsmeier-Haack reaction– Reimer Tiemann reaction and diazo coupling.

Aromatic Nucleophilic Substitution reactions: ArS_N2, ArS_N1 mechanisms– Linear free energy relationship – Hammett equation – the significance of sigma and rho – Limitations and deviations of Hammett equation– Taft equation.

Unit – V Elimination and Addition reactions (15 hours)

Elimination reaction–E1, E2 and E1cB mechanisms– Regioselectivity in β Elimination reactions– Orientation of the double bond– Hoffmann, Saytzeff and Bredt's rules– Competition between elimination and substitution.

Addition reaction: Electrophilic addition of halogens to carbon-carbon multiple bonds– Hydroboration– Micheal addition– Nucleophilic addition to carbonyl bond – Aldol, Dieckmann, and Stobbe condensations– Reformatsky, Perkin, Knoevenagel and Mannich reactions– Stereochemistry of addition reactions– Syn- and anti-additions.

Reference Books

1. P.S. Kalsi, "Organic Reactions Stereochemistry and mechanism", New Age International Publishers (2020).
2. R.P. Narain, "Fundamentals of Reaction Mechanism in Organic Chemistry", PHI Learning Pvt. limited (2011).
3. P. Sykes, "A Guide Book to Mechanism in Organic Chemistry" Sixth Edition, John Wiley & Sons, Inc. New York (2011).
4. F. A. Carey and R. J. Sundberg, "Advanced Organic Chemistry", Part A and Part B, 3rd Edition, Plenum press, New York (2008)
5. Jerry March, "Advanced Organic Chemistry: Reactions, Mechanisms and Structure", 5th Edition, Wiley India (2008).
6. E. L. Eliel and S. H. Wilen, "Stereochemistry of Organic Compounds", John Wiley (2008).
7. Peter Sykes, "A Guide book to Mechanisms in Organic Chemistry", 6th Edition, Pearson Education (2003).
8. T. H. Lowry and K. S. Richardson, "Mechanism and Theory in Organic Chemistry", 3rd Edition, Harper and Row (1997).
9. N. Tewari, "Advanced Organic Stereochemistry", Books and Allied (2012)
10. V K Ahluwalia and Rakesh K Parashar, "Organic Reaction Mechanisms", Alpha Science International Ltd (2011).

Course Outcomes(COs)

On completion of the course, students will be able to

CO1: explain the various acid-base concepts, examine the intermediates/ transition state of a reaction and methods of determining the reaction mechanism

CO2: identify the various projection formulas, predict and assign the R,S/ E,Z configuration of a chiral molecule

CO3: illustrate the mechanism of a nucleophilic/electrophilic substitution reaction, identify the non-classical carbocations and justify the formation of products based on the above concepts

CO4: explain the mechanism of aromatic electrophilic/nucleophilic substitution reactions and correlate the structure and reactivity of an aromatic compound

CO5: explain the mechanism of elimination and addition reactions and design an elimination or a substitution reaction based on the above concepts

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	3	2	2	3	2	2	-	-	2	-	-	-	19
	2	2	3	3	2	2	2	2	3	-	2	-	-	-	21
	3	2	2	2	2	2	2	3	2	-	2	-	-	-	19
	4	2	2	2	2	2	3	2	2	-	2	-	-	-	19
	5	2	2	2	2	2	3	2	2	-	2	-	-	-	19
Grand total of COs with PSOs &POs															97
Mean value of COs with PSOs & POs = 97/44															2.20

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.20
Observation	COs of Organic Reaction Mechanism and Stereochemistry is strongly related with PSOs and POs		

QUANTUM CHEMISTRY AND GROUP THEORY

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: I M.Sc. Chemistry	Part	: Core-3
Semester	: I	Hours	: 90
Code	: 22PCHC21	Credits:	5

Course Educational Objectives

The course aims to make the students to

1. derive and to apply the physical and mathematical aspects of quantum mechanics
2. apply and analyse QM models to chemical systems
3. apply and determine MQ in multi-electron atoms and ions
4. Outline and understand the basic concepts of group theory
5. Formulate reducible and irreducible representations to predict the hybridization and spectral properties

Unit – I Essential Mathematical Tool and Postulates of Quantum Mechanics (18 hours)

Coordinate systems – Complex numbers – Functions (odd & even, norm, normalization, orthogonal and Orthonormal).

Vectors – Differential equations - Operators (linear, differential, Laplacian) – Eigen functions and Eigen values.

Failure of Classical Mechanics and the need for QM – Postulates of QM – Wave Function – Probability - Hermitian and Hamiltonian operators and their properties – Time-independent Schrödinger from the time – dependent wave equation.

Unit – II QM Models and their Applications to Chemical Systems (18 hours)

Particle in a 1-D box**:** Solving wave equation – extension to 3D – cubic box and degeneracy – application to linear conjugated molecular systems – free particle – Bohr's Correspondence Principle – Quantum Mechanical Tunneling.

Rigid Rotor: Solving wave equation – Spectroscopic application in calculation of rotational constants and bond length of simple diatomic molecules.

Simple 1-D Harmonic Oscillator: Solving wave equation – Spectroscopic application in the calculation of vibrational energy and force constant.

The Hydrogen atom and H-like ions: Solution to H and H-like wave equation – radial and angular functions – quantum numbers n, l and m and their importance – the radial distribution functions and H-like orbitals and their representation.

Approximation Methods: The variation method – trial variation function and variational integral (examples of variational calculations from particle in a box) – Perturbation Method (only introduction).

QM treatment of angular momentum: simultaneous measurement of several properties – evaluation of commutators such as $[x, p_x]$, $[x, p_x^2]$, $[L_x, L_y]$ and $[L_x^2, L_x]$ and their significance.

Unit – III Multi-Electron Atoms and Molecular QM (18 hours)

He atom: The electron spin – Antisymmetric condition – Pauli Exclusion Principle and Slater determinant for He atom.

Hydrogen molecule ion: Use of linear variation function – the LCAO method – Born-Oppenheimer Approximation

Hydrogen molecule: Molecular orbital theory – Coulomb, Resonance and Overlap integrals and Heitler-London treatment.

Electronic structure of conjugated systems: Hückel method applied to ethylene – allyl system – butadiene and benzene.

Unit –IV Fundamentals of Group Theory (18 hours)

Principles of Group Theory – Symmetry elements – Symmetry operations – Properties of groups – abelian, non-abelian and cyclic groups – Group multiplication tables – classes – subgroups –similarity transformation and conjugate.

Product of symmetry operations – Symmetry point groups – Systematic point group classifications – Optical activity and symmetry.

Matrix representation of symmetry operations – reducible and irreducible representations – the Great Orthogonality theorem - construction of character tables (C_{2v} and C_{3v}).

Unit –V Applications of Group Theory (18 hours)

Standard reduction formula relating reducible and irreducible representations – hybridization schemes for atoms in molecules of different geometry (Linear, Trigonal planar, Tetrahedral, Square planar, trigonal bipyramidal, square pyramidal, octahedral).

Vibrational modes as basis for group representation - Symmetries of vibrational modes in non– linear molecules – selection rules in spectroscopy – applications of group theory in predicting IR & Raman active vibration modes – mutual exclusion rule.

Applications of Group Theory in Electronic Spectra - ethylene and formaldehyde.

SALC principle (H_2O, NH_3)

Reference Books

1. R.P. Rastogi and V.K. Srivastava, “An Introduction to Quantum Mechanics of Chemical Systems”, Oxford & IBH Publishing Co., New Delhi, 1986.
2. Ira. N. Levine, “Quantum Chemistry”, Pearson India Education Services Pvt.Ltd, 7^{th} edition, 2016.
3. K.V. Raman, “Group theory and its applications in Chemistry”, 7^{th} Edition, Tata McGraw Hill, 1990.
4. F. Albert Cotton, “Chemical Applications of Group Theory, An Indian Adaptation”, Wiley Publisher, 2020.
5. R.K. Prasad, “Quantum Chemistry” New Age International Publisher (2020).
6. R.K. Prasad, “Quantum Chemistry through problems and Solutions”, New Age International Publishers, New Delhi, 1997.
7. A. K. Chandra, “Introductory Quantum Chemistry”, Tata McGraw-Hill, 4^{th}Edition, 2001.
8. P.W. Atkins and Julio de Paula, Atkins’ “Physical Chemistry”, VII ed. Oxford university Press, 2002.
9. Engel T. and Reid P., “Quantum Chemistry & Spectroscopy”, Pearson, 3^{rd}Edition, 2006.
10. Donald A. Mc. Quarrie, “Quantum Chemistry”, Viva Books Publications, Reprint, 2011.
11. V. Ramakrishnan, M.S. Gopinath,“Group Theory in Chemistry”, Vishal publication, 2010.
12. R. K. Roy, “Applications of Group Theory in Chemistry”, CBS Publishers & Distributors Private Limited, 2020.

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: derive and to apply the physical and mathematical aspects of quantum mechanics
CO2: apply and analysequantum mechanics models to chemical systems
CO3: apply and determine quantum mechanics in multi-electron atoms and ions
CO4: outline the basic of group theory and construct the character table

CO5: apply the concepts to predict hybridization and spectral behavior of compounds

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	2	2	2	2	3	-	2	-	-	-	20
	2	2	3	2	2	2	2	3	2	-	2	-	-	-	20
	3	2	2	3	2	2	3	2	2	-	2	-	-	-	20
	4	3	2	2	2	2	2	2	2	-	2	-	-	-	19
	5	2	3	2	2	2	2	2	2	-	2	-	-	-	19
Grand total of COs with PSOs &POs															98
Mean value of COs with PSOs & POs = 98/45															2.18

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.18
Observation	COs of Quantum Chemistry and Group Theory is strongly related with PSOs and POs		

CHEMICAL BONDING & SOLIDSTATE CHEMISTRY

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: I M.Sc. Chemistry	Part	: Core-2
Semester	: I	Hours	: 75
Code	: 22PCHC31	Credits: 4	

Course Educational Objectives

The course aims to make the students to

1. discuss and to apply the various approaches in covalent bonding
2. explain, discuss and evaluate the concepts of ionic bonding
3. classify, explain and evaluate the concepts of chemical forces and metallic bonding
4. define laws of crystallography, derive and apply the radius ratio and to illustrate the structures of solids and to characterize crystals using various diffraction methods
5. discuss the bonding and to explain and illustrate the structure of polymeric inorganic compounds

Unit – I Covalent Bonding (15 hours)

VB approach to bonding in covalent compounds – Concept of hybridisation and structure of molecules and ions – Limitations of VB theory – VSEPR theory – predicting the shapes and the bond angles of simple polyatomic molecules and ions – Limitations of VSEPR theory – MO approach to covalent bonding – symmetry and overlap of atomic orbitals – sigma, pi and delta bonding – concept of non-bonding orbitals – energy levels in homo and hetero nuclear diatomic systems – bond length, bond order, bond energy – ionic character in a covalent bond – Dipole moment – Determination and applications – Scales of electronegativity: Concept, derivation and applications – Pauling's, Mulliken's, Allred-Rochow's, Sanderson's and Allen's scales.

Unit – II Ionic Bonding (15 hours)

Properties of ionic compounds – Lattice energy – Madelung constants – Born-Lande equation – Kapustinskii equation – Born-Haber cycle and applications – factors affecting lattice energy – hydration enthalpy – solubility of ionic compounds – ionic size and crystal environment – Factors affecting the radii of ions – Covalent character in ionic compounds – Fajans' rules – Polarisation effects – conductivity in ionic solids – hardness of ionic solids in Mohs' scale.

Unit – III Weak Chemical Forces and Metallic Bonding (15 hours)

Weak Chemical Forces

Types of chemical forces – ion-dipole – dipole-dipole – ion-induced dipole – instantaneous dipole-induced dipole interactions – repulsive forces – effects of chemical forces – hydrogen bonding – types– impact and applications of hydrogen bonding.

Metallic Bonding

Structure of metals – cubic closest packing – polymorphism – conductivity in metals – Drude Lorentz theorem, Sommerfeld's theory – merits and demerits – band theory – band structure and band width – formation of Brillouin zones – conductors and insulators – semiconductors – intrinsic, extrinsic and photoexcited semiconductors – Hall effect – Corbino effect.

Unit – IV Solid State Structure (15 hours)

Laws of Crystallography – space groups – screw axis and glide plane – seven crystal systems and Bravais lattices – Bragg's equation – Miller and Weiss indices – calculation of radius of sphere, edge length, interplanar distance and density in cubic crystal systems – X-ray diffraction studies – powder and rotating crystal methods – close packing of atoms and ions – ccp and hcp types of packing – voids, radius ratio derivation and its influence on structures – structure of solid crystals – rock salt, CsCl, wurtzite, zinc blende, rutile, fluorite, antifluorite, spinel, inverse spinel and perovskite – Structure of graphite and diamond.

Defects in solid crystals – defects and stoichiometry –Point defects – intrinsic and extrinsic defects – Non-stoichiometic compounds and Solid solutions in ionic compounds – Phase transitions in solids – Effect of imperfections on physical properties.

Unit – V Polymeric Inorganic Compounds (15 hours)

Inorganic chains: Chain catenation, heterocatenation – Silicate minerals: classification, structure and applications of silicates, aluminosilicates, silicones and Zeolites.

Inorganic rings: $(SN)_x$, Borazines, Phosphazenes,

Inorganic cages: Phosphorous cage molecules, Boranes and carboranes, metallocarboranes – PSEP theory – Wade's rules – STYX numbers and structure.

Reference Books

1. J. E. Huheey, E. A. Keiter and R. L. Keiter, "Inorganic Chemistry: Principles of Structure and Reactivity", Pearson Education, 4th Edition, 2006.
2. James E. House, "Inorganic Chemistry", Academic Press, 2nd Edition, 2013.
3. John D. Lee, "Concise Inorganic Chemistry", Wiley Publications, 2008.
4. Catherine E. Housecroft and Alan G. Sharpe, "Inorganic Chemistry", Pearson Education, 5th Edition, 2018.
5. Anthony R. West, "Solid State Chemistry and its Applications", Wiley India, 2007.
6. Mark Weller, Jonathan Rourke, Tina Overton and Fraser Armstrong, "Inorganic Chemistry', Oxford, 7th Edition, 2018.
7. Russell S. Drago, "Physical Methods in Inorganic Chemistry", East West Press, (2012).
8. Gary L. Miessler, Paul J. Fischer and Donald A.Tarr, "Inorganic Chemistry", Pearson Education, 5th Edition, 2013.
9. Keith F. Purcell and John C. Kotz, "Inorganic Chemistry", Cengage Learning, 1st Edition, 2010.
10. Mark Weller, Jonathan Rourke, Tina Overton and Fraser Armstrong, "Inorganic Chemistry", Oxford, 7th Edition, 2018.

