DEPARTMENT OF CHEMISTRY

The Gandhigram Rural Institute – Deemed to be University

(MINISTRY OF EDUCATION, Govt. of. India)

Accredited by NAAC with 'A' Grade (3rd cycle)

Gandhigram – 624 302

B.Sc. / B.Sc. (Hons) Chemistry

Syllabus

(with effect from 2024)

The Gandhigram Rural Institute – Deemed to be University

Department of Chemistry

Vision :

- To impart knowledge to the society through teaching, research and extension
- To contribute to the science and technology enabled Nation building

Mission

- To design courses and to train teachers towards academic excellence
- To undertake research activities in frontier areas of chemistry for the advancement of science
- To take laboratory findings to the society aiing at rural epowerent and rural transportation
- To enhance interactionwith all stackholders so as to prepare students for facing challenges

With obtaining UG degree in Chemistry students will be able to have

PEO 1: Subject Proficiency

Succeed in obtaining employment appropriate to their interest in Chemistry related fields and will possess effective skills to critically assess, analyze and solve problems related to domain knowledge.

PEO 2: Professional Growth

Continue to develop in their professional career through life-long learning, as well as higher education in their areas of interest.

PEO 3: Management Skills

Exercise leadership qualities and moral values through ethical ways with a concern for society and environment.

PEO 4: Addressing needs of the Nation

Cater to needs of the industry/ society so as to contribute for the development of the country.

Graduate Attributes

- Analytical Thinking
- Laboratory Skills
- Problem Solving
- Communication Skills
- Environmental Awareness

PSO for B.Sc. Chemistry

PSO1: Knowledge:

Apply the knowledge of chemistry to appreciate, develop and test the theoretical aspects for applications in energy, environment, materials,
medicines, etc.

PSO2: Skills:

Solve the complex problems and acquire analytical skills using latest techniques and tools along with needed skills.

PSO3: Attitude:

Apply the contextual knowledge of chemistry to function effectively as an individual or a leader in multidisciplinary environments.

PSO 4:

Synthesize, compare, evaluate, classify, interpret and effectively apply the basic laws, principles, phenomena, processes and mechanisms involved in the domain of Chemistry

PSO 5:

Explicitly communicate and exchange their ideas with regard to theoretical experimental aspects, the impacts of Chemistry on environment and society to the Chemists and non-Chemists

Semester-wise Credit Distribution for BSc/BSc (Hons) Chemistry from July 2024

Category	Course code	Name of the course	No/of Credits	Hrs per week	Maximum marks		
					CFA	ESC	Total
Semester - I							
CORE	24CHUC1101	Concepts of Chemistry - I	3	3	40	60	100
	24CHUC1102	Inorganic Qualitative analysis Practical	1	3	60	40	100
	24MAUB1101	Mathematics:Algebra and Calculus	4	4	40	60	100
MD		Inter Departmental Elective	3	3	40	60	100
AEC	24ENUA1101	Essential English:Basic	3	3	40	60	100
SEC	24TAUS1101/ 24MLUS1101/ 24HIUS1101	Tamil – I/Malayalam – I/Hindi - I	3	3	40	60	100
VAC	24FSUV1001	Environmental Science	2	2	50	-	50
	24FAUV1001 (OR) 24GTUV1002	Heritage and cultural history of India (OR) Shanthi Sena	2	2	50	-	50
		Total	21	23	360	340	700
Semester - II							
CORE	24CHUC1203	Concepts of Chemistry - II	3	3	40	60	100
	24CHUC1204	Volumetric Analysis Practical	1	3	60	40	100
	24MAUB1202	Mathematical methods and applications	4	4	40	60	100
MD	24CSUI1202	Computational Skills: Web Designing	3	3	40	60	100
AEC	24ENUA1201	Essential English:Intermediate	3	3	40	60	100
SEC	24TAUS1202/ 24MLUS1202/ 24HIUS1202	Tamil – II/Malayalam – II/Hindi – II	3	3	40	60	100
VAC	24PEUV1001	Yoga and FIness	2	2	40	60	100
VAC	24GTUV1001	Let us know Gandhi	2	2	50	-	50
SEC	24TAUS0001/ 24MLUS0001/ 24HIUS0001	Functional Tamil /Malayalam /Hindi	2	2	50	-	50
		Total	23	25	400	400	800
Semester III							
Core	24CHUC2105	Inorganic Chemistry – I	3	3	40	60	100
	24CHUC2106	Physical Chemistry -I	4	4	40	60	100
	24CHUC2107	Applied Chemistry Practical	1	3	60	40	100
	24PHUB2101	Physics – I	3	3	40	60	100
	24PHUB2102	Physics Practical - I	1	3	60	40	100
MD	--	Online Course	3			100	100
AEC	24ENUA2103	Essential English: Advanced	3	3	40	60	100

SEC	24TAUL2103/ 24MLUL2103/ 24HIUL2103	Indian Language – III (Tamil / Malayalam / Hindi)	3	3	40	60	100
Extension	24EXUE2101	VPP	2	-	50	-	50
		Total	23	22	370	480	850
Semester IV							
Core	24CHUC2208	Organic Chemistry – I	4	4	40	60	100
	24CHUC2209	Inorganic Chemistry – II	3	3	40	60	100
	24CHUC2210	Physical Chemistry - II	3	3	40	60	100
	24CHUC2211	Inorganic Quantitative Analysis Practical	2	5	60	40	100
	24PHUB2203	Physics – II	3	3	40	60	100
	24PHUB2204	Physics Practical – II	1	3	60	40	100
AEC	24CHUA2201	Intra departmental Elective	3	3	40	60	100
Extension	24EXUE2201	Community Engagement	2	-	50	-	50
		Total	21	24	370	380	750
Semester - V							
Core	24CHUC3112	Organic Chemistry – II	3	3	40	60	100
	24CHUC3113	Inorganic Chemistry – III	4	4	40	60	100
	24CHUC3114	Physical Chemistry - III	3	3	40	60	100
	24CHUC3115	Organic Qualitative Analysis Practical	2	5	60	40	100
	24CHUB3101	Polymer Chemistry	4	4	40	60	100
	24CHUC3116	Internship	2	-	50	-	50
	24CHUE3101	Field Visit	2	-	50	-	50
		Total	20	19	320	280	600
Semester -VI							
Core	24CHUC3217	Organic Chemistry – III	4	4	40	60	100
	24CHUC3218	Physical Chemistry - IV	3	3	40	60	100
	24CHUC3219	Elements of spectroscopy	4	4	40	60	100
	24CHUC3220	Analytical Chemistry - I	3	3	40	60	100
	24CHUC3221	Physical Chemistry Practical	2	5	60	40	100
	24CHUB3202	Green Chemistry	4	4	40	60	100
	24CHUC322	Project	4	-	40	40+20	100
		(OR)					
		Industrial Chemistry	4	4	40	60	100
Total			24	27	300	400	700
Grand Total up to VI Semesters for B.Sc Chemistry			**132**	**--**	**2120**	**2280**	**4400**
Semester - VII							
Core	24CHUC4123	Inorganic Chemistry - IV	3	3	40	60	100
	24CHUC4124	Organic Chemistry - IV	3	3	40	60	100
	24CHUC4125	Physical Chemistry - V	3	3	40	60	100
	24CHUB4103	Analytical Chemistry - II	4	4	40	60	100
	24CHUB4104	Chemistry Through Problem Solving Approach-I	4	4	40	60	100
	24CHUC4126	Advanced Organic Chemistry Practical	2	5	60	40	100
	24CHUC4127	Advanced Physical Chemistry Practical	1	5	60	40	100

		Total	20	25	320	380	700
Semester – VIII							
Core	24CHUC4228	Chemistry Through Problem Solving Approach-II	3	3	40	60	100
	24CHUC4229	Advanced Methods in Organic Synthesis	3	3	40	60	100
	24CHUC4230	Advanced Inorganic Chemistry Practical	2	5	60	40	100
	24CHUC4231	Project	12	-	120	120+6	300
		Total	20	11	240	360	600
Grand Total up to VIII Semesters for B.Sc(Hons) Chemistry			**172**	**-**	**2680**	**3020**	**5700**

MD: Multidisciplinary; AEC: Ability Enhancement Course; SEC: Skill Enhancement Course; VAC: Value Added Course

LIST OF MULTIDISCIPLINARY COURSES OFFERED TO OTHER DEPARTMENTS

Semester	Course code	Course title	Credit
I	24CHUI1101	Polymer Science	3
I	24CHUI1102	Organic Chemistry for Home Science	3
I	24CHUI1103	Chemistry in the Service of Mankind	3
I	24CHUI1104	Food Adulteration and Analysis	3

LIST OF ALLIED COURSES OFFERED TO OTHER DEPARTMENTS

Semester	Course code	Course title	Credit
I	24CHUB1101	Allied Chemistry–I [For B.Sc.(Hons) Microbiology]	3
I	24CHUB1102	Allied Chemistry Practical–I [For B.Sc.(Hons) Microbiology]	1
II	24CHUB1201	Allied Chemistry–II [For B.Sc.(Hons) Microbiology]	3
II	24CHUB1202	Allied Chemistry Practical–II [For B.Sc.(Hons) Microbiology]	1
III	24CHUB2101	Allied Chemistry–I [For B.Sc.(Hons)/B.Sc.,B.Ed. Physics and B.Sc.(Hons) Geology]	3
III	24CHUB2102	Allied Chemistry Practical–I [For B.Sc.(Hons)/B.Sc.,B.Ed. Physics and B.Sc.(Hons) Geology]	1
IV	24CHUB2201	Allied Chemistry–II [For B.Sc.(Hons)/B.Sc.,B.Ed. Physics	3

		and B.Sc.(Hons) Geology]	
IV	24CHUB2202	Allied Chemistry Practical – II [For B.Sc.(Hons)/B.Sc.,B.Ed. Physics and B.Sc.(Hons) Geology]	1

LIST OF INTRADEPARTMENTAL ELECTIVE

Semester	Course code	Course title	Credit
IV	24CHUA2201	Cosmetic Chemistry	3
IV	24CHUA2202	Nanoscience And Its Applications	3
IV	24CHUA2203	Agricultural Chemistry	3
IV	24CHUA2204	Water Quality Analysis	3

Semester	I	Course Code	**24CHUC1101**
Course Title	**CONCEPTS OF CHEMISTRY – I**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to develop an understanding of atomic structure, chemical bonding, periodic properties of elements. The course also aims to give an understanding on types of organic reactions and detailed reaction mechanism of substitution and elimination reactions.		
UNIT	Content		No. of Hours
I	**Atomic Structure** Rutherford atomic model – Bohr theory of hydrogen atom – Sommerfeld theory - Particle and wave character of electrons – de Broglie's equation – Davisson- Germer experiment - Heisenberg's uncertainty principle-Compton effect – Schrödinger wave equation – Eigen values and Eigen functions – quantum numbers – orbits and orbitals. Shapes of s, p, d and f orbitals; Contour boundary and probability diagrams. Pauli's exclusion principle – Hund's rule of maximum		9 Hours

	multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.	
II	**Chemical Bonding** Types of bonds – ionic, covalent, coordinate and metallic bonds - condition for the bond formation - concept of hybridization – hybridization involving s-, p- and d-orbitals – properties of ionic, covalent and coordinate compounds – valence bond theory –VSEPR theory. Molecular orbital theory – molecular orbital configurations of simple homo nuclear and hetero nuclear diatomic molecules – comparison between VBT and MOT – basic concept of resonance.	9 Hours
III	**Periodic Properties and Solutions** Periodic Properties: s, p, d, f block elements, the long form of periodic table. Periodicity of properties – Shielding effect – factors affecting magnitude of shielding - Effective Nuclear charge –Slater's rule – applications of effective nuclear charge – atomic volume – atomic radii, and ionic radii – factors affecting atomic and ionic radii - Ionization Energy – factors affecting ionization energy - Electronegativity – factors affecting electronegativity - Electron Affinity – factors affecting electron affinity – Diagonal relationship. **Solutions:** Various units of expressing concentrations of solutions – solutions of liquid in liquids – ideal and non-ideal solutions – Raoult's law – solutions of gases in liquid.	8 Hours

IV	**Reactive intermediates and types of organic reactions** Homolytic and heterolytic bond fissions – Types of reagents - electrophiles and nucleophiles - Reactive intermediates: carbocations, carbanions, free radicals, carbene, nitrene and benzyne intermediates - definition and examples for inductive, mesomeric, hyper conjugation, and steric effect. Types of organic reactions: addition, elimination, substitution, rearrangement, oxidation, reduction, molecular reactions and polymerization.	9 Hours
V	**Organic Reaction Mechanism-I** Reactions of alkanes and cycloalkanes: Free radical reactions - Stability and ease of formation of free radicals; Halogenation of alkanes: mechanism; orientation; relative reactivities of alkanes towards halogenation; transition state; orientation and stability; reactivity and selectivity; non-rearrangement of free radicals. Detailed study on mechanism and stereochemistry of S_N1, S_N2, E1 and E2 reactions. Electrophilic aromatic substitution in aryl halides– nucleophilic displacement.	12 Hours
References	Reference Books: 1. Principles of Physical Chemistry, B.R.Puri, L.R.Sharma and M.S.Pathania, Vishal Publishing Co., 47th Ed., 2016. 2. Modern Inorganic Chemistry, R.D.Madhan and Sathya Prakash, 4th Ed., 1996. 3. A New Concise Inorganic Chemistry, J.D. Lee, Oxford Publishers, 5th Ed., 2014. 4. Organic Chemistry, R.T. Morrison, R.N.Boyd, S.K.Bhattacharjee, Pearson Publishers, New Delhi, 7th Ed.	

	2011. 5. Organic Chemistry, Maitland Jones Jr, Steven A. Fleming, W.W.Norton & Company, London, 4th edition, 2010. 6. Organic Chemistry, T. W. Graham Solomons, Craig B. Fryhle. John Wiley & Sons, Inc.,10th edition, 2011. 7. F.A.Carey, R.J.Sundberg, Advanced Organic Chemistry, Structure and Mechanisms, Part A, 5th Edition, Springer, 2008. 8. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th edition, Pearson Education, 2003. 9. J.Clayden, N.Greeves and S.Warren Organic Chemistry, 2nd edition, Oxford University Press, 2012.
Course Outcomes	On completion of the course, students should be able to CO1: Understand atomic theory of matter, composition of atom. CO2: Describe atomic structure, orbital concepts, chemical bonding and their propertiesin inorganic molecules CO3: Explain the periodic properties of elements CO4: Predict the stability of reactive intermediates and types of reactions. CO5: Explain the substitution and elimination reaction mechanism.

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	**3**	**2**	**1**	**2**	**3**
CO2	**3**	**1**	**2**	**2**	**3**
CO3	**3**	**1**	**2**	**1**	**3**
CO4	**3**	**1**	**1**	**3**	**3**
CO5	**3**	**1**	**1**	**3**	**3**

Semester	**I**	Course Code	**24CHUC1102**
Course Title	**INORGANIC QUALITATIVE ANALYSIS PRACTICAL**		
No.of Credits	1	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand , Analyse , Apply		
Course Objectives	The practical course is designed to develop skill in semi-micro inorganic analysis.		

Content	No. of Hours
Semi-micro qualitative analysis of inorganic mixtures containing two of the following cations and one of the interfering acid radicals and a simple acid radical. **Cations:** Pb, Bi, Cu, Sn, Fe, Al, Cr, Ni, Co, Zn, Mn, Ca, Ba, Sr, Mg and NH4+. **Anions:** Acetate, oxalate, tartarate, borate, chromate, chloride, iodide, bromide, nitrate, carbonate, sulphide, sulphate and phosphate.	3 Hours

References	Reference Books: 1. Practical Chemistry by A.O. Thomas, Scientific Book Centre, Cannanore, 2003. 2. Basic Principles of Practical Chemistry, V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu, Sultan Chand & Sons, New Delhi, 2nd Ed., 2004.
Course Outcomes	On completion of the course, students should be able to CO1: Analyze inorganic salts qualitatively and systematically eliminate interfering radicals. CO2: Identify elements in a given inorganic mixture by semi-micro qualitative analysis.

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	2	3
CO2	2	2	2	2	1

Semester	II	Course Code	**24CHUC1203**
Course Title	**CONCEPTS OF CHEMISTRY – II**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand , and Analyse		
Course Objectives	The objective of the course is to understand the organic reactions involving C-C multiple bonds, to know the chemistry of benzenes and arenes, to know the basic principles of metallurgy, to understand the chemistry of s-block elements, to know solid state and concept of conductor.		
UNIT	Content		No. of Hours
I	**Reactions involving C-C multiple bonds** **Alkene:** Preparation of alkenes: dehydrohalogenation, dehydration, dehalogenation and reduction of acetylene. Reactions of alkenes: regiochemistry of the addition reactions - Markovnikov's rule, peroxide effect; addition reactions of alkenes - hydrogenation, halogenation, oxymercuration, hydroboration, epoxidation, cyclopropanation,		12 Hours

	hydrohalogenation, addition of H_2O, hypohalous acid, hydroxylation with H_2O_2 and allylic substitution. Dipolar addition reactions: ozonolysis, oxidation with alkaline $KMnO_4$, oxidation with OsO_4. **Dienes:** stability of isolated and conjugated double bonds - 1,2 and 1,4-addition: thermodynamic and kinetic control of addition reactions - Diels-Alder reaction. **Alkynes:** Methods of preparation; addition reactions – addition reactions of alkynes - hydrogenation, halogenation, oxymercuration, hydroboration, acidity of alkynes	
II	**Benzene and Arenes** Aromaticity- Huckel's rule- nomenclature of benzene derivatives-structure of benzene – Electrophilic aromatic substitution reactions - mechanism of halogenation, sulphonation, and nitration - Friedel-Crafts alkylation - Friedel-Crafts acylation, theory of orientation – classification of substituent groups – effect of substituent groups. Birch reduction of aromatic compounds. **Benzyl group and its reactivity:** Substitution reactions, radical reactions, oxidation at the benzylic position. Alkenyl benzenes - addition to conjugated alkenyl benzenes – orientation.	9 Hours

III	**Process of Metallurgy** Definition for minerals and ores - ore dressing – gravity separation - froth flotation- magnetic separation - chemical separation- calcination and roasting. Extraction of metal- chemical reduction-auto reduction-electrolytic reduction-metal displacement. Refining methods distillation - fractional crystallization - van Arkel method - electrolytic refining - vapour phase refining-ion exchange method-muffle furnace**.**	9 Hours
IV	**s-block Elements** General characteristics - anomalous behaviour of lithium and beryllium - diagonal relationships of lithium with magnesium and beryllium with aluminium. Preparation, properties and uses of lithium hydride, sodium peroxide, potassium iodide, calcium-carbide, super phosphate of lime, plaster of paris and lithopone.	8 Hours
V	**Solid State** Differences between crystalline and amorphous solids -symmetry in crystal systems - law of interfacial angles -law of rational indices - Miller indices - space lattice and unit cell- Bravis lattices-Bragg's equation - powder method. Packing in crystals - types of crystals - structure of sodium chloride - concept of conductor, semiconductor and superconductor-band theory.	7 Hours
References	Reference Books: 1. Organic Chemistry, R.T. Morrison, R.N. Boyd, S.K. Bhattacharjee., Pearson Publishers, New Delhi, 7th Ed., 2011. 2. Organic Chemistry, Maitland Jones Jr, Steven A. Fleming,	

	W.W. Norton & Company, London, 4th edition, 2010. 3. Organic Chemistry, T. W. Graham Solomons, Craig B. Fryhle. John Wiley & Sons, Inc.,10thedition, 2011. 4. F.A.Carey, R.J. Sundberg, Advanced Organic Chemistry, Structure and Mechanisms, PartA, 5th Edition, Springer, 2008. 5. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th edition, Pearson Education, 2003. 6. J.Clayden, N.Greeves and S.Warren, Organic Chemistry, 2nd edition, Oxford University Press, 2012. 7. A New Concise Inorganic Chemistry, J.D. Lee, Oxford Publishers, 5th Ed. 2014. 8. Textbook of Inorganic Chemistry, P.L. Soni, Sultan Chand & Sons, New Delhi, 20th Edn. 2000. 9. Selected Topics in Inorganic Chemistry, Malik, Tuli, Madan, S.Chand & Co., New Delhi, 2010 10. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania,Vishal Publishing Co., 47th Edn., 2016.
Course Outcomes	On completion of the course, students should be able to CO1: Describe the reactions involving unsaturated organic molecules like alkenes, dienes and alkynes CO2: Predict the product of the electrophilic aromatic substitution and nuclear substitution reactions. CO3: Describe various metallurgical processes CO4: Justify the general and anomalous properties of s- block elements CO5: Describe the types of solids, symmetry elements, unit cell, powder-X-ray diffraction method and the concept of conductors.

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	3
CO2	3	3	3	2	3
CO3	3	1	3	1	3
CO4	3	2	3	1	3
CO5	3	1	3	2	3

Semester	**II**	Course Code	**24CHUC1204**
Course Title	**VOLUMETRIC ANALYSIS PRACTICAL**		
No.of Credits	1	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand, Analyse, Apply		
Course Objectives	The practical course is designed to understand basics and gain knowledge on laboratory reagents and their uses in volumetric analysis.		

Content	No. of Hours
1. Preparation of standard solutions. 2. Acidimetry-alkalimetry. 3. Permanganometry. 4. Redox titrations involving dichrometry. 5. Complexometric titrations.	3 Hours

6. Iodometry. 7. Iodimetry. 8. Precipitation titration. **9.** Estimation of ferric iron by reduction method**.**	
References	Reference Books: 1. Practical Chemistry by A.O. Thomas, Scientific Book Centre, Cannanore, 2003. 2. Basic Principles of Practical Chemistry, V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu, Sultan Chand & Sons, New Delhi, 2nd Ed., 2004.
Course Outcomes	On completion of the course, students should be able to CO1: Prepare standard solutions CO2: Understand the concepts of volumetric analysis CO3: Carry out quantitative estimation of inorganic substances

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	3
CO2	3	1	1	1	3
CO3	3	3	1	3	3

Semester	III	Course Code	**24CHUC2105**
Course Title	**INORGANIC CHEMISTRY– I**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to understand the chemistry of p-block elements, to know the chemistry of halogens and inert gases and to understand radioactivity, transmutation, nuclear reactions and the applications of isotopes.		

UNIT	Content	No. of Hours
I	**p-block Elements I** General characteristics of elements - diagonal relationship of boron with silicon. Preparation, properties and structure of orthoboric acid, borax and diborane-Borax bead test. Synthesis and structure of borazine. Classification of carbides. Preparation, structure and uses of silicones-classification and structure of silicates. Relative strengths of boron trihalides as Lewis acids.	12 Hours
II	**p-block Elements II** Preparation and properties of nitrogen dioxide, sulphur dioxide, phosphorous pentoxide, selenium oxide, orthophosphoric acid, arsenious oxide and ozone. Synthesis and structure of phosphazine. Nomenclature, structure of compounds and ions containing nitrogen & oxygen; sulphur & oxygen;	9 Hours

	oxyacids of phosphorus and sulphur.	
III	**Halogens and Inert Gases** General characteristics, comparison of oxidizing action of halogens. Acid strengths of hydrogen halides- Nomenclature and structure of oxy acids of halogens. Preparation, properties and structure of interhalogen compounds. Inert gas-position in the periodic table-electronic configuration and reactivity-chemistry of xenon hexafluoride, xenon oxyfluoride and xenon trioxide.	8 Hours
IV	**Nuclear Chemistry – I** Composition of nucleus- nuclear stability- n/p ratio magic numbers- nuclear binding energy-mass defect - Radioactivity- types of radioactivity- types of radioactive rays -nuclear shell model - groups displacement law - decay constant – half-life period - radioactive equilibrium- transmutation- artificial transmutation- applications of artificial transmutation-radioactive series.	10 Hours
V	**Nuclear Chemistry – II** Nuclear reactions types: fission and fusion reactions-principle and working of nuclear reactors. Isotopes: Separation of isotopes-identification of isotopes- isotopes of hydrogen- isotope effect- application of isotopes in chemistry, agriculture and medicine - carbon dating - nuclear isomerism	6 Hours
References	Reference Books:	

	1. A New Concise Inorganic Chemistry, J. D. Lee, Oxford Publishers, 5th Ed., 2014. 2. Text book of Inorganic Chemistry, P.L. Soni, Sultan Chand & Sons, New Delhi, 20th Edn., 2000. 3. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson and P.L. Gaus John Wiley & Sons Inc. 3rd Edn. 1995.
Course Outcomes	On completion of the course, students should be able to CO1: Describe general characteristics, preparation of derivatives and structure of boron, carbon and silicon. CO2: Understand the properties of nitrogen, sulphur, phosphourus and selenium. CO3: Interpret the properties and structure of inter-halogen compounds and inert gases. CO4: Understand the origin of radioactivity, types of radiation and nuclear stability. CO5: Explain the types of nuclear reactions and application of isotopes in chemistry, agriculture and in medicine.

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	3
CO2	3	2	2	2	3
CO3	3	2	3	3	3
CO4	3	1	3	3	3
CO5	3	2	3	3	3

Semester	**III**	Course Code	**24CHUC2107**
Course Title	**APPLIED CHEMISTRY PRACTICAL**		
No.of Credits	1	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand , Analyse, Apply		
Course Objectives	The objective of the practical course is to enhance knowledge in basic principles of titrimetry, to develop skill in titrimetric analysis, to gain practical knowledge in oil analysis and to develop skill in identification of water quality parameters.		

Content	No. of Hours
1. Estimation of Phenol. 2. Estimation of Glucose (Fehling's method). 3. Estimation of Glucose (Bertrand's method). 4. Determination of iodine value of oil. 5. Determination of saponification value. 6. Determination of free fatty acid. 7. Estimation of total solids in water. 8. Estimation of chloride in water. 9. Estimation of fluoride in water. 10. Alloy analysis.	3 Hours

References	Reference Books:
	1. Basic Principles of Practical Chemistry, V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu, Sultan Chand & Sons, New Delhi, 2nd Edn., 2004.

Course Outcomes	On completion of the course, students should be able to CO1: Estimate certain organic compounds by titrimetry CO2: Analyze free fatty acids CO3: Calculate saponification value and iodine value CO4: Estimate water quality parameters

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	2	2	3	3	2
CO3	3	2	3	2	3
CO4	3	2	3	3	3

Semester	III	Course Code	**24CHUC2106**
Course Title	**PHYSICAL CHEMISTRY– I**		
No.of Credits	4	No. of contact hours per week	4
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand, Analyse		
Course Objectives	The objective of the course is to understand basic laws and applications of thermodynamics, to understand basics of surface chemistry and surface phenomena, to impart the knowledge of basic interactions between molecules and to gain familiarity of the forces existing in molecular systems.		

UNIT	Content	No. of Hours
I	**Thermodynamics-I** Terminology–Systemandsurrounding-typesofsystems-statevariables-state and path functions- thermodynamic equilibrium - extensive and intensive properties - types of processes - zeroth law of thermodynamics- first law of thermodynamics – statement - internal energy – enthalpy - heat capacity – relation between Cp and Cv - expansion of ideal gas – work done in isothermal and adiabatic expansions - Joule-Thomson effect and Joule-Thomson coefficient-inversion temperature.	8 Hours
II	**Thermodynamics-II** Spontaneous, non-spontaneous and cyclic process–reversible and irreversible processes. Carnot cycle – statement of the second law of thermodynamics– efficiency of heat engine – Carnot's theorem – concept of entropy – entropy changes in reversible and irreversible processes-entropy changes in isothermal expansion of ideal gas-entropy of mixing of gases – physical significance of entropy– Maxwell relations; thermodynamic equation of state.	10 Hours

III	**Thermodynamics-III** Gibbs–Helmholtz free energies and equations –partial molar properties– dependence of thermodynamic parameters on composition-chemical potential - Gibbs-Duhem equation chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases-Clausius–Clapeyron equation-Concept of fugacity. Third Law of thermodynamics, residual entropy, calculation of absolute entropy of molecules.	12 Hours
IV	**Colloids and Colligative Properties** **Colloids:** Types of colloidal systems – lyophilic and lyophobic sols – kinetic –optical and electrical properties of colloids–protective colloids–emulsions–gels application of colloids. Colligative properties – definition – measurement of lowering of vapour pressure – elevation of boiling point – depression of freezing point – osmotic pressure – reverse osmosis.	6 Hours
V	**Surface Chemistry and Electric Properties of Molecules** **Surface Chemistry:** Physisorption – chemisorption – Fruendlich and Langmuir adsorption isotherms – BET theory multilayer adsorption – BET equation (derivation not required)– determination of surface using BET theory-applications of adsorption. **Electric Properties of Molecules:** Electric dipole-dipole moment–induced dipole moment polarization- polarizabilities– Clausius-Mossoutti equation-relative permittivity– refractive index.	9 Hours

References	Reference Books: 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical chemistry, Vishal Pub.Co. Jalandhar, 48th edition, 2020. 2. Peter Atkins and Julio de Paula, Physical Chemistry, Oxford University Press, 9th edition, 2011. 3. Robert. G. Mortimer, Physical Chemistry, Academic Press; 3rd edition, 2008. 4. B. S. Bahl, G. D. Tuli and Arun Bahl, Essentials of Physical Chemistry, S. Chand &Co. Ltd, New Delhi, 12th Edn., 2011. 5. A.S. Nagi and S.C. Anand, A Text Book of Physical Chemistry, Wiley Eastern Ltd, New Delhi, 7th Edn.,2000. 6. Ball, D. W. Physical Chemistry, Thomson Press, India, 2007. 7. Castellan, G. W. Physical Chemistry, 4th Ed. Narosa, 2004. 8. Engel, T. and Reid, P. Physical Chemistry, 3rd Ed., Pearson, 2012.	
Course Outcomes	On completion of the course, students should be able to CO1: Understand the basics in thermodynamics CO2: Interpret the concept of entropy and free energy CO3: Describe the concepts of partial molar properties and third law of thermodynamics CO4: Interpret the concepts and theories of surface chemistry and colloids. CO5: Analyze the surface using BET theory and describe the interactions between molecules.	