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: discuss and apply the various approaches in covalent bonding (K2, K3)

CO2: explain, discuss and evaluate the concepts of ionic bonding (K3, K4)

CO3: classify, explain and evaluate the concepts of Chemical Forces and Metallic Bonding (K2, K3, K4)

CO4: define laws of crystallography, derive and apply the radius ratio and to illustrate the structures of solids and to characterize crystals using various diffraction methods (K2, K3, K4, K5)

CO5: discuss the bonding and to explain and illustrate the structure of polymeric inorganic compounds (K3, K4)

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	3	2	3	2	2	2	3	-	2	-	-	-	21
	2	2	3	2	2	3	2	2	2	-	2	-	-	-	20
	3	2	2	3	2	2	3	2	2	-	2	-	-	-	20
	4	3	2	2	3	2	2	2	3	-	2	-	-	-	21
	5	2	3	2	2	3	2	2	2	-	2	-	-	-	20
Grand total of COs with PSOs & POs															102
Mean value of COs with PSOs & POs = 102/45															2.27

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.27
Observation	COs of Chemical Bonding &Solid State Chemistry is strongly related with PSOs and POs		

CHEMISTRY OF MATERIALS

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: I M.Sc. Chemistry	Part	: Elective-1
Semester	: I	Hours	: 90
Code	: 22PCHE11A	Credits: 4	

Course Educational Objectives (CEOs)

The course aims to make the students to

1. discuss and identify the various types and synthetic methods of materials
2. discuss and illustrate the modern characterization of materials
3. compare and illustrate the semiconductors and superconductors under technological importance and applications
4. comprehend and apply the uses of the nanoparticles in biosensors, drug delivery, gene therapy, antimicrobial activity and wound healing
5. apply the uses of nanomaterials in environment

Unit – I Introduction to Materials (18 hours)

Inorganic materials – Organic materials – Nanotechnology – Composites – Refractories and Nanomaterials – Synthetic strategies – Gas phase evaporation –Physical vapour deposition (PVD) and Chemical vapour deposition (CVD) – Solution phase evaporation methods – Sol-gel – Microemulsion–Hydrothermal – Properties – Optical –Electrical, mechanical and magnetic Properties.

Unit –II Metallic compounds, Semiconductors and Superconductors (18 hours)

One-, two- and three-dimensional compounds: Preparation and examples – $(SN)_x$, Graphite intercalation compounds – Li^+ Intercalated with TiS_2.

Semiconductors: Inorganic and semiconductors – band gap, defects – Control valence semiconductors – Photovoltaic cell- Photo galvanic – Photo electrolytic cell–Photo catalytic water splitting using TiO_2.

Superconductors: BCS theory – Meissner effect – Cooper pair – Critical temperature and critical magnetic field – Type I and Type II superconductors – superconducting state – heat capacity – coherence length – elastic constants – Applications.

Unit –III Characterization of Nanomaterials (18 hours)

Routine characterization tools of nanomaterials and nanocomposites: Principle, instrumentation and applications – UV-Visible and UV-DRS spectroscopy– Fluorescence spectroscopy– FT-NMR – FT-IR – Particle size analyzer–Powder X-ray diffraction (*p*XRD) – High resonance scanning electron microscopy (HR-SEM) – High resonance transmission electron microscopy (HR-TEM) – X-ray photoelectron spectroscopy (XPS) - Atomic force microscopy (AFM).

Unit – IV Nanomaterials in Medicine (18 hours)

Diagnosis – Fluorescent nano particles for Biosensors and Bio-labelling – Carbon nanotubes– Graphene –Fullerenes– Quantum Dots. Magnetic nanoparticles – Devices based on Nanotechnology for diagnosis – Nano materials as Therapeutic Agents – Drug delivery. Gene therapy– Antimicrobial activity and Wound healing – Artificial Implants.

Unit – V Catalytic applications of Nanomaterials (18 hours)

Green Nanotechnology–Nano materials for Pollution Abatement – Environmental monitoring and purification through nano particles– Nano-structured metals for reductive degradation of Hazardous organics and heavy metal remediation– Nanomaterials for

Photocatalytic decontamination –Environmental Nano sensors – Sensing based on Surface Plasmon Resonance (SPR) –Sensing based on Forster Resonance Energy Transfer effect (FRET)–Applications of nanomaterials in acid catalysis, base catalysis, photocatalysis and biocatalysis.

Reference Books

1. A. Marikani, "Materials Science", PHI Learning private limited (2017).
2. Bradley D. Fahman, "Materials Chemistry", 3rd Edition, Springer (2018).
3. C. N. R. Rao, A. Muller, A. K. Cheetam, "The Chemistry of Nanomaterials", Vol. 1,2 Wiley-VCH, Weinheim (2004).
4. Charles P. Poole Jr. Frank J. Owens, "Introduction to Nanotechnology", John Wiley & Sons, Inc. (2003).
5. C. P. Poole Jr., F. J. Owens, "Introduction to Nanotechnology", Wiley Interscience (2003).
6. J.C. Anderson, K.D. Leaver, J.M. Alexander, R.D. Madan, Rawlings, "Materials Science", ELBS (1990).
7. William D. Callister, Jr. and David G.Rethwisch, "Materials Science and Engineering - An Introduction", 9th Edition, Wiley (2013).
8. Nan Yao, Zong Lin Wang, "Handbook of Microscopy for Nanotechnology", Kluwer academic publishers, London (2005).
9. Kenneth J. Klabunde, "Nanoscale Materials in Chemistry", Wiley- Interscience (2001).
10. T. Pradeep, "Nano: The Essentials in Understanding Nanoscience and Nanotechnology", Tata McGraw Hill (2007).
11. Viswanathan, "Nano Materials", Narosa Publishing House (2009).

Course Outcomes (COs)

On completion of the course, students will be able to

CO1:describe the various synthetic methodology of nanomaterials and design the synthesis.

CO2: interpret the various spectra of nanomaterials

CO3: explain the properties and applications of superconductors and semiconductors

CO4: illustrate the importance of nanomaterials in medicine

CO5: apply and use the nanomaterials in various catalytic applications

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	2	2	2	2	3	2	-	-	-	2	22
	2	2	3	2	3	2	2	3	2	2	-	-	-	3	24
	3	2	2	2	2	2	2	2	3	2	-	-	-	2	21
	4	2	3	2	2	2	3	2	2	2	-	-	-	2	22
	5	2	2	2	2	3	2	2	2	3	-	-	-	2	22
Grand total of COs with PSOs &POs															111
Mean value of COs with PSOs & POs = 102/45															2.22

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.22
Observation	COs of Chemistry of Materials is strongly related with PSOs and POs		

INDUSTRIAL WASTE MANAGEMENT

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: I M.Sc. Chemistry	Part	: Elective - 1
Semester	: I	Hours	: 90
Code	: 22PCHE11B	Credits: 4	

Course Educational Objectives (CEOs)

The course aims to make the students to

1. describe and explain the various techniques to control air pollution
2. illustrate the various effluent treatment methods used in industry
3. discuss the various methods of solid waste management
4. examine and analyse the toxic effects of various pollutants and investigate their impact on various tragedy
5. outline the various national and global efforts to save the environment

Unit – I Air Pollution Control (18 hours)

Air Quality Standards (for varied industries)– Industrial safety– Classification of Air Pollutants– Sources of Air Pollution– Ozone Depletion– Green House Effect – Causes and Consequences.

Pollution Control of Particulates – Gravity Settling Chamber, Cyclone Collector, Filters, Wet and dry Scrubbers, Electrostatic Filters, Electrostatic Precipitator.

Control of CO– Oxides of Nitrogen– Oxides of Sulphur– Hydrocarbons– Photochemical Pollutants, Green House Gases.

Unit – II Waste Water Treatment and Disposal of Industrial Effluents (18 hours)

Water Quality Standards– Sources of Water Pollution– Characterization of Waste Water by Physical and Chemical methods.

Primary Treatment: Sedimentation– Grid Removal – Coagulation – Neutralization– Equalization.

Secondary Treatment: Aerobic Treatment–Oxidation Ponds– Oxidation Ditches–Trickling Filters– Activated Sludge Process– Aerated Lagoons– Anaerobic Treatment.

Tertiary Treatment: Filters – activated carbon filters – Ultrafiltration – Reverse Osmosis– Electrodialysis– Desalination – ejected water management – zero emission technology (ZET) – Mixed Bed Bio Reactor (MBBR) – Membrane Bio Reactor (MBR).

Industrial Effluents: Characteristics and Treatment Options for Effluents from various Industries–Textiles and Dyes– Paper and Pulp– Leather– Food and Dairy– Fertilizers– Electroplating Industries– Distilleries – Sewage Treatment and Water Conservation– Recycling of Waste Water and Rain Water Harvesting.

Unit – III Solid Waste Management (18 hours)

Solid Wastes– Types– Characteristics– Solid Waste Disposal – Sanitary Landfills–Vermi Composting– Incineration – Waste Minimization and Recycling.

Unit – IV Environmental Toxicology (18 hours)

Toxicity– Threshold Limiting Value of Pollutants–LD50 – Toxic Effects of Pb, As, Cd, Hg, PCBs, Pesticides, Heavy Metals and Nanoparticles – Case Studies: Bhopal Gas Tragedy– Chernobyl Accident– Love Canal Episode–Minamata Disease–Itai-Itai Disease.

Unit – V Environmental Management Plan (18 hours)

Sustainable Development: Definition– Sustainability Cycle– Biodiversity– Problems of Urbanization and Steps towards Sustainable Development –Environmental Impact Assessment: Concept– Environmental Risk Assessment– Legal and Regulatory Aspects in

India– Environmental (Protection) Act 1986– Air (Prevention and Control of Pollution) Act 1981–Water (Prevention and Control of Pollution) Act 1981–ISO 14000– Tsunami Disaster – Industrial Safety and Health: EPA, OSHA – Regulations– Polluter Pays Principle - Global and National Efforts: Steps taken towards Green Future at the National and Global Level - Coastal Management (National Standards).

Reference Books

1. B. K. Sharma, H. Kaur, "Environmental Chemistry", 8th Edition, Goel Publishers (2014)
2. G. Gaur "Soil and Solid Waste Pollution and its Management", Sarup and Sons (2000)
3. A. K. De, "Environmental chemistry", 8th Edition, New age international Private Ltd. New Delhi (2017).
4. S. S. Dara, "A Text Book of Environment Chemistry and Pollution Control", S.Chand (2004).
5. Leelakrishnan, "Environmental laws in India", Butterworths (2002).
6. I. Mohan, "Environmental Pollution and Management", Ashish (1990).
7. NIIR Board, Modern Technology of Waste Management – Pollution Control, Recycling, Treatment and Utilization, Asia Pacific Business (2003).
8. Paul L. Bishop, "Pollution Prevention – Fundamentals and Practices", McGraw Hill (2000).
9. R. K. Trivedy, N. S. Raman, "Industrial Pollution and Environmental Management" Scientific Publishers (2003).

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: describe and explain the various techniques to control air pollution
CO2: illustrate the various effluent treatment methods used in industry
CO3: discuss the various methods of solid waste management
CO4: examine and analyse the toxic effects of various pollutants and investigate their impact on various tragedy
CO5: outline the various national and global efforts to save the environment

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs With PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	2	2	3	2	2	2	3	2	-	-	-	2	22
	2	3	2	2	3	2	2	3	2	2	-	-	-	3	24
	3	2	3	2	2	3	2	2	3	2	-	-	-	2	23
	4	2	2	2	2	2	3	2	2	2	-	-	-	2	21
	5	3	2	2	2	3	2	2	2	3	-	-	-	2	23
Grand total of COs with PSOs &POs															113
Mean value of COs with PSOs & POs = 113/50															2.26

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.26
Observation	COs of Industrial Waste Management is strongly related to POs and PSOs		

ORGANIC CHEMISTRY PRACTICAL-I

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: I M.Sc. Chemistry	Part	: Practical
Semester	: I	Hours	: 60
Code	: 22PCHP11	Credits	: 3

Course Educational Objectives (CEOs)

The course aims to make the students to

1. separate and analyze systematically a given organic compound, identify the functional group present in it, and prepare a suitable derivative of the functional group
2. apply separation techniques to isolate caffeine from tea and casein from milk

Organic Analysis

Qualitative Analysis of Organic Mixture: Two compound systems.

Solvent separation based on solubility in acid, base or neutral media – Pilot separation & Bulk separation– Elemental Analysis –Nature – Tests for saturation/ unsaturation – Aliphatic/Aromatic character – Functional group identification – Preparation of derivatives – Determination of melting points.

Separation of Organic Compounds

1. Isolation of caffeine from tea leaves
2. Isolation of casein from milk

Chromatographic Techniques (Demo only)

1. Thin layer chromatography
2. Column chromatography

Reference Books

1. Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R. Tatchell, “Vogel's Textbook of Practical Organic Chemistry”, 5th Edition, Pearson Education (2003).
2. N.S. Gnanapragasam and G. Ramamurthy, “Organic Lab Manual”, S. Viswanathan Pvt. Ltd. (2009).

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: demonstrate the separation the organic compounds into individual components

CO2: explain the procedure for the systematic analysis of different functional groups by various methods.

CO3: To analyze the chemical nature of various functional groups and synthesize the respective derivatives

CO4: apply separation techniques to isolate organic compounds from natural sources using simple extraction methods

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	3	2	3	2	2	3	3	3	2	-	-	-	26
	2	3	3	3	3	2	3	3	3	2	2	-	-	-	27
	3	2	3	3	3	2	2	3	2	2	2	-	-	-	24
	4	2	2	2	2	2	2	2	2	2	2	-	-	-	20
Grand total of COs with PSOs & POs															97
Mean value of COs with PSOs & POs = 97/40															2.43

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.43
Observation	COs of Organic Chemistry Practical-I is strongly related to POs and PSOs		

EVALUATION

Continuous Internal Assessment (50 Marks)

S. No	**Components**	**Marks**
1.	Regular practical observation	10
2.	Results of the regular practical	15
3	Viva	5
4.	Internal Test	20
	TOTAL	**50**

End-Semester Examination (50 Marks)

S.No.	**Components**	**Marks**
1.	Record Notebook	5
2.	Procedure	10
3.	Organic Analysis– Each component of report – 5 marks	25
4.	Derivative Preparation	5
5.	Viva	5
	TOTAL	50

INORGANIC CHEMISTRY PRACTICAL-I

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: I M.Sc. Chemistry	Part	: Practical
Semester	: I	Hours	: 60
Code	: 22PCHP21	Credits	: 3

Course Educational Objectives (CEOs)

The course aims to make the students to

1. state the principle of quantitative analysis
2. develop skills to prepare standard solutions and analyze with accuracy and precision
3. apply volumetric techniques and gravimetric techniques to estimate the given solution

1. Quantitative Analysis

Titrimetry and Gravimetry

1. Volumetric Estimation of Cu(II) ions and Gravimetric Estimation of Ni (II) ions in a mixture
2. Volumetric Estimation of Fe(III) ions and Gravimetric Estimation of Cu(II) ions in a mixture

Complexometric Titration using EDTA

1. Estimation of Zn(II) ions
2. Estimation of Mg(II) ions
3. Determination of manganese in the presence of iron
4. Determination of nickel in the presence of iron

2. Inorganic Preparations

1. Tris(thiourea)copper(I) chloride
2. Tetraamminecopper(II) sulphate
3. Potassium tris(oxalato)chromate(III)
4. Potassium tetrachlorocuprate(II)
5. Hexaamminenickel(II) tetrafluoroborate

Reference Books

1. J. Mendham, R.C. Denney, J. D. Barnes and M. J. K. Thomas, "Vogel's textbook of quantitative analysis", Pearson Education, 3rd Edition (2007).
2. A. I. Vogel, "Quantitative Inorganic Analysis", 7th Edition, Pearson Education, (2002)
3. J. D. Woollins, "*Inorganic Experiments*" VCH, Weinheim, (1994).