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	2	2	2
CO2	3	3	3	3	3
CO3	3	2	3	2	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3

Semester	IV	Course Code	**24CHUC2208**
Course Title	**ORGANIC CHEMISTRY - I**		
No.of Credits	4	No. of contact hours per week	4
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to understand the various conformations of alkanes and cycloalkane, chemistry of organic molecules based on the spatial orientation of constituent atoms or groups, to know the chemistry of carbonyl compounds such as aldehydes, ketones and carboxylic acid derivatives and also to understand selected name reactions involving carbonyl compounds.		
UNIT	Content		No. of Hours
I	**Stereochemistry-I**		13 Hours

	Projections- Intertranslations of different projection formulae-Conformations of ethane, propane and butane. Conformations of mono and di-substituted cyclohexanes and decalins; Relative stabilities of cycloalkanes - ring strain; Baeyer's strain theory; heats of combustion; orbital structure of angle strain;. Isomerism –Isomerism in alkenes: cis- / trans- and E/Z nomenclature.	
	Stereochemistry-II Optical isomerism-Optical activity, specific rotation, definition of optical isomerism – elements of symmetry, chirality, optical isomerism of compounds containing asymmetric carbon atoms – lactic and tartaric acids – enantiomers and diastereoisomers – racemic mixtures –Walden inversion – asymmetric synthesis – absolute configuration by R/S – notation, optical activity of compounds without asymmetric carbon atoms – allenes, spiranes and biphenyl compounds. Topical relationship in organic molecules – Homotopic, enantiotopic, diastereotopic groups and faces, Pro R and S descriptors and Re and Si for ligands.	13 Hours

III	**Carbonyl Compounds-I** Reactivity of aldehydes and ketones – nucleophilic addition reaction (H, C, N, O and S based nucleophiles) reductions- Clemmensen reduction and Wolff-Kishner reductions- Cannizarro reaction – Enolization catalysed by acids and bases, generation of thermodynamic vs kinetically controlled enolates; base promoted and acid catalysed halogenations of ketones – acidity of α-hydrogen-reactions involving carbanions, aldol condensation, crossed aldol condensation, Knoevenagal condensation and Perkin condensation	12 Hours
IV	**Carbonyl Compounds-II** Synthesis of carboxylic acids – oxidation, nitrile synthesis and reaction of organometallic reagent with CO_2; Acidity of carboxylic acids, stability of carboxylate anion-effect of substituents on acidity; reactions of carboxylic acids: Formations of esters, amides, acid chlorides and anhydrides-decarboxylation; Hunsdiecker reaction; Hell Volhard Zelensky reaction. Functional derivatives of carboxylic acids - nucleophilic acyl substitution (H, C, N, O based nucleophiles) nucleophilic substitution: alkyl vs. acyl. Hydrolysis of amides, acid and alkaline hydrolysis of esters, trans esterification. Dicarboxylic acids - action of heat on dicarboxylic acids. Hydroxy acids - Reformatsky reaction, action of heat on hydroxy acids**.**	11 Hours
V	**Name reactions involving carbonyl compounds** Mechanism and applications of reactions of	10 Hours

	following name reactions -Micheal addition, Robinson annulation, Baylis-Hillman reaction, Darzens reaction, Mannich reaction, Vilsmeier-Haack, Claisen condensation, Dieckmann condensation, acyloin condensation, Stobbe condensation	
References	Reference Books: 1. A.J. Kirby, Stereoelectronic Effects, Oxford University Press, 1996. 2. E.L. Eliel and S.H. Wilen, Stereochemistry of Organic Compounds. Wiley Student Edition, 2008. 3. I.L. Finar, Organic Chemistry, Vol.2 ELBS, 5th edition, 1974 and Pearson India, 5th edition, 2011. 4. Organic Chemistry, R.T. Morrison and R.N. Boyd., Prentice Hall of India Pvt. Ltd., New Delhi, 7th Edn. 2011. 5. OrganicChemistry, I.L. Finar, ELBS, Vol 1, 6th Edn. 2002. 6. Organic Chemistry, Maitland Jones Jr, Steven A. Fleming, W.W. Norton & Company, London, 4th edition, 2010. 7. Organic Chemistry, T. W. Graham Solomons, Craig B. Fryhle. John Wiley & Sons, Inc. 10th edition, 2011. 8. F.A.Carey, R.J. Sundberg, Advanced Organic Chemistry, Structure and Mechanisms, Part B, 5th Edition, Springer, 2008. 9. J.Clayden, N. Greeves and S. Warren, Organic Chemistry, 2nd edition, Oxford University Press, 2012.	
Course Outcomes	On completion of the course, students should be able to CO1: Describe the conformation analysis of alkanes and cycloalkanes. CO2: Describe commonly used terms in stereochemistry and predict the absolute configuration of a chiral organic molecule CO3: Demonstrate the chemistry of aldehydes and ketones CO4: Describe the preparation and reactions of carboxylic acid and their derivatives	

	CO5: Demonstrate the mechanism and applications of selected name reactions involving carbonyl compounds.

Mapping of CO with PSO

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	3	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3

Semester	IV	Course Code	**24CHUC2209**
Course Title	**INORGANIC CHEMISTRY– II**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Advanced Skill		
Cognitive Levels addressed by the course	Understand and Analyse		
Course Objectives	The objective of the course is to understand the basic concepts of		

	acids and bases, classification of solvents and their reactions, to learn the general characteristics of d- and f- block elements, to realize the chemistry of metal carbonyls and to gain knowledge of the functions of metal ions in biological systems.	
UNIT	Content	No. of Hours
I	**Acids and Bases** Lewis concept – Classification of Lewis acids – Lux-Flood concept – Hard-Soft acid base concept and its applications. Non- aqueous solvents- Classification of solvents- Neutralization reaction and solvolysis in liquid ammonia- Metal- ammonia solutions. Neutralisation, solvolysis and redox reactions in liquid sulphur dioxide.	9Hours
II	**d-Block and f- Block elements** **d-Block elements:** General characteristics - electronic configuration, variable valency, non-stoichiometric compounds. Preparation, properties and uses of potassium dichromate, potassium permanganate and manganese dioxide. Anomalous behaviour of mercury. **f-Block elements:** General characteristics- electronic configuration- oxidation states- Lanthanide contraction and its consequences. Separation methods- fractional crystallization, oxidation- reduction, ion-exchange method and chromatographic separation.	10 Hours

II	**Oxidation and Reduction** Oxidation number concept of oxidation and reduction reactions: Evaluation of oxidation number, Periodic variation in oxidation number - Balancing redox reactions by ion-electron method – Equivalent weight of oxidant and reductant – Complementary and non-complementary redox reactions – Standard electrode potential, Electrochemical series – Digrammatic representation of redox potential data: Latimer diagram for dichromate and permanganate ions – Frost diagram for nitrogen compounds and manganese system – Ellingham diagram: Thermodynamics of metallurgical processes.	9 Hours
IV	**Organometallic Compounds** Metal carbonyls- definition and classification- General methods of preparation- effective atomic number rule - structure and bonding of mononuclear carbonyls of nickel, iron and chromium, binuclear carbonyls of iron, cobalt and manganese and trinuclear carbonyls of iron and osmium. Tetra nuclear carbonyls of iridium. Zeigler-Natta catalyst**.**	10 Hours
V	**Bio Inorganic Chemistry** Metals in biology-bulk and trace metals-biological role of myoglobin and hemoglobin-Metalloenzymes- carboxypeptidase – carbonic anhydrase- Biological functions and toxicity of chromium, manganese, cobalt, nickel, copper, arsenic, iodine and mercury.	7 Hours
References	Reference Books:	

	1. A New Concise Inorganic Chemistry, J. D. Lee, Oxford Publishers, 5th Ed., 2014. 2. Text book of Inorganic Chemistry, P.L. Soni, Sultan Chand & Sons, New Delhi, 20th Edn., 2000. 3. Selected topics in Inorganic Chemistry, W. U. Malik, G. D. Tuli and R. D. Madan, S. Chand & Co. Ltd., New Delhi, 2012. 4. Advanced Inorganic Chemistry, S.P.Banerjee, 2nd Ed., Books and Allied Ltd., Kolkata.
Course Outcomes	On completion of the course, students should be able to CO1: Describe basic concepts of acids and bases and non-aqueous solvents CO2: Predict the properties of d- and f-block elements CO3: Classify and demonstrate the methods of preparation of organometallic compounds CO4: Describe the role of metals in biological systems such as enzymes and demonstrate the metal toxicity.

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	3	1
CO2	3	2	3	2	3
CO3	3	2	2	3	2
CO4	3	1	3	3	3

Semester	IV	Course Code	**24CHUC2210**
Course Title	**PHYSICAL CHEMISTRY– II**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Advanced Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to understand application of thermodynamics, to know the basic concepts of chemical equilibira, ionic equilibira and phase equilibria and to be familiar with the kinetic properties of gases		

UNIT	Content	No. of Hours
I	**Thermochemistry** Heat changes in chemical reactions –enthalpy of formation-enthalpy of combustion – enthalpy of solution - enthalpy of dilution - enthalpy of neutralization -relation between enthalpy of a reaction at constant volume and at constant pressure - calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations), pressure on enthalpy of reactions.	10Hours
II	**Chemical Equilibria** Law of mass action – equilibrium constant K, Kp and Kc, relation between Kp and Kc–De Donder's treatment of chemical equilibria-	11 Hours

	thermodynamic relations for chemical affinity-Homogeneous equilibria – $N_2(g) + O_2 (g) \rightleftharpoons 2NO$; Temperature dependence of the equilibrium constant-van't Hoff equation; Heterogeneous equilibria (examples only)-Le-Chatelior principle and its application to $N_2+3H_2 \rightleftharpoons 2NH_3$ system.	
III	**Ionic Equilibria** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono and diprotic acids. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.	6 Hours
IV	**Phase Equlibria** Phase, component and degree of freedom, derivation of phase rule, one component Systems - water system, sulphur system, CO_2, Trouton's Rule, two component systems-Lead- Silver system, zinc-Magnesium system, formation of compounds with incongruent and congruent melting points-ferric chloride-water system, sodium sulphate-water system. Three component system- Systems of three liquids-systems consisting of two salts and water. The Ehrenfest classification of phase transitions.	10 Hours

V	**Gaseous State** Gaseous State: Kinetic theory of gases- Maxwell's distribution of molecular velocities (derivation included)-collision diameter-collision number, collision frequency-mean free path-real and ideal gases- van der Waal's equation. Transport properties, principle of equipartition of energy, degree of freedom and molecular basis of heat capacities, critical phenomena.	8 Hours
References	Reference Books: 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical chemistry, Vishal Pub.Co. Jalandhar, 48th edition, 2020. 2. Peter Atkins and Julio de Paula, Physical Chemistry, Oxford University Press, 9th edition, 2011. 3. Robert. G. Mortimer, Physical Chemistry, Academic Press; 3rd edition, 2008. 4. Ball, D. W. Physical Chemistry, 2nd Edition, Cengage Learning, India, 2017. 5. Castellan, G. W. Physical Chemistry, 4th Edition, Narosa, 2004. 6. Kapoor, K.L.A Textbook of Physical Chemistry, Vol 1-5, 6th Edition, McGraw Hill Education, 2015. 7. Engel, T. and Reid, P. Physical Chemistry, 3rd Ed., Pearson, 2012. 8. B. S. Bahl, G. D. Tuli and Arun Bahl, Essentials of Physical Chemistry, S. Chand &Co. Ltd, New Delhi, 12th Edn., 2011.	

Course Outcomes	On completion of the course, students should be able to CO1: Calculate the change in enthalpies of various chemical reactions CO2: Describe the concept of chemical equilibria and its application CO3: Compute the dissociation constant of acids and bases, pH of buffer solution CO4: Analyse and interpret the phase diagram of simple systems CO5: Describe the Kinetic model of gas and its properties of gases

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2
CO2	3	2	3	2	2
CO3	3	3	3	3	3
CO4	1	1	1	2	2
CO5	3	1	2	2	1

Semester	**IV**	Course Code	**24CHUC2211**
Course Title	**INORGANIC QUANTITATIVE ANALYSIS PRACTICAL**		
No.of Credits	2	No. of contact hours per week	5
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%

Category	Core Course
Scope of the Course	Basic Skill
Cognitive Levels addressed by the course	Understand and Analyse
Course Objectives	The objective of the practical course is to understand the chemistry of inorganic quantitative analysis, to acquire skills in inorganic quantitative estimation methods, to get trained in quantitative estimation methods, and to gain knowledge in the preparation of some inorganic complexes.

Content	No. of Hours
1. **Argentometry**: Estimation of Chloride (Mohr's method) **2. Colorimetry:** i. Estimation of iron (III) ii. Estimation of copper (II) **3. Gravimetric analysis** i. Estimation of lead as lead chromate ii. Estimation of nickel as Ni-(DMG) iii. Estimation of aluminium as aluminium oxinate iv. Estimation of calcium as calcium oxalate v. Estimation of barium as barium sulphate **4. Preparation** i. Tetrammine copper(II) sulphate ii. Tris(ethylenediamine) nickel(II) chloride (iii) Prussian blue iii. Hexammine cobalt(III) Chloride	5 Hours

References	Reference Books:
	1. Practical Chemistry by A.O. Thomas, Scientific Book Centre, Cannanore, 2003. 2. Basic Principles of Practical Chemistry V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu, S. Chand & Sons, New Delhi, 2nd Edn., 2004.

Course Outcomes	On completion of the course, students should be able to CO1: Demonstrate the principles of inorganic quantitative estimation methods CO2: Plan and execute an experiment to prepare metal complexes and gravimetrically analyze certain metal complexes.

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	2
CO2	3	2	3	3	3

Semester	V	Course Code	**24CHUC3112**
Course Title	**ORGANIC CHEMISTRY II**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Advanced Skill		
Cognitive Levels addressed by the course	Understand and Apply		
Course	The objective of the course is to understand the chemistry of alcohols, ethers, epoxides and phenols, to know the chemistry of polynuclear aromatic compounds and active methylene compounds, to understand the chemistry of nitrogen containing functional groups, to know the chemistry of five and six membered heterocyclic compounds and to understand organic		

	chemical reactions of heterocyclic compounds and to understand the mechanism of selected rearrangement reactions.	
UNIT	Content	No. of Hours
I	**Alcohols, Ethers Epoxides and phenols** Preparation – Oxymercuration and demercuration – Hydroboration and Oxidation – orientation, stereochemistry and mechanism of hydroboration – Grignard synthesis of alcohols. Glycols: Woodward cis and Prevost trans dihydroxylations-periodic acid oxidation. Ethers: Williamson's synthesis – preparation of substituted ethers. Epoxides: Preparation – acid and base catalyzed cleavage of epoxides. Nomenclature, preparation, properties - acidity of phenols, effect of substituents on acidity - Fries rearrangement - Kolbes synthesis of phenolic acids, Reimer - Tiemann reaction and reaction with HCHO.	9 Hours
II	**Polynuclear Aromatic Compounds and Active Methylene Compounds** Naphthalene – anthracene, phenanthrene – reduction and substitution reactions – Haworth's synthesis – Aromatization, orientation in polynuclear compounds. Synthetic uses of acetoacetic ester – decarboxylation of keto acids, Keto-enol tautomerism. Preparation and synthetic uses of malonic ester.	8 Hours
III	**Compounds with nitrogen containing functional groups** **Preparation-**Hofmann degradation- synthesis of secondary and tertiary amines - Hinsberg reaction - basicity of amines -basicity constant -structure and basicity, Effect of substituent on	11 Hours

	basicity -Hofmann rearrangement. Quaternary ammonium salts: Exhaustive methylation, Hoffmann elimination - conversion of amines into substituted amides-ring substitution in aromatic amines. **Nitro compounds:** reduction of nitrobenzene in various media –nucleophilic substitution of aromatic nitro compounds: SNAr mechanism-acidity of α-hydrogen: Henry reaction-Diazonium salts: preparation and preparation and reactions- Sandmeyer reactions, synthetic uses of diazonium salts**.** **Cyanides -**preparation and reactions-hydrolysis, alcoholysis, reaction with Grignard and reduction- isocyanides-prearation-carbylamines-reactions- hydrolysis, alcoholysis, oxidation and reduction.	
IV	**Heterocyclic Compounds** Synthesis and reactivity of five and six membered heterocycles-Furan, pyrrole, thiophene, pyridine- aromatic nature, electrophilic substitution, basicity of pyridine, Synthesis of Benzo fused five and six membered heterocycles with one nitrogen atom-indole, quinoline, isoquinoline, - Fischer indole synthesis, Skraup synthesis and Bischler–Napieralski reaction. Introductory concepts of pyrimidines and purines.	7Hours
V	**Molecular Rearrangements** Molecular Rearrangements: Rearrangements involving reactive intermediates (anionotropic, cationotropic, free radical, inter- and intramolecular processes) – Wagner-	9 Hours

	Meerwein, pinacol-pinacolone, Demjanov, Beckmann, Favorskii, Curtius, Schmidt, Lossen, Hofman-Loffler-Freytag, Wolff, benzilic acid, Claisen and benzidine rearrangements	
References	Reference Books: 1. A.J. Kirby, Stereoelectronic Effects, Oxford University Press, 1996. 2. E.L.Eliel and S.H. Wilen, Stereochemistry of Organic Compounds, Wiley Student Edition, 2008. 3. I.L. Finar, Organic Chemistry, Vol.2, ELBS, 5th edition, 1974 and Pearson India, 5th edition, 2011. 4. Organic Chemistry, R.T. Morrison and R.N. Boyd., Prentice Hall of India Pvt. Ltd., New Delhi, 7th Edn., 2011. 5. Organic Chemistry, I. L. Finar, ELBS,Vol 1, 6th Edn. 2002. 6. Organic Chemistry, Maitland Jones Jr, Steven A. Fleming, W. W. Norton & Company, London, 4th edition, 2010. 7. Organic Chemistry, T. W. Graham Solomons, Craig B. Fryhle. John Wiley & Sons, Inc., 10th edition, 2011. 8. F.A. Carey, R.J. Sundberg, Advanced Organic Chemistry, Structure and Mechanisms, Part B, 5th Edition, Springer, 2008. 9. J. Clayden, N. Greeves and S.Warren, Organic Chemistry, 2nd edition, Oxford University Press, 2012.	
Course Outcomes	On completion of the course, students should be able to CO1: Describe the methods of preparations and reactions of alcohols, ethers epoxides and phenols CO2: Demonstrate the reactions of polynuclear aromatic compounds and active methylene compounds CO3: Describe the preparation, properties and reactions of nitrogen containing functional groups. CO4: Describe the preparation, properties and reactions of five and six membered heterocyclic compounds CO5: Predict the mechanism of certain organic rearrangements.	

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	2
CO2	3	3	2	2	1
CO3	3	2	3	3	2
CO4	3	2	3	3	2
CO5	3	3	3	3	3

Semester	V	Course Code	**24CHUC3113**
Course Title	**INORGANIC CHEMISTRY III**		
No.of Credits	4	No. of contact hours per week	4
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand and Apply		
Course Objectives	The objective of the course is to learn the basic concepts of coordination chemistry, to understand different theories and applications of coordination compounds, to understand the properties of coordination compounds and to gain knowledge in mechanical aspects of coordination compounds.		
UNIT	Content		No. of Hours

I	**Introduction to Coordination Chemistry** Addition compounds -Double salts- complex compounds- complex ion and coordination number- Ligands and their classification- chelates and their uses- coordination number and stereochemistry of complexes- IUPAC Nomenclature of coordination compounds. Isomerism: Structural isomerism - ionization, hydrate, ligand, linkage, coordination, position, Stereoisomerism - geometrical isomerism in square planar and octahedral complexes - optical isomerism in octahedral complexes.	11 Hours
II	**Theories of Coordination Compounds** Werner's theory- Sidwick's electronic interpretation- EAN concept- Valence Bond Theory- Postulates of VBT - Complexes with sp^3, dsp^2 and d_2sp^3 hybridizations -outer and inner orbital complexes- Limitations of VBT- Crystal Field Theory- Postulates of CFT- Crystal field splitting in octahedral, tetragonal, square planar and tetrahedral complexes- High spin and Low spin complexes.	13 Hours
III	**Theories and Applications** Factors affecting crystal field splitting, John Teller distortion- Crystal field stablisation energy- calculation and uses- Limitations of crystal field theory. Applications of copper and silver complexes in inorganic qualitative analysis. Applications of Ca-EDTA and Ni-DMG complexes in inorganic quantitative analysis.	13 Hours
IV	**Properties of Complexes** Magnetic susceptibility-origin of magnetism-	11Hours

	Dia and Para magnetism-magnetic moments-Spin only formula-Gouy's experimental method. Color of transition metal complexes-visible spectrum of aqueous Ti (III) ion. Stability of complexes-overall and stepwise formation constants-Factors affecting stability of metal complexes with reference to the nature of metal ion and ligand -Determination of stability constant by Job's and Bjeruum's method.	
V	**Reaction Mechanism in Complexes** Lability and inert complexes - VBT and CFT-Ligand substitution reactions in octahedral complexes-Basic concepts of dissociation, association and SN1CB mechanism-substitution reactions in square planar complexes, trans- effect-applications of trans effect. Electron transfer reactions-Basic concepts of outer sphere and inner sphere mechanism- Factors affecting the rates of outer sphere electron transfer reactions.	12 Hours
References	Reference Books: 1. A New Concise Inorganic Chemistry, J. D. Lee, Oxford Publishers, 5th Ed., 2014. 2. Principles of Inorganic Chemistry, B. R. Puri, L. R. Sharma and K. C. Kalia, Shoban Lal Nagin Chand & Co., New Delhi, 2001. 3. Text Book of Inorganic Chemistry, P. L. Soni, S. Chand & Sons, New Delhi, 1993. 4. Selected Topics in Inorganic Chemistry, Malik, Tuli, Madan, S. Chand & Co., New Delhi, 2002.	

Course Outcomes	On completion of the course, students should be able to CO1: Describe basic concepts and theories of coordination chemistry CO2: Predict the properties of coordination compounds CO3: Demonstrate the applications of coordination compounds CO4:Predict the reaction mechanisms in coordination complexes. CO5: Determine the stability constant by Job's and Bjeruum methods

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	1
CO2	3	3	3	2	1
CO3	3	3	3	3	2
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	V	Course Code	**24CHUC3114**
Course Title	**PHYSICAL CHEMISTRY III**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand and Apply		
Course Objectives	The objective of the course is to understand the basic terminologies of chemical kinetics, to understand the theories of		

	reaction rates and catalysis, to have an introduction to the basic concepts of electrochemistry and to become familiar with ideal and non-ideal solutions.	
UNIT	Content	No. of Hours
I	**Chemical Kinetics -I** Introduction, order and molecularity, order and molecularity of a complex reactions, mechanism, and integration of rate expressions-zero, first, second and fractional order reactions, determination of orders-pseudo unimolecular reaction, half-life of a reaction, temperature dependence of reaction rates, Arrhenius equation.	10 Hours
II	**Chemical Kinetics- II** Theories of reaction rates, collision theory, absolute reaction rate theory (derivation not included), significance of the free energy of activation and entropy of activation, unimolecular reactions, Lindmann theory. Catalysis, types of catalysis, characteristics of catalytic reactions, theories of catalysis, enzyme catalysis, Michaelis-Menton equation.	8 Hours
III	**Ideal and Non-ideal Solutions** Ideal solutions, non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. Duhem- Margules equation, Lever rule, Azeotropes, Critical solution temperature (CST); effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.	8 Hours
IV	**Basics of Electrochemistry - I** Conductors, metallic conductors, electrolytic	10 Hours

	conductors, conductivity of electrolytes-electrical units- Electrolysis-Faraday's Laws - ohm's law, specific, molar and equivalent conductance and variation of conductance with dilution, cell constant, Kohlrausch's law and its applications, transport number, determination by moving boundary method-applications.	
V	**Basics of Electrochemistry - II** Theory of strong electrolytes- Arrhenius theory- limitations- Debye-Huckel theory of strong electrolytes. Activity coefficients-mean ionic activity coefficient-Debye – Huckel limiting law. Onsager equation (no derivation), conductance measurements-acid-base titration-precipitation titration-applications, Ostwald's dilution law.	9 Hours
References	Reference Books: 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical chemistry, Vishal Pub.Co. Jalandhar, 48th edition, 2020. 2. Peter Atkins and Julio de Paula, Physical Chemistry, Oxford University Press, 9th edition, 2011. 3. Robert. G. Mortimer, Physical Chemistry, Academic Press; 3rd edition, 2008. 4. Ball, D. W. Physical Chemistry, 2nd Edition, Cengage Learning, India, 2017. 5. Castellan, G. W. Physical Chemistry, 4th Edition, Narosa, 2004. 6. Kapoor, K.L.A Textbook of Physical Chemistry, Vol 1-5, 6th Edition, McGraw Hill Education, 2015. 7. Laideler K. J. and Meiser J. M. Physical Chemistry Third Edition (International), 1999. 8. B. S. Bahl, G. D. Tuli and Arun Bahl, Essentials of Physical Chemistry, S. Chand &Co. Ltd, New Delhi, 12th Edn., 2011	

Course Outcomes	On completion of the course, students should be able to CO1: Determine the order of the reaction, calculate the half-life of the reaction and study the effect of temperature on reaction rate CO2: Describe the theories of reaction rates and catalysis CO3: Analyses the basic concepts of binary solutions and its applications CO4: Describes the basics of conductance CO5: Describes the basics of electrolyte

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	2	3	2	1
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**V**	Course Code	**24CHUC3115**
Course Title	**ORGANIC QUALITATIVE ANALYSIS PRACTICAL**		
No.of Credits	2	No. of contact hours per week	5
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand and Analyse		

Course Objectives	The objective of the practical course is to understand the principles of organic qualitative analysis and to develop skill in single stage preparation of organic compounds.	
Content		No. of Hours
Qualitative Analysis of organic compounds: Analysis of mono and bifunctional organic compounds. Preparation of derivatives, recrystallization, and determination of physical constants. **Single stage preparation of organic compounds: a**cylation, oxidation, hydrolysis, nitration, esterification, condensation and bromination.		5 Hours
References	Reference Books: 1. Text Book of Practical Organic Chemistry, A.I. Vogel, ELBS, London, 5th Edn., 2010. 2. N.S. Gnanaprakasam and G. Ramamoorthy, Organic Chemistry Lab Manual, S. Viswanathan Company Pvt. Ltd. 1998.	
Course Outcomes	On completion of the course, students should be able to CO1:Analyze mono and bifunctional organic compounds qualitatively CO2: Synthesize organic compounds and their derivatives CO3: Recrystallize and purify the products of organic reactions CO4: Determine the physical constants of the products	

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3

Semester	V	Course Code	**24CHUB3101**
Course Title	**POLYMER CHEMISTRY**		
No.of Credits	4	No. of contact hours per week	4
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to understand the importance of polymers and an exposure to polymer chemistry, to understand various polymerization techniques and characterization of polymers, to enable a student to understand polymer structure, properties, and to know the polymer processing techniques and properties of commercially available polymers.		
UNIT	Content		No. of Hours
I	**Polymerization Reactions and Techniques** Introduction – degree of polymerization – functionality-classification of polymers – polymerization reactions – addition and condensation polymerization – mechanism – polymerization techniques – bulk, solution, suspension and emulsion methods.		9 Hours
II	**Polymer Characterization** Polymer Isolation-Fractionation- concept of number and weight averages – the practical significance of molecular weight– measurement of molecular weight – end group, viscosity, light scattering, osmotic pressure and ultra-centrifugation methods – testing of polymers – tensile strength, fatigue, impact strength, tear resistance, hardness and abrasion		12 Hours

	resistance.	
III	**Properties of Polymers** Polymer structure and physical properties – the relationship between Tg and Tm – Factors affecting Tg and Tm – significance – stereo regularity. Polymer degradation – types – mechanical, thermal and photo degradation – management of polymers	11 Hours
IV	**Polymer Processing and Additives** Plastics –thermoplastic and thermosetting plastics. Processing techniques – calendaring, compounding injection moulding, transfer moulding and extrusion moulding, spinning – melt – Dry and Wet methods. Polymer additives: Plasticizers, fillers, antioxidants, pigments and thermal stabilizers..	12 Hours
V	**Chemistry of Important Commercial Polymers** Polyethylene, teflon, polyamides, polyesters, phenolic resins, epoxy resins and polyurethane foam. Conducting polymer, biomedical polymer – contact lens, dental polymers and artificial heart.	13 Hours
References	Reference Books: 1. Polymer Science and Technology, Goel R. Fried, Prentice-Hall of India, New Delhi, 2nd Edn., 2003. 2. Polymer Science and Technology of Plastics and Rubbers by Premamoy Ghosh, Tata McGraw -Hill Publishing Company Ltd., New Delhi, 2009. 3. Polymer Science by V.R. Gowariker, N.V. Viswanathan and Sadadeve Sreedhar, New Age International (P) Ltd.	