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: recall the principle of volumetric and gravimetric estimation

CO2: develop skills to estimate the components with high accuracy and precision

CO3: apply the learned synthetic skills to formulate new synthesis and estimation of inorganic compounds

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	2	2	2	3	3	2	3	2	-	-	-	-	21
	2	2	3	2	2	2	2	3	2	2	-	-	-	-	20
	3	2	2	3	2	2	3	2	3	2	-	-	-	-	21
Grand total of COs with PSOs &POs															62
Mean value of COs with PSOs & POs = 62/27															2.30

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.30
Observation	COs of Inorganic Chemistry Practical-I is strongly related to POs and PSOs		

EVALUATION

Continuous Internal Assessment (50 Marks)

S. No.	**Components**	**Marks**
1.	Regular practical observation	10
2.	Results of the regular practical	15
3	Viva	5
4.	Internal Test	20
	TOTAL	**50**

End-Semester Examination (50 Marks)

S.No.	**Components**	**Marks**
1.	Record Notebook	5
2.	Procedure	5
3.	Estimation – Final Result within the prescribed error limit	25
5	Preparation	10
5.	Viva	5
	TOTAL	**50**

CONFORMATIONAL ANALYSIS, REAGENTS AND ORGANIC SYNTHESIS

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: I M.Sc. Chemistry	Part	: Core
Semester	: II	Hours	: 75
Code	: 22PCHC42	Credits	: 4

Course Educational Objectives (CEOs)

The course aims to make the students to

1. discuss the various conformations of acyclic and cyclic molecules and to illustrate the conformations of rigid systems
2. explain and justify the reactivity based on dynamic stereochemistry of various reactions
3. apply the uses of reagents in synthesis of organic compounds
4. classify the rearrangements based on its mechanism and explain the formation of the products
5. design the synthesis of organic compounds based on the concept of retrosynthetic analysis

Unit – IConformational analysis (15 hours)

Conformational isomerism: Conformations of acyclic compounds – Ethane and n-Butane. Conformations of cyclic molecules – cyclopropane, cyclobutane and cyclopentane. Conformations of cyclohexane – chair conformation, boat conformation, interconversion of chair conformations – Conformations of substituted cyclohexanes – mono and disubstituted cyclohexanes – Conformationof decalins, perhydrophenanthrene and perhydroanthracene.

Unit – II Dynamic Stereochemistry (15 hours)

Conformation and reactivity in–Weinstein Eliel equation – Curtin-Hammett principle – Steric assisted and steric hindered reactions – stereoelectronic effects – cis elimination – Cyclohexyl systems – esterification– oxidation – Substitution reaction - E2 elimination – intramolecular rearrangements – neighbouring group participation – formation and cleavage of epoxide – Reactionsof enols and enolates.

Unit – III Reagents in Organic Synthesis (15 hours)

Reagents in organic synthesis and functional group transformations: Complex Metal Hydrides –Organocuparates – Gilmanreagents –Wilkinsons Catalyst – Lithium diisopropylamide (LDA) –dicyclohexyl carbodiimide (DCC) – Trimethylsilyl halides – Tri-N-Butyltin Hydride (Bu_3SnH) – Osmium tetroxide – 2,3-Dichloro-5,6-Dicyano-1,4-Benzoquinone (DDQ) – Baker's Yeast – Woodward and Prevost Hydroxylation – Peterson Synthesis.

Unit – IV Molecular Rearrangements (15 hours)

Rearrangements – General Mechanism – Natureof migration – migratory aptitude.

Nucleophilic Rearrangements to Electron Deficient Carbon – Wagner-Meerwein, Favorski, Benzilic Acid, Fries, rearrangements – Nucleophilic Rearrangements to Electron Deficient Nitrogen - Hoffmann, Curtius, Beckmann, Lössen and Neber rearrangements – Electrophilic Rearrangements - Stevens and Sommelet-Hauser rearrangements.

Unit – V Retrosynthetic Approach in Organic Synthesis (15 hours)

Terminology – Strategies of retrosynthetic analysis - Importance of synthesis – carbon-carbon bond making reactions – functional group modifications – reterosynthetic analysis – synthons and synthetic equivalents – nucleophilic, electrophilic, electroneutral and free radical synthons – umpolung – protection and deprotection –trimethylsilyl ether,

Ethoxyethylactal, tert-butoxycarbamate and 1,3—dithiolane. Diels Alder reactions – C-X, C-C disconnections. Robinson annulation method – 1,2 and 1,3 disconnections.

Reference Books

1. P.S. Kalsi, "Organic Reactions Stereochemistry and Mechanism", New Age International Publishers (2020).
2. P.S. Kalsi, "Stereochemistry: Conformation and Mechanism", New Age International Publisher (2019).
3. D. Nasipuri, "Stereochemistry of Organic compounds", 3rd Edition, New Age International, New Delhi (2020).
4. Ernest Ludwig Eliel, Samuel H. Wilen,"Stereochemistry of Organic Compounds", John Wiley & Sons (2008).
5. Peter Sykes, "A Guidebook to Mechanism in Organic Chemistry" 6th Edition, Pearson Publisher (2003).
6. GR Chatwal, "Reaction Mechanism and Reagents in Organic Chemistry", Himalaya Publishing House (2018).
7. Stuart Warren and Paul Wyatt, "Organic Synthesis: The Disconnection Approach", Wiley Publisher (2008).
8. Ernest L. Eliel, Samuel H. Wilen, "Stereochemistry of Organic Compounds" Student Edition, Wiley Publisher (2008).
9. V.K. Ahluwalia & Rakesh K. Parashar, "Organic Reaction Mechanisms", Narosa Publishing House (2010).
10. Jonathan Clayden, Nick Greeves, Stuart Warren, "Organic Chemistry: Second Edition" Oxford Publisher (2014).

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: discuss the various conformations of acyclic and cyclic molecules and to illustrate the conformations of rigid systems

CO2: explain and justify the reactivity based on dynamic stereochemistry of various reactions

CO3: apply the uses of reagents in synthesis of organic compounds

CO4: classify the rearrangements based on its mechanism and explain the formation of the products

CO5: design the organic synthesis based on the concept of retrosynthetic analysis

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	3	1	2	2	2	2	3	-	1	-	-	-	19
	2	3	3	2	2	2	2	2	2	-	-	-	-	-	18
	3	3	3	2	2	3	2	2	3	-	2	-	-	-	22
	4	3	2	3	2	2	3	2	2	-	-	-	-	-	19
	5	3	3	2	2	3	2	3	2	-	2	-	-	-	22
Grand total of COs with PSOs &POs															100
Mean value of COs with PSOs & POs = 100/43															2.33

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.33
Observation	COs of Conformational Analysis, Reagents and Organic Synthesis is strongly related to POs and PSOs		

COORDINATION, ORGANOMETALLICS AND BIO-INORGANIC CHEMISTRY

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: I M.Sc. Chemistry	Part	: Core
Semester	: II	Hours	: 75
Code	: 22PCHC52	Credits: 4	

Course Educational Objectives (CEOs)

The course aims to make the students to

1. discuss and apply the concepts and theories of coordination compounds
2. explain and apply the inorganic reaction mechanism in coordination compounds
3. discuss the properties, preparation and structure of pi-acceptor complexes and analyse correlation diagrams
4. discuss the structure and functions of metalloporphyrins, metalloenzymes and metalloproteins
5. discuss the nature of bonding and to apply 18 electron rule in organometallics

Unit – ITheories of Coordination Compounds (15 hours)

Valence Bond theory – prediction of hybridization, geometry, and magnetic moment – Limitations – Crystal Field Theory – Splitting of d orbitals under different geometries – octahedral, tetrahedral and square planar – spectrochemical series –High-spin & Low-spin complexes – CFSE – evidence for CFSE – structure of spinels& inverse-spinels – factors affecting CFSE – Colour of complexes – d-d transition, charge transfer (LMCT & MLCT) – Jahn-Teller distortion – Limitations of CFT – M.O. theory of bonding – sigma and p-bonding in coordination compounds.

Unit – II Chemistry of Coordination Compounds (15 hours)

Pi acceptor complexes: Structure and bonding of metal carbonyls – synthesis, properties, structure and bonding of mono-nuclear and poly-nuclear carbonyls – nitrosyl complexes – dinitrogen complexes – metal carbonylato complexes, carbonyl hydrides and complex metal cyanides.

Electronic Spectra: Microstates – Term symbols – splitting of orbitals and terms in crystal fields – correlation diagrams – Orgel and Tanabe-Sugano diagrams to d^1 to d^9 complexes, their merits and demerits – effect of Jahn-Teller distortion and spin-orbit coupling on electronic spectra – calculation of 10 Dq and B for octahedral complexes - Spectral properties of lanthanide complexes – Charge Transfer spectra of complexes.

Unit – III Chemistry of Coordination Compounds (15 hours)

Electron transfer reactions: Outer-sphere and inner sphere electron transfer reactions – Marcus theory – complementary and non-complementary reactions.

Substitution reactions: substitution reactions of square planar complexes of Pt(II) and other d^8 metal complexes – trans-directing series – application of trans-effect in preparation of cis & trans complexes – substitution reactions of octahedral complexes – acid and base hydrolysis reactions – anation reactions.

Unit – IV Organometallic Chemistry (15 hours)

18& 16 electron rules: calculation, applications and limitations – olefin and acetylene complexes – Zeise's salt – Dewar-Chatt approach to bonding in ethylene and acetylene complexes – cyclopentadiene, benzene and cyclobutadiene complexes of transition metals – their preparations, bonding and reactions. Homogeneous catalysis involving organometallics – oxidative addition and reductive elimination reactions – hydrogenation, isomerization and

hydroformylation of olefins –carbonylation of methanol, oxidation of olefins (Wacker's process) – heterogeneous catalysis –Ziegler-Natta polymerization of propylene.

Unit – V Bioinorganic Chemistry (15 hours)

Metalloporphyrins – chlorophyll, hemoglobin and myoglobin – structure and function of haemoglobin & cytochromes – Metalloenzymesenzyme action inhibition and restoration – carboxypeptidase-A, carbonic anhydraseand superoxide dismutase – Vitamin B_{12} and B_{12} coenzymes

Metalloproteins – non-heme iron proteins – rubredoxin and ferrodoxin – Blue copper proteins and their classification – nitrogenases, their structure and function. Metal ions in biology – Na^+/K^+ ion pump – metal poisons and chelating agents in medicine.

Reference Books

1. J. E. Huheey, E. A. Keiter and R. L. Keiter, "Inorganic Chemistry: Principles of Structure and Reactivity", Pearson Education, 4th Edition (2006).
2. Gary L. Miessler, Paul J. Fischer and Donald A.Tarr, "Inorganic Chemistry", Pearson Education, 5th Edition (2013).
3. Catherine E. Housecroft and Alan G. Sharpe, "Inorganic Chemistry", Pearson Education, 5th Edition (2018).
4. Mark Weller, Jonathan Rourke, Tina Overton and Fraser Armstrong, "Inorganic Chemistry', Oxford, 7th Edition (2018).
5. James E. House, "Inorganic Chemistry", Academic Press, 2nd Edition (2013).
6. F.A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann "Advanced Inorganic Chemistry", 6th Edition.Wiley Publishers (2007).
7. B. D. Gupta and A. J. Elias, "Basic Organometallic Chemistry: Concepts, Syntheses and Applications", University Press, 2nd Edition (2013).
8. Bodie Douglas, Darl McDaniel and John Alexander, "Concepts and Models of Inorganic Chemistry", 3rd Edition (2006).
9. R. C. Mehrotra and A. Singh, "Organometallic Chemistry: A Unified Approach", New Age International Publishers, 2nd Revised Edition (2020).
10. K. Hussain Reddy, "Bioinorganic Chemistry", New Age International Publishers, 2nd Revised Edition (2020).
11. Asim K. Das, "Bioinorganic Chemistry, Books and Allied Publishers (2007).
12. Ajai Kumar, "Organometallic & Bioinorganic Chemistry", AaryushEducation, 4th Edition (2021).

Course Outcomes (CO)

On completion of the course, students will be able to

CO1: discuss and apply the concepts and theories of coordination compounds

CO2: explain and apply the inorganic reaction mechanism in coordination compounds

CO3: discuss the properties, preparation and structure of pi-acceptor complexes and analyse correlation diagrams

CO4: discuss the structure and functions of metalloporphyrins, metalloenzymes and metalloproteins

CO5: discuss the nature of bonding and to apply 18 electron rule in organometallics

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	3	3	2	3	3	2	-	2	-	-	-	23
	2	2	2	2	2	2	3	2	3	-	2	-	-	-	20
	3	2	2	3	2	2	2	3	3	-	2	-	-	-	21
	4	3	2	2	2	2	3	2	3	-	2	-	-	-	21
	5	2	2	2	3	2	2	3	2	-	2	-	-	-	20
Grand total of COs with PSOs &POs															105
Mean value of COs with PSOs & POs = 105/45															2.33

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.33
Observation	COs of Coordination, Organometallics and Bio-inorganic Chemistry is strongly related to POs and PSOs		

PRINCIPLES OF MOLECULAR SPECTROSCOPY

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: I M.Sc. Chemistry	Part	: Core -3
Semester	: II	Hours	: 90
Code	: 22PCHC62	Credits: 5	

Course Educational Objectives (CEOs)

The course aims to make the students to

1. understand the fundamentals of microwave and infrared spectroscopy
2. explain the concepts of Raman and electronic spectroscopy
3. illustrate the basic principles of proton NMR spectroscopy
4. examine the applications of 2D NMR and ^{13}C NMR spectroscopy
5. describe the principles and applications of ESR spectroscopy

Unit – IMicrowave and Infrared Spectroscopy (18 hours)

Introduction to spectroscopy: Electromagnetic radiation – quantization of energy –General features of spectroscopy – signal to noise ratio – line broadening – factors affecting intensity of spectral lines.

*Microwave Spectroscopy***:** Rotation of molecules – diatomic molecules as rigid rotator – intensity of rotational lines – Selection rules – Effect of isotopic substitution – rotational spectrum of rigid and non-rigid rotator – linear and symmetric top molecules – Stark effect – Applications – determination of bond length, bond angle dipole moment and atomic mass from microwave spectra.