	Publishers, 2003. 4. "Text Book of Polymer Science" by Fred W. Billmeyer, J.R. John Wiley Publishers, 3rd Edn., 2003.
Course Outcomes	On completion of the course, students should be able to CO1: Classify polymers and describe different types of polymerizations reactions CO2: Characterize polymers based on available experimental data CO3: Describe the structure and properties of polymers CO4: Demonstrate the properties of commercially available polymers

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	1
CO2	3	2	2	2	1
CO3	3	2	3	2	2
CO4	3	2	3	3	3

Semester	VI	Course Code	**24CHUC3217**
Course Title	**ORGANIC CHEMISTRY III**		
No.of Credits	4	No. of contact hours per week	4
New Course/Revised Course	Revised Course	If revised, Percentage of Revision	20%

		effected	
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand , Analyse and Apply		
Course Objectives	The objective of the course is to understand the chemistry of carbohydrates, to know the chemistry of selected alkaloids and terpenes, to know the chemical aspects of amino acids and peptides, to understand the basic principles involved in green chemistry and their utility, to know the synthetic utility of selected oxidizing and reducing organic reagents.		
UNIT	Content		No. of Hours
I	**Carbohydrates** Nomenclature and structure of carbohydrates; interrelationship among monosaccharides; mutarotation and its mechanism – cyclic structure -pyranose and furanose forms - determination of ring size, haworth projection formula, configuration and conformational analysis of monosaccharides- Fischer determination of the structure of D-glucose; lengthening of carbon chain in aldoses – Killiyani-Fischer synthesis of aldoses; Shortening of carbon chains in aldoses: Ruff degradation. **Reactions of carbohydrates:** Epimerization in base; Reduction; oxidation; osazone formation; ether and ester formation. Interco nversion of aldoses and ketoses and vice versa, interconversion of aldoses to their epimers**.**		12 Hours
II	**Terpenes and Alkaloids** Terpenes - general methods of determination of structure - Isoprene rule, isolation of terpenes - structure and constitution of zingeberene, abietic acid and camphor**.**		13Hours

	Alkaloids - alkaloidal reagents - general methods of determination of structure of alkaloids - structure and synthesis of nicotine, quinine, morphine and atropine.	
III	**Amino Acids and Proteins** **Aminoacids:** classification; dipolar ions; isoelectric point; synthesis - Gabriel synthesis and Strecker synthesis; reactions of amino acids – acylation, esterification, reaction with ninhydrin. **Peptides:** structure of peptides; Sangers and Edmond method, terminal residue analysis, synthesis of peptides - role of protective groups (carbobenzyloxy, phthaloyl), Merrifield Solid-Phase Peptide Synthesis – classical method - its limitations - proteins - classification - denaturation - primary, secondary, tertiary and quaternary structure of proteins. Colour reactions of proteins.	14 Hours
IV	**Steroids** Chemistry of Cholesterol -Structural Elucidation-Synthesis – Conversions of cholesterol to Androsterone, Testosterone, Progesterone.	10 Hours
V	**Reagents-I (oxidation and reduction)** Structure, mechanism and applications of reactions involving oxidation with Jones, Collins reagents, PCC, PDC, SeO_2, MnO_2, $KMnO_4$, m-CPBA, TBHP, DIAD, $NaIO_4$, IBX, Dess-Martine periodinane, CAN, TEMPO and Swern oxidation. Structure mechanism and applications of reactions involving reductions with $NaBH_4$, $Na(CN)BH_3$, BH_3:THF, $LiBH_4$, $LiAlH_4$,	11 Hours

	DIBAL-H, Ra-Ni, Zn in acidic media, Lindlar Catalyst, Rosenmund Reduction**.** .	
References	Reference Books: 1. I. L. Finar, Organic Chemistry, Vol. 2, ELBS, 5th edition, 1974 and Pearson India, 5th edition, 2011. 2. Organic Chemistry, R.T. Morrison and R.N. Boyd. Prentice Hall of India Pvt. Ltd. New Delhi, 7th Edn.2011. 3. Organic Chemistry, I.L. Finar, ELBS, Vol 1., 6th Edn. 2002. 4. Organic Chemistry, Maitland Jones Jr, Steven A. Fleming, W. W. Norton & Company, London, 4th edition, 2010. 5. Organic Chemistry, T. W. Graham Solomons, Craig B. Fryhle. John Wiley & Sons, Inc.,10thedition, 2011. 6. J.Clayden, N. Greeves and S. Warren Organic Chemistry, 2nd edition, Oxford University Press, 2012. 7. W. Carruthers, Some Methods of Organic Synthesis, Cambridge University Press. 8. H. O. House, Modern Synthetic Reactions, Benjamin-Cummings Publishing Co. 2nd edition, 1972. 9. G.S. Zweifel and M.H. Nantz, Modern Organic Synthesis-An Introduction, W.H. Freeman and Company, 2006.	
Course Outcomes	On completion of the course, students should be able to CO1: Describe the chemistry of carbohydrates CO2: Determine the structures of selected alkaloids and terpenes CO3: Classify protein and demonstrate the structure of proteins. CO4: Describe the structure and synthesis of selected steroids CO5:Describe and formulate the mechanism of oxidation, reduction, rearrangements reactions and some selected name reactions.	

Mapping of CO with PSO

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	2	3
CO5	3	2	3	3	3

Semester	VI	Course Code	**24CHUC3218**
Course Title	**PHYSICAL CHEMISTRY IV**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand and Apply		
Course Objectives	The objective of the course is, to understand the basics concepts of photochemistry, molecular spectroscopy, to have an introduction of point groups, group multiplication table and to become familiar with the fundamentals of quantum chemistry.		
UNIT	Content		No. of Hours
I	**Photochemistry** Introduction, Lambert-Beer law, law of photochemical equivalence, quantum yield, experimental determination, photosensitized reactions, steady state approximation,		9 Hours

	photochemical reactions of H_2-Cl_2, H_2-Br_2 and dimerization of anthracene. Jablonski diagram, Phosphorescence, fluorescence and chemiluminescence.	
II	**Quantum Mechanics** Limitations of classical mechanics, black body radiation, photoelectric effect, Compton effect, Heisenberg's uncertainty principle, Schrodinger wave equation, eigen values and eigen functions, significance of wave function, orthogonality and normalization, postulates of quantum mechanics, particle in one dimensional box.	10 Hours
III	**Molecular Spectroscopy-I** Microwave spectroscopy: Rotation of molecules-Diatomic molecules- rigid and non-rigid rotators-intensities of spectral lines-effect of isotopic dilution-Polyatomic molecules-symmetric and asymmetric Top molecules-chemical analysis by microwave spectroscopy. Fundamental vibrations of diatomic and polyatomic molecules- classical theory of Raman effect, Rotational Raman spectra and vibrational Raman spectra	10 Hours
IV	**Electrochemical Cells** Cells, types of Cells, EMF of cells, reversible and irreversible cells, electrodes-primary, secondary and glass electrode- electrode potential, cell reaction, e.m.f. measurements and its applications, Nernst equation, Overpotential, hydrogen and oxygen overvoltage, theories of overvoltage, electrode concentration cells, electrolyte concentration	8 Hours

	cells, potentiometric titrations.	
V	**Basics of Group Theory** Definition of a mathematical group and its properties – symmetry elements - symmetry operations – classes of symmetry operations - group multiplication table - cyclic groups- subgroups - classes –classification of molecular point groups with examples.	8 Hours
References	Reference Books: 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical chemistry, Vishal Pub.Co. Jalandhar, 48th edition, 2020. 2. Peter Atkins and Julio de Paula, Physical Chemistry, Oxford University Press, 9th edition, 2011. 3. Robert. G. Mortimer, Physical Chemistry, Academic Press; 3rd edition, 2008. 4. Ball, D. W. Physical Chemistry, 2nd Edition, Cengage Learning, India, 2017. 5. Castellan, G. W. Physical Chemistry, 4th Edition, Narosa, 2004. 6. House, J.E. Fundamentals of Quantum Chemistry, 2nd Edition, Elsevier, 2004. 7. McQuarrie, D.A. Quantum Chemistry, Viva Books, 2016. 8. F. A. Cotton: Chemical Applications of Group Theory, Wiley Eastern, 1985 9. A. Salahuddin Kunju & G. Krishnan, Group Theory and its Applications in Chemistry, 2nd Edition, PHI learning, 2015. 10. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy, 4th Ed. Tata McGraw-Hill:	

	New Delhi, 2006. 11. J.D. Graybeal, Molecular Spectroscopy, Mc-Graw Hill, 1988. 12. G. M. Barrow, Introduction to Molecular Spectroscopy, Mc-Graw Hill, 1964.
Course Outcomes	On completion of the course, students should be able to CO1: Analyse the photophysical process with Jablonski diagram and determine the kinetics of photochemical reactions CO2: Demonstrate the photoelectric effect, Compton effect, Heisenberg's uncertainty principle and Schrodinger wave equation CO3: Demonstrate the basics of vibrational, rotational and raman spectroscopic techniques CO4: Describe the basics and applications of electrochemical cell CO5: Describe the basics of group theory and construction of group multiplication table

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	2	2	2	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	2	3

Semester	VI	Course Code	**24CHUC3219**
Course Title	**ELEMENTS OF SPECTROSCOPY**		
No.of Credits	4	No. of contact hours per week	4
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand and Apply		
Course Objectives	The objective of the course is to impart the knowledge of UV-vis spectroscopy, to familiarize with the electronic excitations, to impart knowledge of infrared spectroscopy, to gain expertise of assigning experimental values to the different vibrations, to understand the basics of NMR spectroscopy and solving simple organic molecules NMR spectra, to impart basic knowledge of mass spectrometry and to gain the knowledge of magnetism and its interaction with external field and concept in electron spin resonance		
UNIT	Content		No. of Hours
I	**Electronic Spectroscopy** UV -Vis Spectroscopy: Electromagnetic radiation - electronic excitation– selection rules- λmax & εmax, chromophore, auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts-solvent effects-Woodward rule for calculation of the λmax for dienes and unsaturated carbonyl compounds –applications to organic molecules.		12 Hours
II	**Vibrational Spectroscopy** Infrared Spectroscopy: Principle – Infrared radiation – vibrational transitions - selection		12Hours

	rules - and types of molecular vibrations, fundamental absorptions and overtones-fingerprint region - applications of IR spectroscopy to organic compounds – effect of inter and intermolecular hydrogen bonding on IR spectra.	
III	**NMR Spectroscopy** Introduction – basic principles of 1H NMR - equivalent and non-equivalent protons - number of signals – position of signals – chemical shift – peak area and proton coupling. Splitting of signals – spin-spin coupling– coupling constant – NMR spectra of simple organic compounds. Basics of 13C NMR spectroscopy. 2D- NMR spectroscopy-1H-1H COSY, HMBC and NOESY Techniques.	13 Hours
IV	**Mass Spectrometry** Introduction – instrumentation – ionization methods-mass spectrum – molecular ion peak – molecular formula calculation – mass spectrum of simple molecules (cyclohexene, ethyl benzene and methyl propyl ketone). Combined problems on structure elucidation of organic compounds based on spectral data.	13 Hours
V	**Electron Spin Resonance Spectroscopy** Basic principles of ESR-Magnetic moment of an unpaired electron – energy level diagram of electron – hyperfine splitting – ESR spectrum of hydrogen atom and methyl radical.	10 Hours

References	Reference Books: 1. Organic Spectroscopy, William Kemp, 3rd Edn., Palgrave Publications, New York, 2008. 2. Spectroscopy of Organic Compounds, P. S. Kalsi, New Age International Publishers, 6thEdn., 2009. 3. Applications of Absorption Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall of India Pvt. Ltd., New Delhi,1991. 4. Spectrometric Identification of Organic Compounds, Robert M.Silverstein and Francis X. Webster, 6th Edn., John Wiley and Sons, 2003. 5. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania, Shobanlal Nagin Chand & Co. Jalendhar 41st Edn.,2001. 6. Introduction to Spectroscopy, by Donald Pavia, Gary Lampman, George Kriz and James Vyvyan, Brooks/Cole publication; 5th edition, 2014.
Course Outcomes	On completion of the course, students should be able to CO1: Demonstrate principles of UV-Vis spectroscopy and predict absorption maxima. CO2: Interpret IR spectra and describe the instrumentation of IR spectrophotometer. CO3: Demonstrate principles of NMR spectroscopy and interpret NMR spectra of organic molecules. CO4: Interpret mass spectra and describe the instrumentation of Mass spectrometer. CO5: Analyze the interaction of odd electrons with nuclei and interpret the ESR spectra.

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	VI	Course Code	**24CHUC3220**
Course Title	**ANALYTICAL CHEMISTRY-I**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand and Analyse		
Course Objectives	The objective of the course is to understand laboratory safety measures, error analysis and the theory of complexometric titration, to emphasize the basic principles of different electroanalytical techniques, to learn the basic principles, instrumentation and applications of spectrochemical, thermal and radiochemical techniques, and to know the basic principles and applications of separation techniques.		
UNIT	Content		No. of Hours

I	**Laboratory practices, error analysis and titrimetric method** Storage and handling of corrosive, toxic and poisonous chemicals-simple first aid procedure for acid and alkali in eye, acid and alkali burns, heat burns and cut by glasses. Accuracy, precision, classification of errors, minimization of errors, standard deviation, coefficient of variance and significant figures. Complexometric titrations, principle and experimentation. Metal ion indicators and its applications.	7 Hours
II	**Electroanalytical Techniques** Amperometry-different types of titrations-applications-advantages over conventional volumetric method–Electrogravimetry theory-primary requirements-electrodeposition by constant potential and current-applications. Coulometry-types of coulometers-primary and secondary coulometric titrations-Coulometry by constant potential-applications-Constant current coulometry-application to acid base, redox and complexometry-estimation of unstable and corrosive elements.	8 Hours
III	**Spectrochemical Techniques** UV-visible spectrophotometry, principle, Beer's law, applications-deviations from Beer's law. Photometric titrations-instrumentation, monochromators and detectors-single and double beam spectrophotometer. Instrumentation of IR spectrophotometer-sample handling techniques in IR, applications, Theory and applications of atomic absorption spectroscopy and flame emission	8 Hours

	spectroscopy- advantages-differences between AAS and FES-merits and demerits.	
IV	**Thermal and Radiochemical Techniques** Types of thermal techniques-Principles of thermogravimetry-factors affecting the thermogram-thermograms of calcium oxalate and copper sulphate pentahydrate-applications. Principle of differential thermal analysis-interpretation of DTA curve-factors affecting the DTA curves-applications. Differential scanning calorimetry-principle and applications. Theromogram of copper sulfate pentahydrate. Radiometric titrations-types-complex formation and precipitate formation- activation analysis- absolute and comparative methods and applications.	10 Hours
V	**Separation Techniques** Principles - applications of column chromatography- paper chromatography-thin layer chromatography and applications of chromatography. Principle and experimental procedure of ion-exchange methods and types of resins-industrial applications. Brief idea of solvent extraction techniques,-factors favouring extraction. Gas chromatography-principle and applications	12 Hours
References	Reference Books:	

	1. H.W. Willard, L.I. Merrit, J.A. Dean and P.A. Settle, Instrumental Methods of Analysis, CBS Publishers, 7th Edn., 1996. 2. B.K. Sharma, Instrumental Methods of Analysis, Goel Publishers, 1993. 3. Vogel's Text Book of Quantitative Chemical Analysis, ELBS, 1996. 4. N.K. Acharya, Text Book on Intellectual Property rights, Asia Law Hose, 2001.
Course Outcomes	On completion of the course, students should be able to CO1: Handle toxic and poisonous chemicals safely CO2: Provide first-aid in case of small laboratory accidents CO3:Communicate scientific data and conclusions with accuracy and minimum error CO4: Describe the principles, applications and instrumentation of potentiometric and conductometric titrations CO5: Describe the principles, applications and instrumentation of UV-Vis spectrophotometry and IR Spectrophotometer CO6: Identify the thermal method to be used for a particular study CO7: Describe methods to separate compounds such as TLC, column chromatography and solvent extraction

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	3
CO2	3	2	3	1	3
CO3	3	3	3	2	3
CO4	3	1	3	3	3
CO5	3	2	3	3	3
CO6	3	2	3	3	3
CO7	3	2	3	3	3

Semester	**VI**	Course Code	**24CHUC3221**
Course Title	**PHYSICAL CHEMISTRY PRACTICAL**		
No.of Credits	2	No. of contact hours per week	5
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand and analyse		
Course Objectives	The objective of the practical course is to learn the applications of colligative properties, thermodynamics, to carry out experiments based on phase rule, to acquire skills based on chemical Kinetics experiments and to understand electrochemistry through experiments.		

Content	No. of Hours
Experiments **1.** Determination of Molecular Weight by Rast's Macro method 2. Construction of phase diagram of a simple eutectic system. 3. Determination of Critical Solution Temperature of Phenol-Water system. (Determination of concentration of a salt solution through miscibility temperature measurement 4. To study the kinetics of Acid hydrolysis of ethyl acetate with hydrochloric acid using integrated rate law method. 5. Distribution of acetic/ benzoic acid between water and chloroform or cyclohexane. 6. Conductometric titration of strong acid vs. strong base. 7. Determination of pKa of a weak acid. 8. Determination of degree of dissociation through conductance measurement.	5 Hours

9. pH-metric titration between a strong acid and a strong base. 10. Potentiometric titration between Fe2+and Cr6+. 11. Determination of viscosity of various liquids by using Ostwald Viscometer. 12. Study of equilibrium of any one of the following reactions by distribution method 13. I_2 (aq) + I^- (aq) I_3^- (aq) 14. Cu2+ (aq) + nNH3 [Cu(NH3)n]2+	
References	Reference Books: 1. Khosla, B.D.; Garg, V.C.; Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co, New Delhi, 2015. 2. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York, 2003. 3. Practical's in physical chemistry – a modern approach, P.S.Sindhu, Macmillan. 4. Experiments in Physical Chemistry, J.M.Wilson, R.J.Newcomb, A.R.Denaro, 2nd Edn., Elsevier. 5. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York, 2003.
Course Outcomes	On completion of the course, students should be able to CO1: Determine molecular weight of unknown solute by Rast's Macro method and Construct phase diagram of a simple eutectic system CO2: Determine critical solution temperature of phenol-water system and Determine distribution coefficient of Iodine between water and organic solvent CO3: Determine rate constant of acid catalysed hydrolysis of an ester CO4: Determine the pKa of a weak acid CO5: Determine the viscosity of mixture of liquids by using Ostwald Viscometer and Determination of enthalpies by various methods

Mapping of CO with PSO

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	VI	Course Code	**24CHUB3202**
Course Title	**GREEN CHEMISTRY**		
No.of Credits	4	No. of contact hours per week	4
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to develop an understanding of basic principles of green chemistry, atom economic reactions and green catalysis. The course also will give an understanding greener solvents and technologies.		
UNIT	Content		No. of Hours

I	**Principles and concepts of green chemistry** Basic principles-green chemistry-atom economy - rearrangement reaction - addition reactions - atom uneconomic reactions-substitution reaction - Wittig reaction-reducing toxicity**.**	12 Hours
II	**Waste-Problems and prevention** Waste minimizing techniques-sources of waste from chemical industry-Onsite waste treatment - Physical treatment - chemical treatment - degradation of waste - Polymer recycling - reactions (without byproducts).	13 Hours
III	**Green catalysis** Introduction-Comparison of catalysts-heterogeneous catalysis-zeolites-homogeneous catalyst-transition metal catalysts-greener lewis acids-phase transfer catalysis-oxidation (H2O2)- biocatalysis – photocatalysis	13 Hours
IV	**Environmentally Benign Solvents** Introduction-organic solvents-volatile solvents-solvent free system-supercritical fluid- water –water mediated reactions-ionic liquids mediated reactions.	11 Hours
V	**Greener Technologies** Introduction-comparison of greener technology and other technology - Photochemical reactions - microwave medited reactions – sonochemistry - electrochemical synthesis.	11 Hours
References	Reference Books: 1. Green Chemistry-An Introductory Text; Mike Lancaster, RSC Publishers, 2011. 2. V. K. Ahulwalia & M.R. Kidwai: New Trends in Green Chemistry, Annamalaya Publishers, 2005.	

Course Outcomes	On completion of the course, students should be able to CO1: Describe the basic principles of green chemistry. CO2: Explain about atom economic reactions and safety. CO3: Describe about the green catalysis and environmentally benign solvents CO4: Assess the greener technologies.

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	2	1	3
CO2	3	3	2	2	3
CO3	3	2	2	3	3
CO4	3	1	2	2	3

Semester	VI	Course Code	**24CHUC3222**
Course Title	**INDUSTRIAL CHEMISTRY**		
No.of Credits	4	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to enable the student to understand the concepts of fuels and energy resources, generation of energy from various types of fuels, to understand the use of chemicals in the improvement of agricultural crops, to learn the manufacturing processes of iron, steel, alloys, glass, ceramics and refractories		

	and to understand the process of surface coatings.	
UNIT	Content	No. of Hours
I	**Fuels and Energy Resources** Petroleum - origin of petroleum, composition, refining of petroleum fractionation composition of various fractions, cracking - catalytic and thermal cracking, synthetic petrol, knocking, octane and cetane numbers, anti knocking agents, coal gas, producer gas, Methane production from biomass, alcohol as fuel.	12 Hours
II	**Cement and Fertilizers** Cement - manufacture of Portland cement - composition - setting of cement – special cements - Aluminium cement - white Portland cement - water proof cement. Fertilizers - nitrogeous fertilizers - ammonium sulphate-urea - manufacture and action -potassium fertilizers - potassium sulphate - manufacture - phosphate fertilizers – superphosphate	113Hours
III	**Iron, Steel and Alloys** Manufacture of pig iron by blast furnace, wrought iron by puddling processes- steel by Bessemer's process – Heat treatment of steel. Alloys-purpose of making alloys – preparation of alloys by fusion method-electro deposition and reduction method – effects of carbon, silicon, phosphorus and sulphur – application of alloy steels.	13 Hours
IV	**Glass, Ceramics and Refractories** Glass, raw materials and colouring agents - chemical reaction involved in glass manufacture - some special glasses (borosilicate, alkali silicate, optical glass, soda lime glass, their properties and applications).	13 Hours

	Ceramics - various classes of ceramics, general properties, porous and non-porous wares, raw materials for ceramics, uses. Refractories - manufacture of refractories - properties and uses of common refractory bricks - silica bricks - fire clay bricks, magnesite bricks and dolomite bricks.	
V	**Surface Coatings** Pre-treatment of the surface, metallic coating, galvanizing, tinning - Inorganic coatings, organic coatings, oil paints, water paints, special paints, varnishes, enamels and lacquers	9Hours
References	Reference Books: 1. Engineering Chemistry by P.C. Jain and Monica Jain, Dhanphatrai and Sons, 15th Edn., 2006. 2. Industrial Chemistry, B.K. Sharma, Goel Publishing House, 2011. 3. A Text Book of Engineering Chemistry, S.S. Dara, S. Chand &Co., New Delhi, 15th Edn., 2006.	
Course Outcomes	On completion of the course, students should be able to CO1: Categorize fuels and energy sources CO2: Describe the types of polymerization methods as well as preparation and uses of few well-known polymers CO3: Describe the composition and manufacturing process of cements and fertilizers CO4: Demonstrate the manufacturing process and applications of iron, steel, alloys, glass, ceramics and refractories CO5: Categorize the types of surface coatings	

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	2	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	1	3	2	3

Semester	VII	Course Code	**24CHUC4123**
Course Title	**INORGANIC CHEMISTRY-IV**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand , Analyse and Apply		
Course Objectives	The objective of the course is to develop an understanding of both structure and chemical bonding of inorganic compounds and the basic concepts of acids and bases.		
UNIT	Content		No. of Hours

I	**Bonding Models I** Ionic bond - Lattice energy and determination - Born-Lande equation with derivation - Importance of Born Mayer equation and Kapustinskii equation - Application of Born-Haber type calculations - Size effects - Ionic radii - Factors affecting ionic radii - Lewis structure - VB theory. Molecular orbital theory - Symmetry and overlap - Molecular orbitals diagram of diatomic and triatomic molecules - Formal charge.	9 Hours
II	**Bonding Models II** Hybridization - Molecular orbital equivalent of hybridization-Delocalization - Resonance - Molecular orbital equivalent of resonance. Fajan's rule - Results of polarization - Covalent bonding in ionic solids - polarizing power - polarizability- Charge distribution in molecules - Dipole moment - Determination and applications.	10 Hours
III	**Solid State Chemistry I** Cells and description of crystal structure-symmetry-seven crystal systems - Close packing of spheres - Packing efficiency - Hexagonal close packed (HCP) and cubic close packed structures (CCP) - Coordination number - Relative density of packing in simple cubic, CCP, HCP and BCC - Tetrahedral and octahedral holes - Limiting radius ratio rule. Radius ratio for trigonal, tetrahedral, octahedral and cubic sites - Radius ratio and shape of ionic crystals - Structures of cesium chloride, sodium chloride, zinc blende, fluorite, rutile andcalcite.	8 Hours
IV	**Solid State Chemistry II**	9 Hours

	Perovskite structure of spinels - Stoichiometric defects - Schottky and Frenkel defects - Non-stoichiometric defects - Metal excess and metal deficiency defects - Extended defects - Line and plane defects. Band theory - Semiconductors - Intrinsic and extrinsic type - Fermi level- Flow of current in semiconductors - Hopping mechanism - Band structure - p and n type semiconductors - p-n junction - Superconductivity - 1,2,3-superconductor – Photovoltaic effect. Solid state reactions - Classification - Thermal decomposition reactions - Reaction between two solids - Improving reactivity ofsolids.	
V	**Acid-Base Concept** Acid-Base concept- Solvent system concept - Bronsted Lowry- Lux-Flood - Lewis concept and Usanovich concept - Classification of Lewis acids - Lewis acid-base reactions - nonaqueous solvent and acid base strength- super acids - Solvolysis and formation of coordination compounds. Hard and Soft Acids and Bases (HSAB) – Theory of Hard and Soft Acids and Bases – Applications of HSAB theory - - Strength of oxyacids - Pauling's rule - Acidity of cations in aqueous solution- solvation and acid base strength- Factors affecting relative strength acids and bases-substituents-steric effect-resonance effect.	10 Hours
References	Reference Books: 1. Inorganic Chemistry, D.F. Shriver, P.W. Atkins and CH.Langford, ELBS, Oxford University Press, 6th Edn.,2015. 2. Inorganic Chemistry, J.E. Huheey, E.A. Keither and R.L.	

	Keiter, Harper Collins College Publisher, New York, 4th Edn.,1993. 3. Modern Inorganic Chemistry, W.E. Jolly, McGraw Hill International Edition, New York,1994. 4. Theoretical Principles of Inorganic Chemistry, G. S. Manku, Tata McGraw Hill Publishing Company Ltd., New Delhi,1994. 5. Concepts and Models of Inorganic Chemistry, B.Douglas, D.H.Me Daniel and J.J. Alexander, John Wiley and Sons, New Delhi,2001. 6. Solid State Chemistry, D.K. Chakrabarthy, New Age International Publishers, New Delhi, 2005.
Course Outcomes	On completion of the course, students should be able to CO1: Predict the chemistry and theories involved in the structure of ionic compounds. CO2: Assess the types of hybridization involved in ionic solids. CO3: Identify the type of crystal structure exist in ionic solids. CO4: Describe the type of defects in metals, band theory and solid state reaction. CO5: Appreciate the basic concepts of acid-bases and theories involved in it.

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	2	3
CO4	3	2	3	2	3
CO5	3	2	3	3	3

Semester	VII	Course Code	**24CHUC4124**
Course Title	**ORGANIC CHEMISTRY-IV**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to develop an understanding of reactivity of the organic compounds including reaction mechanism, to understand the detailed aspects of organic photochemistry and pericyclic reactions, to know the chemistry of cholesterol and peptides.		
UNIT	Content		No. of Hours
I	**Methods of Determination of Reaction Mechanisms and Aromaticity** **Thermodynamic and Kinetic Requirements of Reactions:** Thermodynamic and kinetic control – methods of determination of reaction mechanisms – product analysis – determination of the presence of intermediate, isolation, detection, trapping – cross over experiments – isotopic labeling – isotopic effect – stereo chemical evidence – kinetic evidence.Kinetic Methods of Determination of Reaction Mechanisms: Hammett equation – significance of substitution and reaction constant – Hammond postulates – Linear free energy relationship – limitations and deviations – Taft equation**.**		9Hours

	Aromaticity: Conditions for aromaticity, Aromatic systems with 2,6,10 electrons, alternent and non-alternent hydrocarbons, systems of more than 10 electrons annulenes- aromaticity of azulenes, ferrocene and sydnones - Aromatic, nonaromatic, antiaromatic systems- concept of homoaromaticity**.** .	
II	**Reaction Mechanism-II** **Reaction Mechanism:** mechanism and evidences- effect of structure- solvent- stereochemistry- S_Ni, S_N1', S_N2', S_N1cA and S_N2cA mechanism-Neighbouring group participation- Non classical carbocations. Elimination Reactions: E1cB – evidences – effect of structure, solvent and base – Hoffmann and Saytzeff rules– Pyrolytic elimination – cis elimination – elimination vs substitution.	9 Hours
III	**Organic Photochemistry** Principles - Jablonski diagram - absorption of electromagnetic radiation - excited state - photochemical processes - photosensitisation, photochemical reactions - photo reductions and photo oxidation – photoreactions of carbonyl compounds – Norrish type I and Norrish type II reactions, di-pi methane rearrangement – photochemistry of arenes, photochemistry of alkenes, cis-trans isomerisation – rearrangements of cyclic , – unsaturated ketones and 2,5-cyclohexadienone – Barton reaction – Paterno Buchi reaction.	9 Hours
IV	**Pericyclic reactions:** Concerted reactions – orbital symmetry and correlation diagram approach – FMO and PMO approach, Woodward-	10 Hours