Infrared Spectroscopy: Vibrating diatomic molecule – harmonic, Anharmonic oscillators – Selection rules – diatomic vibrating rotator – Selection rules - P, Q, R branches – molecular vibrations – vibrations of polyatomic molecules – Types of molecular vibrations – Rotational vibrational spectra of (i) linear and (ii) symmetric top molecules. FT-IR spectroscopy – Instrumentation – Sample preparation.

Unit – II Raman, Electronic and Emission Spectroscopy (18 hours)

Raman spectroscopy: Classical and quantum theory of Raman effect –Stokes', anti-Stokes' and Rayleigh lines – Selection rules – Rotational Raman spectra**–** linear, symmetric top molecules – Vibrational Raman spectra – Raman activity of vibrations – Rule of mutual exclusion – Basics of Raman and Laser Raman spectroscopy.

Electronic Spectra of diatomic molecules: The Born-Oppenheimer approximation – Franck-Condon principle – Selection rules – dissociation energy, predissociation rotational fine structure of electronic vibrational transitions – Fortrat diagram – vibronic coupling.

Emission spectroscopy: fate of an electronically excited molecule – Fluorescence and phosphorescence –– Fluorescence spectroscopy – FRET – Techniques and instrumentation.

Unit – III Nuclear Magnetic Resonance Spectroscopy-I (18 Hours)

Nuclear spin states and NMR active nuclei – nuclear magnetic moments – mechanism of resonance absorption – population of nuclear spin states – proton NMR – interaction of spin magnetic moment of a proton with external magnetic moment – chemical shift and shielding. Nuclear spins in a magnetic field - Zeeman effect – Larmor precession – resonance phenomenon – spin-lattice and spin-spin relaxation times - Free Induction Decay (FID) and basic principle of FT-NMR – NMR Instrumentation – Reference – TMS – NMR spectrum – Nuclear shielding – Diamagnetic Anisotropy –electronegativity and hybridization effects –

acidic exchangeable protons – deuterium exchange and peak broadening – chemical shift – Analysis of simple NMR spectra – spin-spin coupling and coupling constant.

Unit –IV Nuclear Magnetic Resonance Spectroscopy-II (18 Hours)

Analysis of complex NMR spectra – chemical equivalence – chemical environment, spin-spin splitting – geminal, vicinal, long-range, trans, aromatic, allylic coupling – factors influencing coupling constant – splitting of NMR signals – AB, AX and AMX types – Overhauser effect – NMR of paramagnetic compounds – relaxation by paramagnetic ions in solution.

^{13}C NMR: ^{13}C nucleus – Chemical shifts – correlation charts – proton coupled and decoupled ^{13}C spectra - Nuclear Overhauser effect – Off resonance decoupling – DEPT experiments

2D NMR: Pulse sequences – COSY, HETCOR and NOESY – NMR Imaging – MRI-NMR in solids.

UNIT–V: Electron Spin/Paramagnetic Resonance Spectroscopy (18 Hours)

Electron spin – Electronic Zeeman effect – Instrumentation of EPR – Reference in EPR spectrum – EPR spectrum of hydrogen atom (first order treatment) – g factors – Hyperfine splitting: nuclear spin (I = 1/2, 1, 3/2, 5/2) interaction with electron spin – hyperfine coupling constants – EPR spectra of organic radicals (AA and AB type) – EPR spectra of heteronuclear compounds – McConnell's relation –Introduction to multi electron systems: zero field splitting – Kramer's degeneracy – S = 1/2 , 3/2, 5/2 in the transition metal complexes - EPR spectra of $[Cu(en)_3]^{2+}$and bis(salicylaldimine)copper(II) – anisotropy in the hyperfine coupling constant – EPR spectra of triplet naphthalene and high spin Mn(II) complexes.

Reference Books

1. Colin N. Banwell and Elaine M. McCash, "Fundamentals of Molecular Spectroscopy", 4thEdition, McGraw Hill India(2016).
2. Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. Vyvyan, "Introduction to Spectroscopy", 5thEdition, Cengage Learning India (2015).
3. R. M. Silverstein and F. X. Webster, Spectroscopic Identification of Organic Compounds, 8th Edition, John Wiley & Sons, New York (2014).
4. R. S. Drago, "Physical Methods in Inorganic Chemistry", Affiliated East-West Press (2012).
5. J. D. Roberts, "High Resolution Nuclear Magnetic Resonance", Elsevier (1999).
6. G. N. Barrow, "Introduction to Molecular Spectroscopy", International McGraw Hill Edition (1993).
7. K.S. Mukherjee and B. Mukhopadhayay, "Organic Spectroscopy through solved problems", 1st Edition, NCBA, India (2013).
8. B. P. Straughan and S. Walker, "Spectroscopy", Volume I to III, Chapman Hall, London (1976).
9. Engel T. and Reid P., Pearson, "Quantum Chemistry and Spectroscopy", 3rd Edition, (2006).
10. D.N. Sathyanarayana, "Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NQR",2nd Edition, I.K. International Publishing House Pvt. Ltd., (2013).

Course Outcomes (CO)

On completion of the course, students will be able to

CO1: ascertain the spectral lines of molecules that are active in rotational and vibrational spectroscopy

CO2: understand the concepts of Raman, electronic and emission spectroscopy for different molecules

CO3: acquire the knowledge about thebasic principles and instrumentations of ^{1}H NMR

CO4: illustrate vector diagram and pulse sequence for various 2D NMR and ^{13}C NMR.

CO5: explain the principle involved in ESR and apply them to predict the ESR spectra of various molecules and complexes.

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	3	2	2	2	2	3	-	-	-	-	21
	2	2	3	2	2	3	2	3	2	2	-	-	-	-	21
	3	2	3	2	2	3	2	3	2	2	-	-	-	-	21
	4	3	2	3	3	2	3	2	2	2	-	-	-	-	22
	5	2	2	3	2	2	2	2	3	2	-	-	-	-	20
Grand total of COs with PSOs &POs															105
Mean value of COs with PSOs & POs = 105/45															2.33

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.33
Observation	COs of Principles of Molecular Spectroscopy is strongly related to POs and PSOs		

ENVIRONMENTAL CHEMISTRY

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: I M.Sc. Chemistry	Part	: NME
Semester	: II	Hours	: 60
Code	: 22PCHN12	Credits: 3	

Course Educational Objectives (CEOs)

The course aims to make the students to

1. understand environment-oriented chemistry and Natural cycles in the environment
2. demonstrate about atmosphere and air pollution
3. describe cause, consequence and methods of analysis of water pollution
4. discuss the composition of soil and soil pollution
5. discuss and analyse the impact of radioactive emission and radioactive pollution in environment

Unit – I Introduction to Environmental Chemistry (12 hours)

Concept and Scope of environmental Chemistry –Environmental terminology – Nomenclatures – Environmental segments – Atmosphere – Hydrosphere – Lithosphere – Biosphere – Anthrosphere – Natural cycles of the environment – Endogenic and exogenic cycles – Hydrological cycle – Carbon cycle – Oxygen cycle – Nitrogen cycle.

Unit – II Atmosphere and Air pollution (12 hours)

Chemical composition of the atmosphere – Air pollutants – Carbon monoxide – Nitrogen oxides – Sulphur oxides - Acid rain – Organic and Inorganic particulate matter –Smog – Photochemical smog and its effects – Effects of atmospheric pollution – CFCs and Ozone depletion – Green House effect – impact of global climate – Air quality standard –Control measures for air pollution – Air pollutant accidents – The Bhopal Disaster.

Unit – III Hydrosphere and water pollution (12 hours)

Water resources –Aquatic environment – Water pollutants – Organic, Inorganic, Pesticide, industrial, detergents, oil spills, Sediments, Radioactive and Thermal pollutants – Eutrophication – Dissolved oxygen – Biological oxidation demand (BOD) – Chemical oxidation demand (COD) –Hardness of water – Waterquality parameters and standards – TDS – TSS – Minerals– Metals – Organics.

Marine Chemistry – The chemical constituents of sea water - organic matter and suspended material – oceandumping - the estuarine and costal zone – oilpollution - Minamata disasters – Control measures for water pollution.

Unit – IV Agriculture and soil pollution (12 hours)

Composition of lithosphere –Inorganic and organic components in soil – the structure and composition of inner earth - the mantle.

Soil chemistry - the prospects of agriculture - Micronutrients and macronutrients in soil – Soil pollutants – sources and effects of industrial wastes – radioactive wastes – agricultural wastes – pesticides and other persistent pollutants - the deposition of coal and petroleum - Solid waste disposal – solid waste management – Soil pollution control measures.

Unit – V Radioactive Pollution (12 hours)

Nature of radioactive emission - units - Radiation from natural sources and Manmade activities - Effects of radiation on human health - Permissible radiation dose - Comparative risk analysis of fossil fuel based power generation versus nuclear power generation - Radioactive fallout - Nuclear winter: atmospheric turbidity and effects - Radioactive pollution in land, atmosphere and water - Nuclear waste disposal: Nature, general principles

and strategies – Control measures for Radioactive pollution – Causes and prevention of nuclear reactor accidents – Chernobyl – Three Mile Island – Sewazo.

Text and Reference Books

1. A. K. De, "Environmental chemistry", 8th Edition, New Age International Private Ltd. New Delhi (2017).
2. B. K. Sharma, "Environmental Chemistry" Goel Publishers (2001).
3. C. D. Tyagi and M. Mehra, "Textbook of Environmental Chemistry" Anmol Publishers (1996)
4. D. K. Asthana and Meera Asthana, "Environment - Problems and Solutions", S.Chand (2006)
5. Benny Joseph, "Environmental Studies", Tata McGraw Hill Publishing Company Ltd, New Delhi (2005)

Course Outcomes (CO)

On completion of the course, students will be able to

CO1: Understand environment-oriented chemistry and natural cycles in the environment.

CO2: demonstrate about atmosphere and air pollution

CO3: describe cause, consequence and methods of analysis of water pollution

CO4: discuss the composition of soil and soil pollution

CO5: discuss and analyse the impact of radioactive emission and radioactive pollution in environment

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	3	2	3	2	2	2	-	-	-	2	23
	2	2	3	2	2	3	2	2	2	2	-	-	-	2	20
	3	2	2	2	2	3	2	3	2	2	-	-	-	2	22
	4	2	2	3	2	2	2	2	3	2	-	-	-	2	22
	5	2	2	2	2	2	2	2	2	2	-	-	-	2	20
Grand total of COs with PSOs &POs															107
Mean value of COs with PSOs & POs = 107/50															2.14

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.14
Observation	COs of Environmental Chemistry is strongly related to POs and PSOs		

ORGANIC CHEMISTRY PRACTICAL-II

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: I M.Sc. Chemistry	Part	: Practical
Semester	: II	Hours	: 60
Code	: 22PCHP32	Credits: 3	

Course Educational Objectives (CEOs)

The course aims to make the students to

1. design/plan a two-step organic synthesis
2. estimate the amount of organic compound present in a given solution

Organic Estimation

1. Estimation of Phenol
2. Estimation of Aniline
3. Estimation of Glucose
4. Estimation of Ketone
5. Estimation of Ascorbic acid
6. Estimation of Glycine

Double stage preparation of Organic Compounds (Two-step)

1. p-bromo acetanilide from aniline (acetylation and bromination)
2. acetyl salicylic acid from methyl salicylate (hydrolysis and acetylation)
3. p-bromoaniline from acetanilide (bromination and hydrolysis)
4. Coumarin from Phenol (formylation and cyclization)
5. m-nitroaniline from nitrobenzene (nitration and reduction)

Reference Books

1. Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R. Tatchell, “Vogel's Textbook of Practical Organic Chemistry”, 5th Edition, Pearson Education (2003).
2. N.S. Gnanapragasam and G.Ramamurthy, “Organic Lab Manual”, S.ViswanathanPvt. Ltd. (2009).

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: recall the principle of the volumetric analysis of organic compounds

CO2: analyze quantitatively the organic compounds with high precision and accuracy.

CO3: design the synthesis of organic compounds

CO4: construct the reaction set-up and demonstrate the purification of synthesized organic compounds

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	3	2	3	2	2	3	2	-	-	-	24
	2	2	3	3	2	2	2	3	2	2	2	-	-	-	23
	3	2	3	3	2	2	3	2	2	2	2	-	-	-	23
	4	3	2	2	3	3	2	3	2	3	2	-	-	-	25
Grand total of COs with PSOs &POs															95
Mean value of COs with PSOs & POs = 95/40															2.38

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.38
Observation	COs of Organic Chemistry Practical-II is strongly related to POs and PSOs		

EVALUATION

Continuous Internal Assessment (50 Marks)

S. No.	Components	Marks
1.	Regular practical Observation & Viva	10
2.	Results of the regular practical	20
3	Internal Test-I	10
4.	Internal Test-II	10
	TOTAL	**50**

End-Semester Examination (50 Marks)

S. No.	Components	Marks
1.	Record Notebook & Viva	10
2.	Procedure	5
3.	Results with prescribed error	20
4.	Organic preparation and recrystallization	10
5.	Viva	5
	TOTAL	**50**

PHYSICAL CHEMISTRY PRACTICAL-I

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class : I M.Sc. Chemistry Part : Practical
Semester : II Hours : 60
Code : 22PCHP42 Credits: 3

Course Educational Objectives (CEOs)

The course aims to make the students to

1. Understand the principle of conductometry, potentiometry, partition co-efficient, heat of solution and adsorption isotherm
2. Learn to set up the reaction set-up and to calibrate the instruments
3. Obtain the data from the experiments and interpret them.
4. Carry out experiments with accuracy and precession.

1. General Experiments

1. Study of adsorption isotherms and determination of unknown concentration
2. Determination of heat of solution of oxalic acid
3. Determination of heat of solution of ammonium oxalate
4. Determination of molecular weight of the substance by Rast method

2. Conductometry Experiments

1. Determination of solubility product of a sparingly soluble salt ($BaSO_4$)
2. Determination of strength of a mixture of acids

3. Potentiometry Experiments

1. Determination of strength of a mixture of acids
2. Determination of dissociation constant by pH metric method
3. Determination of strength of Fe^{2+} using $K_2Cr_2O_7$ as link

Reference Books

1. J. B. Yadav, "Advanced Practical Physical chemistry", 20th Edition. GOEL publishing House, Krishna Prakashan Media Ltd., (2001)
2. Findlay's, "Practical Physical Chemistry" Revised and edited by B. P. Levitt, 9th Edition, Longman, London, (1985).
3. J. N. Gurtur and R. Kapoor, "Advanced Experimental chemistry", Vol. I. Chand &Co.,Ltd, New Delhi, (1987).

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: perform physical chemistry experiments with high accuracy and precision
CO2: interpret the experimental data, draw graphs and draw conclusions from them
CO3: construct, develop and design new experiments from the learned skills.