	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.	
V	**Electro-organic reactions** Cell design-electrodes-Electrolysis-electro-oxidation-electro-reduction-Some typical examples of electro-organic reactions; Kolbe cascade reaction- Anodic olefin coupling reactions- cation-pool method- Phenol/aniline–arene cross-coupling- Electro-catalytic C–H activation- Electro-catalysis for alkene di-functionalization-Arene C–H amination - Electro-organic fluorination reactions.	8 Hours
References	Reference Books: 1. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Structure and Mechanisms, Part A, 5th Edition, Springer, 2008. 2. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th edition, Pearson Education, 2003. 3. J. Clayden, N. Greeves and S. Warren, Organic Chemistry, 2nd edition, Oxford University Press, 2012. 4. G.S. Zweifel, M.H. Nantz and P. Somfai, Modern Organic Synthesis-An Introduction, 2nd edition, John Wiley, 2017. 5. J. D. Coyle, Introduction to Organic Photochemistry, Wiley, 1991. 6. B. Halton, J. M. Coxon, Organic Photochemistry, Cambridge University Press, 2011. 7. S. Sankararaman, Pericyclic Reactions: A Textbook: Reactions, Applications and Theory, Wiley-VCH, 2005. 8. C.H. DePuy and O.L. Chapman, Molecular Reactions and	

	Photochemistry, Prentice-Hall, New Delhi, 1987. 9. I.L. Finar, Organic Chemistry, Vol.2, ELBS, 5th edition, 1974 and Pearson India, 5th edition, 2011. 10. Electro-organic synthesis – a 21st century technique, D. Pollok, S. R. Waldvogel, Chem. Sci., 2020, 46, 12386-12400. (https://pubs.rsc.org/en/content/articlelanding/2020/sc/d0sc01848a)
Course Outcomes	On completion of the course, students should be able to CO1: Assess the thermodynamic and kinetic controlled products and methods of determination of reaction mechanisms. CO2: Describe and formulate the mechanism of various nucleophilic substitution reactions and elimination reactions. CO3: Draw Jablonski diagram and demonstrate the mechanism of Norrish type I and II reactions CO4: Evaluate concerted reactions via FMO and PMO approach, Electrocyclic reactions, cycloadditions and sigmatropic rearrangements. CO5: Describe the chemistry and structure of cholesterol and oxytocin.

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	2	3	3	3

Semester	VII	Course Code	**24CHUC4125**
Course Title	**PHYSICAL CHEMISTRY-V**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The content of this course is designed to give the knowledge of irreversible and statistical of thermodynamics, to have an introduction of point groups, group multiplication table, to understand the basic concepts of electronic and Mossbauer spectroscopy, to gain knowledge in various theories of semiconductor-electrolyte interface electrochemistry. The course also emphasizes the importance of rechargeable batteries and fuel cells.		
UNIT	Content		No. of Hours
I	**Non-equilibrium Thermodynamics and Group Theory - II** **Non-equilibrium Thermodynamics:** Basic concept of non-equilibrium thermodynamics-postulates and methodologies-linear laws-Entropy of irreversible processes-Clausius inequality-entropy production (heat flow and chemical reactions) - phenomenological equations-Onsager reciprocity relation. **Group Theory-II:** Matrix representations of symmetry operations- representation of groups- reducible and irreducible representations. The Great Orthogonality		9 Hours

	theorem and its consequences-character tables – construction of character tables for C2v and C3v point groups. .	
II	**Statistical Thermodynamics** Scope of statistical thermodynamics-probability theorem-phase space, microstate and macrostate, configuration, system, assembly and ensemble-different types of ensembles-permutations and combinations, thermodynamic probability, Three types of statistics, Maxwell's Boltzmann statistics, Bose-Einstein statistics-Fermi-Dirac statistics, Concept of partition functions, evaluation of translational, rotational, vibrational and electronic partition functions. Sackur-Tetrode equation, use of partition functions for obtaining thermodynamic functions, entropy and probability, Boltzmann Planck's equation, statistical approach to third law of thermodynamics and exception of this law – molar partition function – specific heat of solids – Einstein theory of specific heat – Debye theory	9 Hours

III	**Molecular Spectroscopy- II** Electronic spectroscopy-Born-Oppenheimer approximation-Franck-Condon principle, dissociation energy and dissociation products – pre dissociation-re-emission of energy, fluorescence and phosphorescence-photoelectron spectroscopy-basic principles-photoelectron effect, ionization process, photoelectron spectra of simple molecules. Mossbauer spectroscopy- basic principle-isomer shift, quadrupole splitting, magnetic field effect.	9 Hours
IV	**Advanced Electrochemistry-I** Electrical double layer: Structure of electrical interface, parallel plate condenser model, Gouy- Chapmann diffused charge model, Stern model, limitations of these models. Semiconductor interfaces, Theory of double layer at semiconductor-electrolyte solution interfaces, Lippman equation. Butler- Volmer equation -low field and high field approximations-Tafel equation.	9 Hours
V	**Advanced Electrochemistry-II** Ionic strength- Debye Huckel theory-Debye-Huckel limiting law-relaxation effect-electrophoretic effect-Debye-Huckel-Onsager (DHO) conductance equation - validity of DHO equation-deviations from the DHO equation. Conductivity at high frequency and at high field strength. Debye – Falkenhagen effect and Wien effect Lead-acid batteries-Cadmium-Nickel oxide batteries- Lithium batteries charging and discharging reactions, Fuel cells-classification-chemistry of fuel cells- detailed description.	9 Hours

	Electrochemical theory of corrosion, corrosion due to dissimilar metal cells and concentration cells, Pilling Bedworth rule, passivity. Thermodynamics and kinetics of electrochemical metal deposition and dissolution process (corrosion), mechanism, corrosion current, Evan's diagram, Protection and prevention of corrosion.	
References	Reference Books: 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical chemistry, Vishal Pub.Co. Jalandhar, 48th edition, 2020. 2. Peter Atkins and Julio de Paula, Physical Chemistry, Oxford University Press, 9th edition, 2011. 3. Robert. G. Mortimer, Physical Chemistry, Academic Press; 3rd edition, 2008. 4. J. Bockris and A.K.N. Reddy, Modern Electrochemistry, Vol I & II 2nd Ed, Wiley, New York, 1998. 5. D.R. Crow, Principles and Applications of Electrochemistry, Chapman & Hall, 3rd Edn., New York, 1994. 6. S. Glasstone, Introduction to Electrochemistry, Biblio Bazar, 2011. 7. J. Rajaram, J.C. Kuriakose, Chemical Thermodynamics: Classical, Statistical and Irreversible, 1st Edn, S. Chand and Co., 1999. 8. F. A. Cotton: Chemical Applications of Group Theory, Wiley Eastern, 1985 9. Salahuddin Kunju & G. Krishnan, Group Theory and its Applications in Chemistry, 2nd Edition, PHI learning, 2015. 10. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy, 4th Ed. Tata McGraw-Hill: New Delhi, 2006. 11. J.D. Graybeal, Molecular Spectroscopy, Mc-Graw Hill,	

	1988. 12. G. M. Barrow, Introduction to Molecular Spectroscopy, Mc-Graw Hill, 1964.
Course Outcomes	On completion of the course, students should be able to CO1: Assess the basic concepts of irreversible thermodynamics and Classifying reducible and irreducible representation and construction of group multiplication table CO2: Describe the basic concepts of statistical thermodynamics CO3: Describe the basic concepts of electronic, photoelectron and Mossbauer spectroscopy. Analyse the spectrum of simple molecules CO4: Describe the basic theories at the electrolyte-electrode interfaces. CO5: Outline the electrochemical principles involved in energy storage devices.

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	1	3	1	3
CO3	3	3	3	3	3
CO4	3	1	3	1	3
CO5	3	2	3	2	3

Semester	VII	Course Code	**24CHUB4103**
Course Title	**ANALYTICAL CHEMISTRY-II**		
No.of Credits	4	No. of contact hours per week	4
New Course/Revised	Revised Course	If revised, Percentage	20%

Course		of Revision effected	
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand and Apply		
Course Objectives	The objective of the course is to give the students an in-depth account of various modern analytical techniques like spectrophotometry, X-ray methods, microscopic and electroanalytical techniques with a view to understand the principles, instrumentation and applications. The course also gives account of sampling and chromatographic techniques.		
UNIT	Content		No. of Hours
I	**Sampling, Separation Techniques and Intellectual Property Rights** **Sampling:** Types of sample, sampling plan, quality of sample, subsampling, Sampling of raw materials, intermediates and finished products. Sample preparations – dissolution technology and decomposition, storage of samples. Statistical analysis of data, t – test, Q- test – rejection rules. **Chromatography -** principles, instrumentation and applications of HPLC and GC-Exclusion techniques – gel permeation chromatography. **Introduction to Intellectual Property:** Historical Perspective, Different Types of IP, Importance of protecting IP. Patent: Introduction, patenting process and requirements of patenting..		12 Hours
II	**Spectrophotometry and X-ray methods** Inductively coupled plasma atomic emission spectroscopy (ICEP-AES) and inductively coupled plasma mass spectrometry (ICP-MS)-principle and applications. AAS – Principle – Instrumentation, applications – types of interferences. XRD – principle - single crystal - powder crystal		12 Hours

	methods and application. X-ray photoelectron spectroscopy (XPS), types of peaks, chemical shifts, Instrumentation and Applications.	
III	**Microscopic techniques/ Turbidimetry/ Nephelometry/ Fluorimetry** Fluorimetry – Principles of fluorescence, Instrumentation and Applications. Turbidimetry and Nephelometry – Theory, Instrumentation and Applications. Principles, instrumentations and applications of Scanning electron microscopy (SEM), EDAX – principle and applications. Transmission electron microscopy (TEM) and Auger electron microscopy.	11 Hours
IV	**Electroanalytical Techniques I** Polarography – principle - polarographic maxima – Ilkovic equation - Half-wave potential - applications. Cyclic voltammetry - principle-interpretation of cyclic voltammogram for a reversible couple - simple analytical applications. Hydrodynamic voltammetry: Principle, instrumentation (Types of electrode - Rotating Disc Voltammetry, Rotating Ring Disc voltammetry, Flow through Voltammetry) and applications. Chemically modified electrodes - modification of electrodes by different methods - ultramicroelectrodes in voltammetry. .	13 Hours
V	**Electroanalytical Techniques II** Pulse Polarography: Principle, theory and applications of Differential pulse polarography, square wave polarography, Stripping method. Theory of chronopotentiometry and chronoamperometry. Ion selective electrodes-characteristics-different types-principle and	12 Hours

	applications.	
References	Reference Books: 1. Instrumental methods of analysis, H,W. Willard, L.I. Merrit, J.J.A. Dean and F.A. Settle, CBS publishers,1983. 2. Principles of Instrumental methods of analysis, Skoog and West, Saunders College Publications, 1992. 3. Instrumental methods of chemical analysis, B.K. Sharma, Goel publishing House, 19th Edn., 2000. 4. Electrochemical Methods, Fundamentals and Applications, A.J. Bard and L.R. Faulkner, John Wiley & Sons, 2nd Edn., 2001. 5. Intellectual property rights in the WTO and developing countries, J.Watal, Oxford University Press, Oxford,2001. 6. Principles of Instrumental methods of analysis, D. A. Skoog, F. J. Holler, F. J. and R. Stanley, Boston: Cenage Learning, 7th Edn, 1992.	
Course Outcomes	On completion of the course, students should be able to CO1: Analyze the experimental data using statistical tools. CO2: Summarize the principles and applications of spectrophotometry and X-ray methods. CO3: Describe the different microscopic techniques. CO4: Apply different electroanalytical techniques for the detection of metal ions at trace level.	

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	2
CO3	3	1	3	2	3
CO4	3	2	3	3	3

Semester	VII	Course Code	**24CHUB4104**
Course Title	**CHEMISTRY THROUGH PROBLEM SOLVING APPROACH-I**		
No.of Credits	4	No. of contact hours per week	4
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Advanced Skill		
Cognitive Levels addressed by the course	Understand ,Analyse and Apply		
Course Objectives	The content of this course is designed to impart understanding and enhancement of problem solving ability in chemistry.		

UNIT	Content	No. of Hours
I	Understanding the concept and solving problems related to the following Inorganic chemistry topics: Chemical periodicity - Structure and bonding – acids-base concepts - Non-aqueous solvents - Main group elements - Transition elements - Inner transition elements - Organometallic compounds - Cages and metal clusters. .	12 Hours
II	Problem solving approach in understanding of the following topics in Physical Chemistry: Quantum mechanics - approximate methods - Atomic structure and spectroscopy - MO and VB theories - Huckel theory for conjugated π-electron systems – Group theory and its applications.	12 Hours
III	Understanding the concept and solving problems related to the following Physical chemistry topics: Colloids and surfaces – catalysis - Solid state chemistry - Polymer chemistry – Analytical chemistry – data analysis.	11 Hours

IV	Understanding the concept and solving problems related to the following organic chemistry topics: Stereochemistry – Aromaticity - Organic reactive intermediates - Organic reaction mechanisms - . Common named reactions and rearrangements. .	13Hours
V	Problem solving approach in understanding of the following topics: Pericyclic reactions - photochemical reactions in organic chemistry. Structure determination of organic compounds by IR, UV-Vis, 1H & 13C NMR and Mass spectroscopic techniques.	12 Hours
References	Reference Books: 1. Surbhi Cauhan, NTA-CSIR-NET/JRF/SET Chemical Science 2011-2022, Shree Education & Publication, Ajmer, 2023. 2. Robert G. Mortimer Physical Chemistry, Academic Press, Second edition 2000. 3. Peter William Atkins, Julio De Paula, James Keeler Atkins' Physical Chemistry, Eleventh edition Oxford University Press, 2018. 4. Gary L. Miessler, Paul J. Fischer, Donald A. Tarr, Inorganic Chemistry, Fifth edition, Pearson Education, 2013. 5. James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, Fourth Edition, Pearson Education India, 2006. 6. Jonathan Clayden, Nick Greeves, Stuart Warren, Organic Chemistry, Second edition, OUP Oxford, 2012. 7. W. Carruthers, Iain Coldham, Modern Methods of Organic Synthesis, Fourth edition Cambridge University Press, 2004. 8. Francis A. Carey, Richard J. Sundberg, Advanced Organic Chemistry: Part A and B: Springer Science & Business Media, 2007. 9. Michael B. Smith, Jerry March, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Sixth edition, John Wiley & Sons, 2007.	

Course Outcomes	On completion of the course, students should be able to CO1: Understand the problem solving approach in Inorganic chemistry. CO2: Solve problems in basics as well as advanced topics in quantum mechanics, group theory, molecular spectroscopy and chemical thermodynamics . CO3: Describe the basic concepts and able solve problems in statistical thermodynamics, electrochemistry, chemical kinetics and solid state. CO4: Understand the strategies to solve problems in stereochemistry, aromaticity, reactive intermediates and reaction mechanism. CO5: Solve the problems in synthetic strategies, pericyclic reactions, spectroscopy and natural products.