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	2	2	3	2	2	2	3	3	-	-	-	2	23
	2	2	3	2	3	2	2	2	3	3	-	-	-	2	24
	3	2	2	2	2	2	2	2	3	3	-	-	-	2	22
Grand total of COs with PSOs &POs															69
Mean value of COs with PSOs & POs = 69/30															2.30

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.30
Observation	COs of Physical Chemistry Practical – I is strongly related to POs and PSOs		

EVALUATION

Continuous Internal Assessment (50 Marks)

S. No.	Components	Marks
1.	Regular practical Observation & Viva	10
2.	Results of the regular practical	20
3	Internal Test-I	10
4.	Internal Test-II	10
	TOTAL	**50**

End-Semester Examination (50 Marks)

S. No.	Components	Marks
1.	Record Notebook & Viva	10
2.	Procedure	10
3.	Calculation & Graph	10
4.	Experiment – Final result within prescribed limit	20
	TOTAL	**50**

Natural Products

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core-7
Semester	: III	Hours	: 90
Code	: 22PCHC73	Credits: 5	

Course Educational Objectives

The course aims to make the students to

1. discuss the structural elucidation of terpenes and classify them (K2, K3)
2. classify and explain the structural determination of alkaloids (K3, K4)
3. discuss about the bile acids, sex hormones and color reactions of sterols and explain the structural determination of cholesterol (K2, K4)
4. discuss color reactions, classify flavonoids and design the synthesis of flavones, flavanones, isoflavones, chalcones and anthocyanidins (K2, K3, K5)
5. explain the metabolism, storage of carbohydrates, Glycogenesis, Glycolysis, Citric acid cycle and Pentose phosphate pathway (K3, K4)

Unit – I Terpenoids (18 hours)

Classification of terpenoids. Isoprene rule. General methods of structural determination of terpenes. Structure and synthesis of Myrcene, Zingiberene, Cadinene and Abietic acid.Biosynthesis of terpenoids.

Unit – II Alkaloids (18 hours)

Classification. General methods of structural elucidation – Hofmann Exhaustive methylation, Emde's Degradation, Zeisel's method. Structural determination and synthesis of Ephedrine, Atropine, Morphine. Structural elucidation of Reserpine (synthesis excluded). Biological importance of alkaloids.

Unit – III Steroids (18 hours)

Sterols-Introduction, Classification and Colour reactions. Isolation and structural determination of Cholesterol (synthesis excluded). Biological importance of bile acids. Structural elucidation of sex hormones – Progesterone, Androsterone, Estrone (synthesis excluded).

Unit – IV Flavonoids (18 hours)

Classification of flavonoids. Colour reactions. Change of colour with respect to pH.General methods of structural determination. Synthesis of flavones, flavanones, isoflavones, chalcones and anthocyanidins. Structure and synthesis of Apigenin,Luteolin, Quercetin and Caffeine.

Unit – V Carbohydrates (18 hours)

Classification- reducing and non-reducing – relationship between mutarotation and reducing property - Cellulose,Lignin and Pectin. Metabolism of Carbohydrates. Storage of Carbohydrates. Glycogenesis, Glycogenolysis, Gluconeogenesis. Oxidation – Glycolysis, Citric acid cycle and Pentose phosphate pathway.

Reference Books

1. Gurdeep R. Chatwal, "Organic Chemistry of Natural Products", Volume-I& II, Edited by Arora, Himalaya Publishing House (2018)
2. O.P. Agarwal, "Organic Chemistry Natural Products", Volume I& II, Krishna Prakashan Media (P) Ltd (2021)
3. V.K.Ahluwalia, "Chemistry of Natural Products", Vishal Publishing Co (2013)

4. I.L. Finar, Organic Chemistry- Vol 2 “Stereochemistry & The Chemistry of Natural Products”, Pearson Education Limited(2018)
5. Stephen Stanforth, “Natural Product Chemistry at a Glance”, Anebooks - Blackwell Science (2006)
6. Ashutosh Kar, “Chemistry of Natural Products”, Volume 1& 2, CBS Publishers & Distributors (2018)
7. Anees A Siddiqui, “Precise Chemistry of Natural Products & Heterocyclic Compounds for Pharmacy & Science”, CBS Publishers & Distributors, (2019)

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: discuss the structural elucidation of terpenes and classify them.
CO2: classify and explain the structural determination of alkaloids.
CO3: discuss about the bile acids, sex hormones and color reactions of sterols and explain structural determination of cholesterol.
CO4: discuss its color reactions, classify flavonoids and design the synthesis of flavones, flavanones, isoflavones, chalcones and anthocyanidins.
CO5: explain the metabolism, storage of carbohydrates, Glycogenesis, Glycolysis, Citric acid cycle and Pentose phosphate pathway.

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	2	-	-	-	2	2	2	-	2	-	-	-	12
	2	3	2	-	-	-	2	2	2	-	2	-	-	-	13
	3	2	2	-	-	-	2	2	2	-	2	-	-	-	12
	4	2	3	-	-	-	3	2	2	-	3	-	-	-	15
	5	3	2	-	-	-	3	2	2	-	3	-	-	-	15
Grand total of COs with PSOs & POs															67
Mean value of COs with PSOs & POs = 67/30															2.23

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.23
Observation	COs of Natural Products strongly related with PSOs and POs		

Chemical Thermodynamics, Equilibria and Electrochemistry

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core-8
Semester	: III	Hours	: 90
Code	: 22PCHC83	Credits: 5	

Course Educational Objectives

The course aims to make the students to

1. derive and explain the concepts of equilibrium and non-equilibrium thermodynamics (K2, K4)
2. classify and derive the various types of statistical thermodynamics (K2, K3)
3. explain and justify the concepts behind in chemical and phase equilibria (K3, K4)
4. discuss and analyze the theories of electrochemistry (K2, K4)
5. discuss and explain the various models and process involved in electrochemistry (K2, K4)

Unit – I Equilibrium Thermodynamics and Non-equilibrium Thermodynamics (18 hours)

General review of enthalpy, entropy and free energy concepts - second law of thermodynamics - concept of entropy - Gibbs function- Gibbs- Helmholtz equation- Maxwell relations - Third law and its limitations-Thermodynamics of systems of variable compositions-partial molar quantities and their determination - chemical potential - Gibbs-Duhem equation - Gibbs-Duhem-Margules equation - fugacity and its determination - choice of state. Third law and its limitation.

Non-equilibrium thermodynamics - conservation of mass and energy-entropy production-entropy production in chemical reactions-entropy production and entropy flow in open systems- Onsager's theory - validity and its verification.

Unit – II Statistical Thermodynamics (18 hours)

Combinatory rule - probability theorem - permutations and combinations - energy states and energy levels - macro-states and micro-states - Maxwell-Boltzmann statistics -Partition function and thermodynamic functions- molar partition function- entropy and third law - separation of partition function- translational, rotational, vibrational and electronic partition functions, combined partition function.

Quantum statistics - Bose-Einstein and Fermi-Dirac statistics - comparison of the three statistics- photon gas and electron gas according to such statistics- population inversion.

Unit – III Chemical and Phase Equilibria (18 hours)

Thermodynamic derivation of equilibrium constant for equilibrium involving ideal and real gases-Temperature dependence of the equilibrium constant-Vant-Hoff equation. principle of Le - Chatelier – and Braun – chemical equilibria.

Gibbs phase rule - its thermodynamic derivation - application of phase rule to three component systems - Formation of one pair, two pairs and three pairs of partially miscible liquids - Systems composed of two solids and a liquid.

Unit – IV Electrochemistry-I (18 hours)

Ionic mobility - the Arrhenius ionisation theory- ionic activities and activity coefficients and their determination by various methods -ionic strength –- Debye-Huckel theory of Strong Electrolytes - ionic atmosphere – Mean ion activity and activity coefficient of electrolytes in solution - ion association Debye Huckel limiting law - electrochemical cells and applications of standard potentials. Applications of emf measurements-potentiometric titrations.

Unit – V Electrochemistry-II (18 hours)

The electrical double layer - structure of electrical double layer - double layer models - Helmholtz, Guoy-Chapman and Sternmodels. Electrode kinetics - Butler-Volmer equation– one step one electron transfer kinetics - exchange current density - Tafel equation and plots - polarizable and non-polarizable interfaces- polarization and overvoltage – mechanism of hydrogen evolution and oxygen evolution reactions -primary and secondary batteries - fuel cells - corrosion and its prevention methods.

Reference Books

1. D. A. McQuarrie., J.D Simon, “Physical Chemistry: A Molecular Approach”, University Science books (2011).
2. P. W. Atkins, J. Paula, “Physical Chemistry”, Oxford Publications, 8thedition (2009).
3. J. O. M. Bockris& A. K. N. Reddy, “Modern Electrochemistry of Electrodics”, Vol II (2001).
4. J. Rajaram, J. C. Kuriacose, “Chemical Thermodynamics”, Pearson (2013).
5. I. A. Hill, “An Introduction to Statistical Thermodynamics”, Dover Publications (1987).
6. I. N. Levine, “Physical Chemistry”, McGraw Hill, 6thedition (2008).
7. D. R. Crow, “Principles and applications of Electrochemistry”, John Wiley & sons, 2ndedition (2001).
8. A. J. Bard, F. R. Faulker, “Electrochemical methods: Fundamental & applications”, Wiley 2nd edition (2000).

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: derive and explain the concepts of equilibrium and non-equilibrium thermodynamics

CO2: classify and derive the various types of statistical thermodynamics

CO3: explain and justify the concepts behind in chemical and phase equilibria

CO4: discuss and analyze the theories of electrochemistry

CO5: discuss and explain the various models and process involved in electrochemistry

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	2	-	3	2	2	2	-	2	2	-	22
	2	2	3	2	2	-	2	2	2	3	2	1	-	-	21
	3	2	2	-	2	2	2	2	3	2	2	2	-	-	21
	4	2	2	2	-	2	2	2	2	-	2	2	2	-	20
	5	2	2	2	2	-	2	2	2	2	-	2	2	-	20
Grand total of COs with PSOs & POs															104
Mean value of COs with PSOs & POs = 104/50															2.08

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.08
Observation	COs of Chemical Thermodynamics, Equilibria and Electrochemistry strongly related with PSOs and POs		

Applications of Spectroscopy

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core-9
Semester	: III	Hours	: 75
Code	: 22PCHC93	Credits: 4	

Course Educational Objectives

The course aims to make the students to

1. apply the UV-visible spectroscopy and IR spectroscopy to investigate the structure of organic compounds.
2. analyse and interpret the structure of organic compounds using NMR spectroscopy.
3. analyse critically the Mass spectroscopy and predict the structure of organic compounds.
4. analyse and interpret the structure of inorganic compounds using IR, Raman and NMR spectroscopy.
5. examine the NQR and Mossbauer spectra for structural elucidation of inorganic compounds.

Unit – I Organic Spectroscopy-I **(15 hours)**

UV-Vis Spectra of Organic Compounds

Characterization of organic compounds: application of Woodward-Fieser rules to conjugated dienes, α, β-unsaturated carbonyl compounds; benzene and its substituted derivatives; polycyclic aromatic hydrocarbons; polyenes; polyenes, and heterocyclic compounds.

IR Spectroscopy

Quantitative studies: calculation of force constants of IR vibrations, hydrogen bonding-intra- and intermolecular hydrogen bonding. Conformational studies: cyclic 1,2-diols and 1,3-diols, cyclohexanes. Characteristic group absorptions of organic compounds: carbon skeleton vibrations, alcohols, phenols, ethers, peroxides, ketones, aldehydes, carboxylic acids, esters, lactones, amines, amino acids; groups absorbing in the fingerprinting region, aromatic over tones and combination bands. Effect of inductive and mesomeric effects on carbonyl frequency – effect ring strain on carbonyl stretching frequency.

Unit – II Organic Spectroscopy-II **(15 hours)**

Chemical shifts: region of proton chemical shift in organic molecules; chemical shift equivalence – interchange through symmetry operations, tagging, restricted rotations, magnetic equivalence. NMR spectra of protons bonded to O, N, S: chemical exchange, hydrogen bonding. Factors influencing coupling constant – Karplus equation, simplification of complex spectra. ^{13}C NMR spectroscopy– off resonance decoupling, effect of alkyl and halogen substitution, hybridisation effects. Basic principle of 2D NMR spectroscopy, COSY, NOESY.

Unit – III Organic Spectroscopy-III **(15 hours)**

Mass spectroscopy

Basic principles – molecular ion peak – parent peak – fragments –meta stable ion – isotope peaks – determination of molecular weight and molecular formula – fragmentation pattern of simple organic molecules – McLafferty rearrangement – retro Diels Alder reaction.

Combined spectroscopic problems involving simple organic molecules.

Unit – IV Inorganic Spectroscopy-I **(15 hours)**

IR & Raman Spectroscopy

Selection rules for the linear and non-linear molecules. Rayleigh scattering, Stoke's and anti-Stoke's lines. Combined application of IR and Raman spectra for structural elucidation of CO_2, SO_2, N_2O, BF_3, cis- and trans-N_2F_2, C_2H_2, PCl_3, $POCl_3$, ClF_3. Rule of mutual exclusion. Group theoretical approach to find the IR and Raman active vibrations of simple C_{2v} and C_{3v} molecules.

NMR Spectroscopy

^{31}P NMR spectra of PF_3, PF_5, P_4S_3, H_3PO_2, H_3PO_3 and H_3PO_4.

^{19}F NMR spectra of ClF_3, PF_3, SF_4, PF_5, BrF_5 and equimolar mixture of TiF_6^{2-} and TiF_4 in ethanol.

Lanthanide shift reagents

Unit – V Inorganic Spectroscopy-II **(15 hours)**

NQR Spectroscopy

Quadrupole nucleus, nuclear quadrupole, electric field gradient (EFG) and asymmetry parameter, nuclear quadrupolar coupling constant (e^2qQ) – conditions to observe NQR signals – NQR spectroscopy to identify chemically inequivalent and crystallographically inequivalent NQR active sites – NQR spectra of $SiCl_4$, $PhAsCl_4$, $PFCl_4$, PCl_4Ph, PCl_5, Cl_3COCl.

Mössbauer Spectroscopy

Doppler effect, isomer shift, quadrupole splitting, magnetic interactions; magnetic and quadrupole splitting in ferromagnetic compounds, Mössbauer spectra of high- and low-spin Fe(II) and Fe(III) compounds; site symmetry of metal centers in iron complexes; differentiation of non-equivalent metal centers in polynuclear complexes; discovering oxidation states-Sn, Sn(II), Sn(IV) compounds.

Reference Books

1. P. S. Kalsi, "Spectroscopy of Organic Compounds", 6th Edition, New Age International (2007)
2. Y. R. Sharma, "Elementary Organic Absorption Spectroscopy", 5th Revised Edition, Chand & Co (2013)
3. Asim K Das & Mahua Das, "Fundamental Concepts of Inorganic Chemistry", Volume 7 (2016)
4. R. S. Drago, "Physical Methods in Inorganic Chemistry", Affiliated East-West Press (2012)
5. D. Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, 3rd Edition, New Age International (2018)

6. Jag Mohan, "Organic Spectroscopy – Principles and Applications", Narosa Publications (2009)
7. William Kemp, "Organic Spectroscopy", ELBS, 3rd Edition, Macmillan Publishers (2019)
8. Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. Vyvyan, "Introduction to Spectroscopy", 5th Edition, Cengage Learning India (2015)

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: apply the UV-visible spectroscopy and IR spectroscopy to investigate the structure of organic compounds.

CO2: analyse and interpret the structure of organic compounds using NMR spectroscopy.

CO3: analyse critically the Mass spectroscopy and predict the structure of organic compounds.

CO4: analyse and interpret the structure of inorganic compounds using IR, Raman and NMR spectroscopy.

CO5: examine the NQR and Mossbauer spectra for structural elucidation of inorganic compounds.

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	3	2	3	-	2	3	2	-	-	-	-	-	18
	2	2	3	3	2	-	3	2	2	-	-	-	-	-	17
	3	3	2	2	3	-	2	3	2	-	-	-	-	-	17
	4	2	3	2	3	-	3	2	3	-	-	-	-	-	18
	5	3	2	3	2	-	2	2	3	-	-	-	-	-	17
Grand total of COs with PSOs & POs															87
Mean value of COs with PSOs & POs = 87/35															2.49

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.49
Observation	COs of Applications of Spectroscopy strongly related with PSOs and POs		

Research Methodology

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core Elective-3
Semester	: III	Hours	: 75
Code	: 22PCHE23	Credits: 3	

Course Educational Objectives

The course aims to make the students to

1. List the various types of research and research methods K1, K2
2. Classify the various available chemical literatures and various indexes and abstracts. K1, K2
3. Use the various tools for literature review for their research work K2, K3
4. Discuss the method of writing thesis and research articles and apply them in preparing dissertations K3, K4
5. Describe the various computational techniques in chemistry and apply them to interpret the data in research K4, K5

Unit – I Research Methodology: An Introduction (15 hours)

Meaning, Objectives and motivation of research - Types of research - fundamental research, applied research, action research, historical research, experimental research. Characteristics of Research - Research Approaches: Qualitative and quantitative research - Significance of research - Research Methods versus Methodology - Research and Scientific Method. Research Process – problem identification, formulation and research design. Criteria for Good research and researcher - Problems encountered by Researchers in India.

Unit – II Chemical Literature and Abstracts (15 hours)

Sources of chemical information: primary (Research article, short communications and letters), secondary (Review article, Textbooks and encyclopaedias) and tertiary sources (databases, catalogues, search engines).

Classical and comprehensive reference works in chemistry. Beilstein- compilations of data, synthetic methods and techniques, treatises, reviews.

Indexes and abstracts: Physical, chemical and biological abstracts – index chemicus - index medicus - science citation index – Thomson Reuters - indexing in Scopus and web of science.

Unit – III Online Literature Search (15 hours)

Chemical Abstracts - Subject index, chemical substance index, formula index, index of ring systems, author index, patent index

Online literature search - SciFinder, Scopus, Web of Science, ChemPort, Google Scholar – As soon as publisheble (ASAP) Alerts, Chemical Abstract Alerts.

Journal homepage - American Chemical Society, Royal Society of Chemistry, Science Direct, Wiley, Springer, Taylor and Francis. Citation index – impact factor – h- index.

INFLIBNET – N-List – NDLI- e-Shodhganga. Researchgate, patent, orcid (Introductory idea only)

Unit – IV Research Reports and Thesis Writing (15 hours)

The art of scientific writing – forms of scientific writing, Research reports, Theses, Journal articles and books. Characteristics of a good report.

Format of a research report. Preface of the thesis - Title page, Researcher's declaration, Certificate of the Research Supervisor, Acknowledgements. Table of contents- List of tables - List of figures and illustrations – abbreviations, symbols & SI Units – Abstract – Introduction – Literature review – Aim and objectives – Methodology (Materials and methods) - Results and discussion, Summary & conclusion and recommendations. Citations and Bibliography – ACS, RSC and Elsevier format – Journal Abbreviations - Citation Management software (Endnote) – Mendeley - Footnotes.

Plagiarism – Plagiarism software – copyright – Self-Plagiarism.

Article submission-Journal finder, Guide for author for paper submission, abstract, graphical abstract, keywords, corresponding author, affiliation, conflict of interest, research highlights

Unit – V Computational techniques in Chemistry (MS Excel, Origin and ChemDraw) (15 hours)

Components of MS Excel – spreadsheets, Database, chart, building formula – plotting straight line using excel- Solving simple problems and functions (exponential) using excel.

Origin – Components of origin – plotting and customizing graphs – merging graphs. Straight line fitting - Regression coefficient calculation using origin.

ChemDraw – components of ChemDraw - Drawing schemes – chemical equation schemes – Analysis and chemical properties – Templates available in ChemDraw – Chem3D. Basic knowledge about JCPDS file – interpretation of XRD data.

Reference Books

1. R. L. Dominoswki, Research Methods, Prentice Hall, 1981.
2. H. F. Ebel, C. Bliefert and W. E. Russey, The Art of Scientific Writing, VCH, Weinheim, 1988.
3. C.R. Kothari, "Research Methodology Methods and Techniques" New Age International Publishers, 2010.
4. G. Vijayalakshmi, C. Sivapragasam, "Research Methods Tips and Techniques" MJP Publishers, 2009.
5. H. M. Kanare, Writing the Laboratory Notebook; American Chemical Society: Washington, DC, 1985.
6. Gibaldi, J. Achtert, W. S. Handbook for writers of Research Papers; 2nd ed.; Wiley Eastern, 1987.

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: classify the various research methodologies and research methods and apply them for the research works (K1, K2)

CO2: Use the various available chemical literatures and apply them in their research. (K1, K2)

CO3: Use the various tools for literature review for the project and research (K2, K3)

CO4: Implement the art of writing thesis in their project dissertation and also research articles. (K3, K4)

CO5: Apply and use Excel, ChemDraw, XRD interpretation in their research (K4, K5)

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	2	3	2	3	2	2	2	-	2	-	-	-	20
	2	2	2	2	2	3	2	2	3	-	3	-	-	-	21
	3	3	2	3	2	2	3	3	3	-	2	-	-	-	23
	4	2	3	2	2	2	2	2	2	-	2	-	-	-	19
	5	2	2	3	3	2	3	3	2	-	2	-	-	-	22
Grand total of COs with PSOs & POs															105
Mean value of COs with PSOs & POs = 105/45															2.33

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.33
Observation	COs of Research Methodology strongly related with PSOs and POs		

Polymer Chemistry

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core-Elective-3
Semester	: III	Hours	: 75
Code	: 22PCHE23	Credits: 3	

Course Educational Objectives

The course aims to make the students to

1. classify and explain the types of polymerization (K1, K2)
2. categorize and explain the techniques of polymerization (K2, K3)
3. analyse critically the molecular weight distribution of polymers (K3, K4)
4. analyse and interpret the morphology and glass transition temperature of polymers (K3, K4)
5. explain and examine the polymer degradation and stabilization by various means and methods (K3, K4)

Unit – I Classification of Polymers (15 hours)

Addition- condensation, Chain/step growth polymerization, organic-inorganic, natural-synthetic, thermoplastic – thermosetting, polar - nonpolar polymers with suitable examples, based on applications - fibers, foams, adhesives and elastomers, based on performance – commodity and engineering polymers. Homopolymers, co-polymers, linear polymers, branched polymers, cross linked or three dimensional polymers, block and graft co-polymers, linear, branched, crosslinked types of polymers. Hyperbranched, star branched dendrimers, semiladder, ladder and layerlatties - polymers.

Unit – II Techniques of Polymerization (15 hours)

Bulk, solution, precipitation, suspension, emulsion, inverse emulsion, melt polycondensation, solution polycondensation, interfacial polymerization, phase transfer catalyzed interfacial polymerization, solid state polymerization and gas phase polymerization. Batch, semibatch and continuous process, merits and limitations of each process and comparison of various polymerization processes with suitable commercial examples. (Polymerization in ionic liquids, in super critical media and MW induced. Approach to combinatorial polymer synthesis).

Unit – III Polymer Molecular Weights (15 hours)

Molecular mass of Polymers: Molecular mass distribution, Distribution curve, Polydispersity, Molecular mass average determination, Absolute and relative methods. Colligative properties: ebullioscopy, cryoscopy, end group analysis, Membrane Osmometry, Vapour phase osmometry, Light scattering, Ultracentrifugation. Solution viscosity - Intrinsic viscosity, Determination of viscosity average molecular weight, Mark-Howink equation, determination of k and a, Fractionation of polymers- Gel permeation chromatography (GPC), Relation of chromatogram shape and MWD.Polymer conformation and chain dimensions, freely jointed chains, real chains, characteristic ratio.

Unit – IV Morphology of Polymers (15 hours)

Crystalline and amorphous phase, factors affecting polymer crystallinity, XRD analysis for polymer crystallinity, crystallites, amorphous regions, spherulites, single crystal, fibrils, Orientation, transitions, glass transition temperature (Tg), factors affecting Tg of polymers, determination of Tg, TMA and DSC, interpretations of DSC thermogram, applications - Tg, Tm, heat of fusion and degree of crystallinity etc. (Principles of TMA and DSC expected).

Unit – V Polymer Degradation and Stabilization (15 hours)

Chemical degradation, physical degradation, ageing, crazing, degradation by micro organisms, Biodegradable polymers, Mechanism of degradation, secondary chain reaction, Self reaction, depolymerisation, metal catalysed degradation, Thermal oxidation, Photooxidation, Mechanical degradation, Degradation by ionizing radiation, ozone attack. Degradation of special polymers: Polyolefins, PVC, PS, PMMA. Stabilization: Chain breaking antioxidants, bound antioxidants, Radiation protection, Stabilization against biodegradation.

Reference Books

1. Fred W. Billmeyer,"Textbook of Polymer Science Polymer Chemistry" Wiley India (2008).
2. A Ravve, "Principles of Polymer Chemistry", 2nd Edition. Kluwer Academic Publisher (2000).
3. Charles E. Carraher, "Seymour/Carraher's Polymer Chemistry", 7th Edition, CRC Press (2008).
4. Fred J. Davis, "Polymer Chemistry - A Practical Approach", Oxford University Press (2004).
5. V. R. Gowariker, V. N. Vishwanathan and J. Sreedhar, "Polymer Science", Wiley-Eastern Limited (2005).

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: classify and explain the types of polymerisation.

CO2: categorize and explain the techniques of polymerisation

CO3: analyse critically the molecular weight distribution of polymers.

CO4: analyse and interpret the morphology and glass transition temperature of polymers.

CO5: explain and examine the polymer degradation and stabilization by various means and methods.

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	3	-	2	3	2	-	-	-	-	-	17
	2	2	3	2	2	-	3	2	2	-	-	-	-	-	16
	3	2	2	2	3	-	2	3	2	-	-	-	-	-	16
	4	2	2	3	2	-	3	2	3	-	-	-	-	-	17
	5	3	2	3	2	-	2	2	3	-	-	-	-	-	17
Grand total of COs with PSOs & POs															83
Mean value of COs with PSOs & POs = 83/35															2.37

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.37
Observation	COs of Polymer Chemistry strongly related with PSOs and POs		

Physical Chemistry Practical - II

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core-Lab-5
Semester	: III	Hours	: 60
Code	: 22PCHP53	Credits: 3	

Course Educational Objectives

The course aims to make the students to

5. Understand the principle of conductometry, potentiometry, kinetics and phase diagram.
6. Learn to set up the reaction set-up and to calibrate the instruments.
7. Obtain the data from the experiments and interpret them.
8. Carry out experiments with accuracy and precession.

1. General Experiments

5. Determination of rate constant for hydrolysis of methyl acetate by acid
6. Phase diagram - three component system
7. Determination of activation energy and Arrhenius factor
8. Determination of molecular weight of the substance by Rast method
9. Determination of transition temperature of a hydrated salt

2. Conductometry Experiments

3. Determination of equivalent conductance of a strong electrolyte
4. Conductometric acid-base displacement titration

3. Potentiometry Experiments

4. Potentiometric precipitation titration – Estimation of halide ions
5. Potentiometric redox titration – Estimation of iodide ions

4. Demo for UV-visible spectroscopy and IR spectroscopy

Reference Books

4. J. B. Yadav, "Advanced Practical Physical chemistry", 20th Edition. GOEL publishing House, Krishna Pakashan Media Ltd., (2001)
5. Findlay's, "Practical Physical Chemistry" Revised and edited by B. P. Levitt, 9thEdition, Longman, London, (1985).
6. J. N. Gurtur and R. Kapoor, "Advanced Experimental chemistry", Vol. I. Chand &Co., Ltd, New Delhi, (1987).

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: perform physical chemistry experiments with high accuracy and precision

CO2: interpret the experimental data, draw graphs and draw conclusions from them

CO3: construct, develop and design new experiments from the learned skills.

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	2	2	3	2	2	2	3	3	-	-	-	2	23
	2	2	3	2	3	2	2	2	3	3	-	-	-	2	24
	3	2	2	2	2	2	2	2	3	3	-	-	-	2	22
Grand total of COs with PSOs & POs															69
Mean value of COs with PSOs & POs = 69/30															2.30

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.30
Observation	COs of Physical Chemistry Practical II strongly related with PSOs and POs		

Inorganic Chemistry Practical - II

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core-Lab-6
Semester	: III	Hours	: 60
Code	: 22PCHP63	Credits: 3	

Course Educational Objectives

The course aims to make the students to

1. recall the principles of qualitative analysis
2. recognize the chemical reactions of acid and basic radicals
3. classify and find acid and basic radicals
4. apply colorimetric techniques to estimate the given solution and interpret spectral data

1. Inorganic cation analysis

Analysis of mixtures containing two common and two less common cations.
Ions of the common metals: Pb, Cu, Mn, Cr, Al, Ni, Co, Ba, Sr, Ca, Mg
Ions of less common metals: W, Se, Te, Mo, Ce, Th, Zr, Ti, V, U, Li.

2. Colorimetric estimations

Colorimetric estimations of copper, nickel and iron using photoelectric colorimeter.

3. Spectral Interpretation

Identification of compounds using spectral data of UV and IR (Demo only).

Reference Books

1. V.V.Ramanujam, Inorganic Semimicro qualitative analysis, 3rd edition, National Publishing company, 2004
2. R. Mukhopadhyay & P. Chatterjee, Advanced Practical Chemistry, Book & Allied (p) ltd 2007.
3. A. I. Vogel, "Quantitative Inorganic Analysis", 7th Edition, Pearson Education, (2002)
4. G. Suehla and B. Sivasankar, Vogel's qualitative inorganic analysis (revised) pearson, 7^{th} Edition, Orient Longman (1996)

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: recognize the methods of inorganic analysis

CO2: compare the properties of various group cations

CO3: analyze and identify the test involved in cations

CO4: explain techniques involved in colorimetric estimation and interpret spectral data.

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	-	2	2	3	3	-	-	-	2	3	3	23
	2	3	2	3	2	2	2	2	-	-	-	2	2	2	22
	3	2	3	-	2	2	3	2	-	-	-	3	2	2	21
	4	2	3	2	3	2	2	3	-	-	-	2	2	2	23
Grand total of COs with PSOs & POs															112
Mean value of COs with PSOs & POs = 112/48															2.33

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.33
Observation	COs of Inorganic Chemistry Practical II strongly related with PSOs and POs		

Analytical Chemistry

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core-10
Semester	: IV	Hours	: 60
Code	: 22PCHD04	Credits	: 3

Course Educational Objectives

The course aims to make the students to

1. Examine the errors and analyse critically to minimize errors in chemical analysis. (K3, K4, K5)
2. Discuss the principle of titrimetric analysis (K3, K4)
3. Interpret the results of various thermal analysis of compounds (K4, K5)
4. describe and apply the various chromatographic principles in separation of organic compounds (K2, K3, K4)
5. Investigate and analyse the various compounds qualitatively and quantitatively using various electroanalytical techniques (K4, K5)

Unit – I Errors in Chemical Analysis (12 hours)

Errors and treatment of analytical data – Classification of errors - Systematic and random errors – minimization and elimination of errors - Accuracy and precision - Distribution of experimental results.

Statistical treatment –Significant Figures – mean – standard deviation – variance, confidence interval. Application of statistics to data treatment and evaluation - student-t and f tests - detection of gross errors, rejection of a result-Q test – Chi square test - estimation of detection limits – signal to noise ratio – Calibration of plots - Least square analysis - correlation coefficient and its determination - numerical problems involving straight line graphs.

Unit – II Titrimetric analysis (12 hours)

Stoichiometry and expressions of concentrations. Principle – titration curves of a weak dibasic acid versus strong base.

Redox titrations: Formal and standard potentials in various media – standardization - oxidizing systems: Mn(VII) and Cr(VI) - Reducing systems: Sn(II) and Fe(II).

Acid-base titrations in non-aqueous solvents: Classification – principle - auto-protolysis constant - dielectric constant and its effect. Detection of equivalence point – titrations in ethylene diamine, glacial acetic acid.

Complexometric Titrations: Stability of complexes - stepwise formation constants - titration curves - feasibility of complexation titration.

Unit – III Spectral and Thermal Techniques (12 hours)

AAS and AES: Principle - Instrumentation - Types of optical instruments - components of optical instruments - sources, monochromators and detectors - Sample preparations - Applications in quantitative analyses.

Thermogravimetry (TG), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC) – Principle – instrumentation – Characteristics of TGA and DTA curves - Factors affecting TGA & DTA curves – TG-DTA curves of CaC_2O_4. H_2O and $CuSO_4$. $5H_2O$ – Phase transition studies using DSC.

Unit – IV Electroanalytical Techniques (12 hours)

Two electrode and three electrode system - importance of supporting electrolyte - mass transport processes - General classification of electroanalytical techniques.

Polarography – Principle – Polarographic measurements - interpretation of polarographic waves - equation for polarographic wave - half wave potential - DME - Applications.Amperometric Titrations.

Cyclic voltammetry – Principle – instrumentation – Applications of CV: prediction of reaction mechanism - redox behaviour of compounds – identification of number of electrons in redox reactions.

Ion selective electrodes – theory and applications of Potentiometry and coulometric titration.

Unit – V Chromatographic Techniques (12 hours)

Super critical fluid chromatography - Reversed phase chromatography - Ion exchange and Gel permeation chromatography.

HPLC - Principles – advantages of HPLC– instrumentation - applications of HPLC.

Gas Chromatography – Principle – Instrumentation - Carrier gas – Column – Detector – Applications.

Electrophoresis and capillary electrophoresis - principle, instrumentation and applications.

Reference Books

1. Daniel C. Harris, Charles A. Lucy, "Quantitative Chemical Analysis" W. H. Freeman, 10th Edition, 2019.
2. D. A. Skoog, D. M. West and F. J. Holler, Analytical Chemistry an Introduction, Saunders College Publishers, 2000.
3. J. Mendham, R. C. Denney, J. D. Barnes and M. Thomas, Vogel's Text book of Quantitative Chemical Analysis, Pearson Education Pvt. Ltd., 2004.
4. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, "Fundamentals of Analytical Chemistry", 9th Edition, Cengage Learning (2013).
5. R. A. Day Jr. A. L. Underwood, "Qualitative Analysis", 6th Edition, PHI Learning Private Limited (2012).
6. K. S. Viswanathan R. Gopalan,"Analytical Methods: Interpretation, Identification, Quantification", Universities Press (2018).
7. H. Kaur, Instrumental methods of Chemical Analysis, Pragati Prakashan, (2010).
8. James W. Robinson, Eileen M. Skelly Frame, George M. Frame II, "Instrumental Analytical Chemistry" CRC Press, (2021).
9. J. Mendham, R. C. Denney, J. D. Barnes & M. Thomas, "Vogel's Text book of Quantitative Chemical Analysis", Pearson Education (2010).

10. A. Sharma, S. G. Schulman, “Introduction to Fluorescence Spectroscopy”, Wiley-Interscience, (1999).
11. C. N. Banwell and E. M. McCash, “Fundamentals of Molecular Spectroscopy”, 4th edition Tata McGraw Hill (2017).
12. Vogel, A.I. “A Textbook of Quantitative Inorganic Analysis”, ELBS. (2013).

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: examine the errors and analyse critically to minimize errors in chemical analysis.

CO2: discuss and apply the concepts of titrimetric analysis

CO3: interpret the results of various thermal analysis of compounds

CO4: describe and apply the various chromatographic principles in separation of organic compounds

CO5: investigate and analyse the various compounds qualitatively and quantitatively using various electroanalytical techniques

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	2	3	3	2	2	3	2	-	-	2	26
	2	2	2	2	2	2	3	2	2	2	3	-	-	2	24
	3	3	2	2	2	2	2	2	2	2	2	-	-	2	23
	4	2	3	2	3	2	2	2	2	3	2	-	-	2	25
	5	2	2	2	2	2	2	3	2	2	3	-	-	2	24
Grand total of COs with PSOs & POs															122
Mean value of COs with PSOs & POs = 122/55															2.22

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.22
Observation	COs of Analytical Chemistry strongly related with PSOs and POs		

Photochemistry, Pericyclic reactions and Supramolecular Chemistry

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core-11
Semester	: IV	Hours	: 75
Code	: 22PCHD14	Credits	: 4

Course Educational Objectives

The course aims to make the students to

1. identify the coordination complexes having photochemical properties in energy conversion applications (K3, K4, K5)
2. illustrate the applications of photochemistry in organic reactions and rearrangements (K4, K5)
3. describe and illustrate the orbital correlation of pericyclic reactions with selectivity (K2, K3, K4)
4. explain the bonding forces in supramolecules and classification of supramolecules (K2, K3)
5. examine the synthetic route to assemble various types of supramolecules and applications of supramolecules in catalysis (K2, K3, K4)

Unit – I Photochemistry – I (15 hours)

Laws of photochemistry - photophysical processes - Jablonski diagram - fluorescence - phosphorescence - Kasha's rule - Stern-Volmer relationship-Stoke's shift - types of electronic transitions in transition metal complexes - photochemistry of Cr(III) complexes - photosubstitution - photoaquation - Adamson's rules - photorearrangement – isomerisation– racemisation - photoredox reactions - solar energy conversion – photogalvanic cell – splitting of water to evolve hydrogen and oxygen.

Unit – II Photochemistry – II (15 hours)

Fundamental concepts - Jablonskii diagram - - Intersystem crossing - Energy transfer - Molecular orbital view of excitation - The geometry of excited states - Reactivity of electronically excited ketones - α- cleavage - γhydrogen transfer Norrish Type I and Type II- Paterno Buchi reaction – photochemistry of alkenes and dienes - photochemistry of enones and Dienones, photo reduction, photochemical oxidation (di-pi methane or Zimmerman rearrangement), Oxa-di-pi methane rearrangement-Barton reaction –photo Fries rearrangement - photo chemistry of α , β unsaturated carbonyl compounds – photo chemistry of arenes.

Unit – III Pericyclic reactions (15 hours)

Pericyclic reactions: Concerted reactions – orbital symmetry and correlation diagram approach – FMO and PMO approach, Woodward-Hofmann rules – Electrocyclic reactions (1,3-butadiene-cyclobutene and 1,3,5-hexatriene-cyclohexadiene systems) – cycloadditions [2+2] and [2+4] systems (ethylene-cyclobutane, ethylene and 1,3-butadiene-cyclohexene

systems) – selection rules – cycloreversion (reterocycloaddition reactions) – 1,3-dipolar cycloaddition - sigmatropic rearrangements – Sommelet-Hauser, Cope, Fries and Claisen rearrangements.

Unit – IV Fundamentals of Supramolecular Chemistry (15 hours)

Origins to supramolecular chemistry – various types of non-covalent interaction – Nature and importance of supramolecular assemblies- ion-ion, ion-dipole, dipole-dipole, H-bonding, cation-p, anion-p, p-p, van der Waals interactions, Solvation and hydrophobic effects. Classification of supramolecules – Molecules with specific shape – Rotaxane, catenane, Dendrimers Molecules recognizing a partner molecule by lock and key and guest-host chemistry – crown ethers, macrocyclic polyamines, cyclodextrin, calixarene.

Unit – V Synthesis and Applications of Supramolecules (15 hours)

Template synthesis of Schiff bases – synthesis of calixarenes, crown ethers and cryptands- Salient features of supramolecular catalysis Product selectivity, stereospecificity – Supramolecular polymers - Main chain supramolecular polymers, side-chain supramolecular polymers, examples of stimuli responsive supramolecular polymers and selfhealing polymers- Applications of Dendrimers.

Reference Books

1. Jagdamba Singh & Jaya Singh, "Photochemistry and Pericyclic reactions", New Age International (2005)
2. K. K. Rohotgi-Mukherjee, "Fundamentals of Photochemistry", 3rd Edition, New Age Publishers (2017)
3. Satyajit Dey, Nirmal Hazra, "Pericyclic Reactions & Organic Photochemistry", Techno World (2019)
4. A.K. Das, M. Das, "An Introduction to Supramolecular Chemistry", CBS Publishers & Distributors Pvt Ltd (2020).
5. P.S. Kalsi, J.P. Kalsi, Ashu Chaudhary, Bioorganic, Bioinorganic and Supramolecular Chemistry, 4th Edition, New Age International Publisher (2020).
6. J.M. Lehn, Supramolecular Chemistry Concepts and Perspectives, Wiley Publisher (2018).
7. K. K. Rohatgi and Mukerjee, Fundamentals of Photo Chemistry, Wiley Eastern Ltd (1986)
8. J. W. Steed and J. L. Atwood, "Supramolecular Chemistry", John Wiley & Sons (2013)

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: identify the coordination complexes having photochemical properties in energy conversion applications

CO2: illustrate the applications of photochemistry in organic reactions and rearrangements

CO3: describe and illustrate the orbital correlation of pericyclic reactions with selectivity

CO4: explain the bonding forces in supramolecules and classification of supramolecules

CO5: examine the synthetic route to assemble various types of supramolecules and its applications.

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	2	-	3	2	2	-	2	2	2	2	24
	2	2	2	2	-	2	3	2	2	2	-	2	2	2	23
	3	3	2	2	-	2	2	2	-	2	2	-	2	2	21
	4	2	3	2	-	2	2	2	2	-	2	2	2	2	23
	5	2	2	2	2	-	2	3	2	-	-	2	2	2	21
Grand total of COs with PSOs & POs															112
Mean value of COs with PSOs & POs = 112/53															2.11

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.11
Observation	COs of Photochemistry, Pericyclic reactions and Supramolecular Chemistry strongly related with PSOs and POs		

Chemical Kinetics, Surface and Polymer Chemistry

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core-12
Semester	: IV	Hours	: 75
Code	: 22PCHD24	Credits	: 4

Course Educational Objectives

The course aims to make the students to

1. Discuss the various theories of reaction rate to understand mechanism involved in reactions (K3, K4)
2. Explain the kinetics of complex, fast and polymerization reactions (K3, K4)
3. Examine the kinetics in solution and homogeneous catalytic reactions (K3, K4)
4. Discuss the basic concepts of surface chemistry and deduce the kinetics of surface reactions (K4, K5)
5. Describe the sources of cheminformatics and discuss the various aspects of polymers (K3, K4)

Unit – I Theories of Reaction Rate (15 hours)

Basic kinetic concepts – Arrhenius equation – potential energy surfaces and reaction coordinates – Theories of reaction rates – Collision theory of bimolecular gaseous reaction – Transition State theory (ARRT) – Thermodynamic derivations of ARRT – Eyring equation - estimation of free energy, enthalpy and entropy of activation and their significance - Theories of unimolecular reactions – Lindemann and Hinshel Wood treatments. Elementary idea of RRK, RRKM and Slater's treatments.

Unit – II Kinetics of Complex, fast and polymerization Reactions (15 hours)

Kinetics of complex reactions – rate expression for opposing, parallel and consecutive reactions. Chain reactions - chain length, Rice-Herzfeld pyrolysis of acetaldehyde - kinetics of decomposition of HI&anthracene dimerization reactions in benzene (Photochemical reactions).

Kinetics of fast reactions - Methods of studying fast reactions- flow methods - relaxation technique, flash photolysis.

Kinetics of polymerization reactions – Principle of polymerization kinetics – molecular and free radical mechanisms

Unit – III Kinetics in Solution and Catalysis (15 hours)

Application of ARRT to solution kinetics-effects of solvents, double sphere model, effect of ionic strength on ionic reactions –kinetic isotope effect.

Catalysis – Introduction – selectivity – promotors – catalytic poisoning – deactivation of catalyst – inhibitors - auto catalysis – turnover number.

Homogeneous catalysis - Hammett acid-base catalysis – rate of acid and base catalysis – acidity function - Bronsted catalysis law - Enzyme catalysis: Brief introduction on enzymes – advantages – Michaelis-Menten kinetics -Lineweaver Burk plot – The Eadie-Hofstee Method - enzymatic inhibitor – Influence of pH and temperature.

Unit – IV Surface Chemistry (15 hours)

Adsorption – Physisorption and Chemisorption – Adsorption isotherms - Freundlich, Langmuir, BET and Gibbs adsorption isotherms – surface area determination - Adsorption from solution – surface film. Electro-kinetic phenomena – zetapotential.

Kinetics of surface reactions: Langmuir-Hinshelwood mechanisms – unimolecular and bimolecular surface reactions.

Micelles – formation, critical micellar concentration (CMC), factors affecting CMC in aqueous media, micellar catalysis – reverse micelles.

Unit – VPolymer Chemistry and Cheminformatics (15 hours)

Polymers – Monomers, Oligomers, polymers and their characteristics - Classifications of polymers – Bonding in polymers – primary and secondary forces in polymers - Molar masses of polymers – number average and mass average molar mass – Glass transition temperature – factors influencing glass transition temperature – Determination of molar masses – Polymerization reactions – Mechanism of addition, condensation, free radical polymerization. Zeigler Natta Polymerization – step growth polymerization – gas phase polymerization.

Introduction to cheminformatics –evolution of cheminformatics –prospects and applications of cheminformatics – data, relational database management - introduction to molecular modelling and drug design.

Reference Books

1. K. J. Laidler, "Chemical Kinetics", 3rd edition, Tata McGraw Hill (2008)
2. Tim Clark, "A Handbook of Computational Chemistry", John Wiley, New York (1985)
3. Vasanth R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, "Polymer Science" New Age International (2005)
4. P. W. Atkins, "Advanced Physical Chemistry", 7thedition, Clarendon (2002)
5. S. M. Bachrach, "Internet for Chemists". ACS Publications. Washington (1996)
6. A. R. Leach, "Molecular Modelling Principles & Applications", 2nd edition, Prentice Hall (2001)
7. J. C. Kuriacose and J. Rajaram, Kinetics and Mechanisms Transformations, Macmillan & Co (1993)
8. S. K. Basandra, "Local Area Networking". Galgotia (1999)
9. A. S. Tanenbaum, "Computer Networks". Prentice Hall of India (1996)

Course Outcomes (COs)

On completion of the course, students will be able to

1. Examine the theories of reaction rate to elucidate the mechanism of reactions (K3, K4)
2. Derive the rate expression for fast, complex and polymerization reactions and validate its mechanism of similar other reactions (K3, K4)
3. deduce the kinetics of reactions in solution and propose the mechanism of homogeneous catalytic reactions (K3, K4)

4. Apply the underlying concepts of surface chemistry to deduce the kinetics of surface reactions (K4, K5)
5. Explain the various preparation and properties of polymers and describe the sources of cheminformatics (K3, K4)

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	2	3	2	3	3	2	2	2	-	-	-	24
	2	2	3	3	2	2	2	2	3	2	3	-	-	-	24
	3	3	2	2	2	2	3	2	2	3	2	-	-	-	23
	4	2	2	2	3	2	2	3	2	2	2	-	-	-	22
	5	2	2	2	2	3	2	2	3	2	2	-	-	-	22
Grand total of COs with PSOs & POs															115
Mean value of COs with PSOs & POs = 115/50															2.3

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.3
Observation	COs of Chemical Kinetics, Surface and Polymer Chemistry & Cheminformatics strongly related with PSOs and POs		

Biochemistry & Medicinal Chemistry

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core-Elective-4
Semester	: IV	Hours	: 60
Code	: 22PCHE34	Credits	: 3

Course Educational Objectives

The course aims to make the students to

1. Outline the basic principles and approaches to new drug design and select the proper drug design method (K2, K3)
2. Describe the importance of enzyme and to explain the chemistry of drugs and drug action drug action (K2, K3)
3. Classify and to recognize chemotherapy and antimicrobial agents (K2, K3)
4. identify the catalytic power, specificity and regulation properties and uses of enzymes
5. Assess the chemistry of co-enzymes, and biotechnological applications and clinical uses and uses of coenzymes in various fields (K3, K4)

Unit – I Physical Principles (12 hours)

Structure and activity – Relationship between chemical structure and biological activity (SAR) – Receptor Site Theory. Approaches to drug design – Introduction to combinatorial synthesis in drug discovery – Factors affecting bioactivity – Relationship between Free-Wilson analysis and Hansch analysis.

Unit – II Drug Action (12 hours)

Pharmacodynamics – Introduction – elementary treatment of enzymes stimulation – enzyme inhibition – sulfonamides – membrane active drugs – drug metabolism – xenobiotics – biotransformation – significance of drug metabolism in medicinal chemistry.

Unit – III Antibiotics and Antibacterials (12 hours)

Introduction, Antibiotic β-Lactam type - Penicillins, Cephalosporins, Antitubercular. Streptomycin, Ciprofloxacin, Norfloxacin. Broad spectrum antibiotics. Tetracyclines – Anticancer – Dactinomycin (Actinomycin D) – Synthesis & drug action, antibacterial drug.

Unit – IV Nucleic Acids (12 hours)

Double helical structure of DNA – structure of RNA. DNA replication - semi-conservative nature of replication – RNA transcription – Genetic code and biosynthesis of proteins. Recombinant DNA-Cloning vectors – restriction enzymes for cloning – techniques of restriction mapping – construction of a restriction map – construction of chimeric DNA – molecular probes – construction and screening of genomic and CDNA libraries.

Unit – V Vitamins and Co-Enzymes (12 hours)

Co-Enzyme Chemistry. Cofactors as derived from vitamins – coenzymes – prosthetic groups – apoenzymes. Structure and biological functions of coenzyme A – thiamine pyrophosphate, pyridoxal phosphate, NAD^+, $NADP^+$, FMN, FAD, lipoic acid, vitamin B12. Enzyme Models – Host-guest chemistry – chiral recognition and catalysis – molecular recognition – molecular

asymmetry and prochirality. Biotechnological Applications of Enzymes – Use of enzymes in food and drink industry – brewing and cheese making. Enzymes as targets for drug design – Clinical uses of enzymes, enzyme therapy.

Reference Books

3. John M. Beale, Jr., John H. Block. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, 12th Revised Edition (2010)
4. S.S. Pandeya& J.R. Dimmock, An Introduction to Drug Design, New Age International (1997)
5. U. Satyanarayana, U. Chakrapani, Biochemistry, 5th Edition, Elsevier (2020)
6. J. L. Jain, Sunjay Jain and Nitin Jain, Fundamentals of Biochemistry, 7th Edition, S Chand; (2016)
7. R.B. Silverman, The Organic Chemistry of Drug Design and Drug Action, Academic Press, 2nd Edition, 2004.
8. D. Lednicer, Strategies for Organic Drug Synthesis and design, John Wiley, 2nd Edition, 2008.
9. Donald Voet, Judith G. Voet& Charlotte W. Pratt, "Principles of Biochemistry", 3rd Edition, John Wiley & Sons (2004)
10. Ivano Bertini, Harry B. Gray, Stephen J. Lippard and Joan Selverstone Valentine, "Bioinorganic chemistry", University Science Books (1994)
11. A. L. Lehninger, D. L. Nelson & M.M. Cox, "Principles of Biochemistry", CBS Publishers, Delhi, 4th Edition (2004).
12. P.K. Gupta, Elements of Biotechnology, Rastogi Publications, 1st Edn.,(1994).

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: outline the basic principles and approaches to new drug design and select the proper drug design method

CO2: describe the importance of enzyme and to explain the chemistry of drugs and drug action drug action

CO3: classify and recognize chemotherapy and antimicrobial agents

CO4: identify the catalytic power, specificity and regulation properties and uses of enzymes.

CO5: assess the chemistry of co-enzymes, and biotechnological applications and clinical uses and uses of coenzymes in various fields.

Mapping Course outcome with

Outcomes		PSO					PO								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	2	3	2	3	2	2	3	2	2	2	-	-	2	25
	2	2	2	2	2	3	3	2	2	2	2	-	-	2	24
	3	3	2	2	2	2	2	2	3	2	3	-	-	2	25
	4	2	2	3	2	2	2	2	2	2	2	-	-	2	23
	5	2	2	2	3	2	2	2	2	3	2	-	-	2	24
Grand total of COs with PSOs & POs															121
Mean value of COs with PSOs & POs = 121/55															2.2

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs	-	-	2.2
Observation	COs of Biochemistry and Medicinal Chemistry strongly related with PSOs and POs		

Green Chemistry

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core-Elective-4
Semester	: IV	Hours	: 60
Code	: 22PCHE34	Credits	: 3

Course Educational Objectives

The course aims to make the students to

1. To learn the principle and importance of green chemistry
2. To understand about the green solvents and green chemistry strategies for designing the chemical synthesis.
3. Acquire knowledge in ionic liquids and phase transfer catalyst.
4. To study about the supercritical CO_2 in green synthesis.
5. explain the metabolism, storage of carbohydrates, Glycogenesis, Glycolysis, Citric acid cycle and Pentose phosphate pathway.

Unit – I Introduction to Green Chemistry (12 hours)

Green chemistry - Introduction - need for green chemistry - goals of green chemistry - Anastas twelve principles of green chemistry –Limitations and the progress of green chemistry. Atom economy. Designing a green synthesis - choice of starting materials, solvents, catalysts, reagents, processes with suitable examples.

Unit – II Microwave and Ultrasound Assisted Organic Synthesis (12 hours)

Microwave activation - advantages of microwave exposure –Difference between conventional heating and microwave heating. Microwave assisted reactions, condensation reactions - oxidation, reduction reactions, multicomponent reactions.

Sonochemistry– uses, acoustic cavitation - saponification - substitution, addition, oxidation reactions, reductions by sonochemical method.

Unit – III Ionic liquids - Phase Transfer Catalyst (12 hours)

Ionic liquids - synthesis, physical properties of ionic liquids - applications in alkylation, epoxidation, Friedal-Crafts reaction - Diels-Alder reactions – Knoevengal condensations and Wittig reactions.PTC–Crown ethers, Quaternary ammonium salt. Definition - advantages, types of PTC reactions - synthesis of PTC, applications of PTC in organic synthesis - Michael reaction - alkylation of aldehydes and ketones. Wittig, generation of dihalocarbene, elimination reaction.

Unit – IV Biocatalyst and Supercritical CO_2 in Green Synthesis (12 hours)

Solid supported synthesis - use of biocatalysts in green chemistry - advantages - biochemical (microbial) oxidation and reduction reactions.

Supercritical CO2- uses in extracting natural products, dry cleaning, bromination, Kolbe-Schmidt synthesis - Friedel-crafts reaction. Dimethyl carbonate as a methylating agent in green synthesis.

Unit – V Industrial case studies **(12 hours)**

Methyl Methacrylate (MMA)- Greening of Acetic acid manufacture, Vitamin-C – Leather manufacture- Types of Leather- Difference between Hide and Skin- Tanning – Reverse tanning- Vegetable tanning- Chrome tanning- Fat liquoring- Dyeing- Application- Polyethylene-Ziegler Natta Catalysis, Metallocene Catalysis- Eco friendly Pesticides- Insecticides.

Reference Books

1. Paul T. Anastas and John C. Warner, "Green Chemistry", Oxford University Press, Indian Edition, 2008.
2. V. K. Ahluwalia and M. Kidwai, "New Trends in Green Chemistry", Anamaya Publishers, 2nd Edition, 2007.
3. V. Kumar, "An Introduction to Green Chemistry", Vishal Publishers, 1st Edition, 2013.
4. V. K. Ahluwalia and R. S. Varma, "Green Solvents", Narosa Publishing, 1st Edition, 2009.
5. V.K.Ahluwalia and Renu Aggarwal, "Organic Synthetic Special Techniques", Narosa, 2nd Edition, 2009.

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: Have the knowledge on twelve principles of green chemistry.

CO2: Apply the attractive techniques in green chemistry.

CO3: Use of ionic liquids and phase transfer catalyst in green synthesis.

CO4: Use of biocatalyst and supercritical CO_2 synthesis in green chemistry

CO5: Have a knowledge on Applications of green chemistry.

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	3	2	2	3	3	3	2	2	3	-	-	-	26
	2	2	2	3	3	2	2	2	2	2	2	-	-	-	22
	3	3	2	2	3	2	2	3	2	2	2	-	-	-	23
	4	3	2	2	3	2	3	2	2	2	2	-	-	-	23
	5	2	3	3	2	3	2	3	2	2	2	-	-	-	24
Grand total of COs with PSOs & POs															118
Mean value of COs with PSOs & POs = 118/50															2.36

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.36
Observation	COs of Green Chemistry strongly related with PSOs and POs		

Project

(Applicable to the students admitted from the academic year 2022-2023 onwards under OBE Pattern)

Class	: II M.Sc. Chemistry	Part	: Core
Semester	: IV	Hours	: 180
Code	: 22PCHD34	Credits: 7	

Course Educational Objectives

The course aims to make the students to

1. review and analyse the literature reviews and identify the research problem (K2, K3, K4)
2. formulate and construct a research plan and carry out the research experiments (K4, K5)
3. produce evidences for the research work using spectral and theoretical data and integrate and analyse the experimental results (K4, K5)
4. interpret the experimental results critically, compare the experimental results with theoretical conceptsand draw conclusions (K4, K5, K6)
5. justify, criticize the research work and present ideas clearly and coherently to defend their research work (K4, K5)

Suggested Area of Research:

Synthetic Organic Chemistry, Coordination Chemistry, Corrosion Studies, Environmental Chemistry, Polymer Chemistry, Phytochemistry, Nanochemistry, Physical Chemistry, Theoretical Chemistry, Material Chemistry.

Research Supervisors will be allotted for each student. A specific problem will be assigned to the students or they will be asked to choose a problem from their area of interest. The topic/area of work will be finalized at the end of III semester, allowing scope for the students to gather relevant literature. The research work can be carried out in the college or at any other organization approved by the guide and the HoD. The project will require practical work with the submission of a project report. It should include experimental lab work or theoretical results derived from software. The duration of the project work is between 3 and 6 months. The project report should be submitted in the prescribed format containing a minimum of 40 pages. The report should be enhanced with graphs, spectra, tables and/ or photographs.

Each candidate must prepare 4 hard copies of the thesis - 1 copy for the candidate and 3 copies for the department. The project should be submitted on the scheduled date prescribed by the Department. Upon submission of the project report to the office of the Controller of Examinations, the viva-voce examination will be conducted by the supervisor, Head of the Department and an external expert suggested by the supervisor. In the absence of internal examiner, Head of the Department can act as internal examiner. The Project report and the viva-voce will be evaluated for 100 marks (50 internal + 50 external).

Methodology: Each project should contain the following details:

- Brief introduction on the topic
- Review of Literature
- Materials and Methods
- Results and Discussions – evidences in the form of figures, tables and photographs
- Conclusion / Summary
- Bibliography

Course Outcomes (COs)

On completion of the course, students will be able to

CO1: review and analyse the literature reviews and identify the research problem

CO2: formulate and construct a research plan and carry out the research experiments

CO3: produce evidences for the research work using spectral and theoretical data and integrate and analyse the experimental results

CO4: interpret the experimental results critically, compare the experimental results with theoretical concepts and draw conclusions

CO5: justify, criticize the research work and present ideas clearly and coherently to defend their research work

Mapping Course outcome with

Outcomes		**PSO**					**PO**								Sum of COs with PSOs & POs
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
CO	**1**	3	2	3	3	2	2	3	3	2	2	-	-	-	25
	2	3	2	2	2	2	2	2	2	3	2	-	-	2	24
	3	2	3	2	3	2	3	2	2	2	3	2	-	2	28
	4	3	3	3	3	2	2	2	2	3	2	2	-	2	29
	5	3	2	3	3	2	2	2	2	3	2	2	-	2	28
Grand total of COs with PSOs & POs															136
Mean value of COs with PSOs & POs = 136/57															2.39

Mapping Scale	1	2	3
Relation	0.01-1.0	1.01-2.0	2.01-3.0
Quality	Low	Medium	Strong
Mean value of COs with POs & PSOs			2.39
Observation	COs of Project strongly related with PSOs and POs		