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**VII**	Course Code	**24CHUC4126**
Course Title	**ADVANCED ORGANIC CHEMISTRY PRACTICAL**		
No.of Credits	2	No. of contact hours per week	5
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Advanced Skill		

Cognitive Levels addressed by the course	Understand
Course Objectives	The practical course is designed to acquire skill in separation and qualitative analysis.

Content	No. of Hours
1. Different laboratory techniques-Melting point, Distillation-at atmospheric pressure-at reduced pressure, TLC, Column Chromatography, Crystallization, Sublimation, Preparation of dry solvents. 2. Separation and qualitative analysis of two component mixtures of organic compounds- Characterization of derivatives and identification of the components. 3. Single stage preparation of organic compounds using classical organic reactions such as nitration, bromination, acetylation, condensation and oxidation by green approach. 4. Extraction of caffeine from tea leaves, piperine from pepper, lachanoric acid from lichens and casein from milk.	5 Hours

References	Reference Books: 1. Vogel's Text Book of Practical Organic Chemistry, Furniss, S. B.; Hannaford, A. J.; Smith, P. W. G.; Tatchell, A. R. 5th Ed.; Longman Scientific & technical, England, 1989. 2. Laboratory Manual of Organic Chemistry, Dey and Sitaraman, Allied Publishers, 1992.
Course Outcomes	On completion of the course, students should be able to CO1: Adopt different laboratory techniques for crystallization and sublimation. CO2: Formulate strategies for the separation and qualitative analysis of two and three component mixtures of organic compounds. CO3:Plan for the preparation of desired organic compounds, extraction and purification of organic compounds

Mapping of CO with PSO

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3

Semester	**VII**	Course Code	**24CHUC4127**
Course Title	**ADVANCED PHYSICAL CHEMISTRY PRACTICAL**		
No.of Credits	1	No. of contact hours per week	5
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Advanced Skill		
Cognitive Levels addressed by the course	Understand and Apply		
Course Objectives	The practical course is designed to set-up different electrochemical cells and to carry out different applications of potentiometric, pH metric, conductometric titrations and to verify the theories by conductometry method.		

Content	No. of Hours
1. Setting up of various cells and measurement of their values, Examples: Zn /0.1M ZnSO4/ KCl/ 0.1 M CuSO4/Cu. 2. Determination of redox potential of Fe2+/Fe3+ system through cyclic voltametry. 3. Determination of redox potentials and equivalence points from potentiometric titration. 4. Determination of the solubility and solubility product of silver chloride in	5 Hours

water potentiometrically. 5. Potentiometric titration of a mixed solution of KCl and KI against AgNO3. 6. Determination of dissociation constant of a weak acid by pH metric titration. 7. pH metric titration of mixture of weak acid and strong acid against strong base. 8. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid. 9. Experimental verification of Debye-Huckel-Onsager equation. 10. Conductometric titration of a mixture of a weak acid and strong acid against a strong base. 11. Determination of neutralization enthalpy of HCl and CH3COOH by NaOH. 12. Determination of solution enthalpy by thermometric method. Oxalic acid-water, K2Cr2O7- water and naphthalene -toluene.	

References	Reference Books: 1. Experimental Physical Chemistry, G. Peter Mathews, Oxford Science Publications, 1985. 2. Experimental Physical Chemistry, E.Danielsetal., International student edition, McGraw Hill Kogakusha Ltd.,1970. 3. Senior Practical Physical Chemistry, D.D.Khosala, A.Khosala, V.C.Gard, R.Chand & Co., New Delhi,1975. 4. Practical Physical Chemistry, B.Viswanathanand, P.S.Raghavan, Viva Books Pvt. Ltd., New Delhi, 2008
Course Outcomes	On completion of the course, students should be able to CO1: Set-up of electrochemical cells. CO2: Analyze the dissociation constant and solubility product by conductometry and potentiometry respectively. CO3: Identify the thermodynamics of simple systems. CO4: Assess and adopt the conductometric methods to verify the theories.

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	3
CO2	3	2	3	3	3
CO3	3	3	3	3	3
CO4	3	2	3	3	3

Semester	VIII	Course Code	**24CHUC4228**
Course Title	**CHEMISTRY THROUGH PROBLEM SOLVING APPROACH-II**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Advanced Skill		
Cognitive Levels addressed by the course	Understand and Apply		
Course Objectives	The content of this course is designed to impart understanding and enhancement of problem solving ability in chemistry.		

UNIT	Content	No. of Hours
I	Application of inorganic chemistry in biology - Spectroscopic application in inorganic chemistry structural elucidation - Nuclear chemistry - Analytical chemistry concepts in separation, spectroscopic, electro- and thermoanalytical methods..	9 Hours
II	Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; magnetic resonance.	10 Hours

	Chemical thermodynamics – First, second, third and zeroth laws – chemical equilibrium – phase equilibria - thermodynamics of ideal and non-ideal gases, and solutions.	
III	Understanding the concept and solving problems related to the following Physical chemistry topics: Statistical thermodynamics – Electrochemistry – Chemical kinetics.	8 Hours
IV	Understanding the concept and solving problems related to the following organic chemistry topics: Organic transformations and reagents - Concepts in organic synthesis - Asymmetric synthesis..	8 Hours
V	Problem solving approach in understanding of the following topics: Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S). Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.	9 Hours
References	Reference Books: 1. Surbhi Cauhan, NTA-CSIR-NET/JRF/SET Chemical Science 2011-2022, Shree Education & Publication, Ajmer, 2023. 2. Robert G. Mortimer Physical Chemistry, Academic Press, Second edition 2000. 3. Peter William Atkins, Julio De Paula, James Keeler Atkins' Physical Chemistry, Eleventh edition Oxford University Press, 2018. 4. Gary L. Miessler, Paul J. Fischer, Donald A. Tarr, Inorganic Chemistry, Fifth edition, Pearson Education, 2013. 5. James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, Fourth Edition, Pearson Education India, 2006. 6. Jonathan Clayden, Nick Greeves, Stuart Warren, Organic Chemistry, Second edition, OUP Oxford, 2012. 7. W. Carruthers, Iain Coldham, Modern Methods of Organic Synthesis, Fourth edition Cambridge University Press, 2004.	

	8. Francis A. Carey, Richard J. Sundberg, Advanced Organic Chemistry: Part A and B: Springer Science & Business Media, 2007. 9. Michael B. Smith, Jerry March, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Sixth edition, John Wiley & Sons, 2007.
Course Outcomes	On completion of the course, students should be able to CO1: Understand the problem solving approach in Inorganic chemistry. CO2: Solve problems in basics as well as advanced topics in quantum mechanics, group theory, molecular spectroscopy and chemical thermodynamics . CO3: Describe the basic concepts and able solve problems in statistical thermodynamics, electrochemistry, chemical kinetics and solid state. CO4: Understand the strategies to solve problems in stereochemistry, aromaticity, reactive intermediates and reaction mechanism. CO5: Solve the problems in synthetic strategies, pericyclic reactions, spectroscopy and natural products.

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	VIII	Course Code	**24CHUC4229**
Course Title	**ADVANCED METHODS IN ORGANIC SYNTHESIS**		
No.of Credits	2	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		

Scope of the Course	Advanced Skill	
Cognitive Levels addressed by the course	Understand and Apply	
Course Objectives	The objective of the course is to understand basics of asymmetric synthesis, to know the chemistry of commonly used organic reagents, to understand the reaction and mechanism of selected name reactions, the chemistry of protecting and deprotecting groups and to know the synthesis of selected drug molecules.	
UNIT	Content	No. of Hours
I	**Asymmetric Synthesis** Principles of Asymmetric synthesis - Stereospecific, Stereoselective – enanatioselective and diastereoselective-Asymmetric synthesis on chiral substrate: Nucleophilic addition to α–chiral carbonyl compounds; Asymmetric synthesis using chiral reagents: Chiral modification of lithium aluminum hydride, BINAL-H - application in reduction of prochiral ketones T. S model; oxazaborolidines. T.S model; Asymmetric Michael addition to α ,β – unsaturated carbonyl compounds T.S model; Asymmetric synthesis using chiral auxiliary: menthol, oxazolidine-2-one, and BINOL; Asymmetric synthesis using chiral catalysts: Sharpless epoxidation. Resolutions via diastereomeric salt formation-Commonly used resolving agents- (S)-phenylethylamine, L-tartaric acid, Resolution of chiral ligands - BINOL, trans 1,2-diaminocyclohexane..	10 Hours
II	**Reagents-II** Structure-Intermediates synthetic applications of Lawesson's Reagent,Gilman's Reagent; DDQ-aromatization, oxidation of active methylene and hydroxyl groups; LDA, LiHMDS-basicity, Kinetic	8 Hours

	neonate formation and synthetic applications; nBuLi-synthetic applications-ortholithiation; EDCI, DCC, HATU, HOBT, BOP-reagents-coupling reactions.	
III	**Name reactions** Reaction and Mechanism of following name reaction: Arndt-Eistert Syntheis, Buchwald-Hartwig Cross Coupling Reaction, Grubbs reaction, Heck reaction, Suzuki Coupling, Mukaiyama Aldol Addition, Sandmeyer Reaction, Stille Coupling, Tebbe Olefination, Yamaguchi Esterification, Simmon-Smith reaction, Peterson's Synthesis, Stark enamine synthesis, Shapiro reaction.	8 Hours
IV	**Functional Group interconversion and Strategies in Organic Synthesis** Conversion of Alcohols to Alkylating Agents-Sulfonate Esters, Halides-Introduction of Functional Groups by Nucleophilic Substitution at Saturated Carbon-Nitriles, Oxygen Nucleophiles, Nitrogen Nucleophiles, Sulfur Nucleophiles, Phosphorus Nucleophiles-Interconversion of Carboxylic Acid Derivatives-Acylation of Alcohols, Preparation of Amides.synthons and synthetic equivalents, disconnection approach, - the importance of order of events in organic synthesis, nucleophilic and electrophilic synthons - umpolong reactions - typical examples of one group C-X and two group C-X disconnections – two group disconnections – 1,2; 1,3-difunctionalised compounds–-α,β-unsaturatedcarbonylcompounds–1,4-difuctionalisedcompounds–Diels–Alderreactions and Micheal additions.	10 Hours

V	**Protection and deprotection in organic Synthesis** Installation and Removal of Protective Groups-Hydroxy-Protecting Groups-Ether-Bn, Tr, Allyl,PMB, MOM, THP-Silyl-TMS-Cl, TBDMS, TIPS-Cl-Esters-acetic anhydride, benzoyl chloride, pivaloyl chloride-Amino-Protecting Groups-Boc, CBz, Fmoc, Bn, Allyl, Phthalyl-Carbonyl-Protecting Groups-1,3-Dioxanes, 1,3-dithianes.	10 Hours
References	Reference Books: 1. Stereochemistry of Organic Compounds, E.L. Eliel, Samuel H. Wilen, Wiley – India Edition 2008. 2. Advanced Organic Chemistry Part A, F. A. Carey and R. J. Sundberg, Springer, 5th Edition, 2007. 3. Advanced Organic Chemistry Part B, F. A. Carey and R. J. Sundberg, Springer, 5th Edition, 2007. 4. Advanced Organic Chemistry Reactions, Mechanisms and Structure, M. B. Smith and J. March, Wiley, 6th Edition, 2007. 5. Organic Chemistry, I.L. Finar, Vol.2, ELBS, 5th edn., 1974. 6. Moderns Methods of Organic Synthesis, Carruthers, W. and Coldham, I, Cambridge University Press, UK, 4th edn., 2004. 7. Organic Synthesis, Michael B Smith, 3rd Edition, Academic Press, 2011. 8. E. J. Corey and X. M. Cheng, The Logics of Chemical Synthesis, Wiley, 1989. 9. K. C. Nicolaou, Classics in Total Synthesis, Vol 1, 2 and 3. 10. S. Warren and P. Wyatt, Organic Synthesis: The Disconnection Approach, 2nd edition, Wiley, 2008. 11. J. H. Fuhrhop, G. Li, Organic Synthesis: Concepts and Methods, 3rd edition, VCH, 1994. 12. Protective Groups in Organic Synthesis: Theodora W. Greene and Peter G. M. Wuts, 3rd Edition, John Wiley & Sons, Inc. 1999.	

Course Outcomes	On completion of the course, students should be able to CO1: Describe the methods of asymmetric synthesis which involve chiral substrate, chiral reagents, chiral auxiliary and chiral catalyst. CO2: Predict the structure and mechanism of reactions involving commonly used organic reagents CO3: Identify the mechanism of selected name reactions. CO4: Analyze the chemistry of protection and de-protection strategies involved in hydroxyl group by ether and ester, carbonyl group, and amino group sand functional group interconversion by substitution reactions. CO5: Predict the synthesis of selected drug molecules.

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓ (3)	✓(2)	✓ (3)	✓ (3)	✓ (3)
CO2	✓ (3)	✓ (3)	✓ (3)	✓ (3)	✓ (3)
CO3	✓ (3)	✓ (2)	✓ (3)	✓ (3)	✓ (3)
CO4	✓ (3)	✓ (3)	✓ (3)	✓ (3)	✓ (3)
CO5	✓ (3)	✓ (3)	✓ (3)	✓ (3)	✓ (3)

Semester	**VII**	Course Code	**24CHUC4230**
Course Title	**ADVANCED INORGANIC CHEMISTRY PRACTICAL**		
No.of Credits	2	No. of contact hours per week	5
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Advanced Skill		
Cognitive Levels addressed by the course	Understand and Apply		

Course Objectives	The practical course is designed to develop skills in identification of elements by inorganic qualitative analysis and also preparation of some inorganic complexes.

Content	No. of Hours
1. Analysis of mixtures containing two common and two less common cations. 2. 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. 3. Inorganic Preparations 4. Hexamminecobalt(III) Chloride 5. Tatraamminecopper(II) Sulphate 6. Hexaaminechromium(III)Nitrate 7. Hexaureachromium(III)Chloride 8. Tris(ethylendiamine)nickel(II) Chloride 9. Tris(ethylenediamine)chromium(III)Chloride 10. Potassiumtris(oxalato)ferrate(III) 11. Potassiumtris(oxalato)chromate(III) 12. Potassiumtris(oxalato)cuprate(II) 13. Potassiumhexathiocyanatochromate(III) 14. Potassiumtetrathiocyanatodiamminechromate(III) 15. Hexathiourealead(II)nitrate	5 Hours

References	Reference Books: 1. Inorganic Semi-Micro Qualitative Analysis, V.V. Ramanujam, The National Publishing House, Chennai, 1990.
Course Outcomes	On completion of the course, students should be able to CO1: Analyze most common and less common ions by using semi-micro inorganic qualitative methods. CO2: Formulate suitable methods for the preparation of desired inorganic complexes

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	3	3	3	3

Semester	IV	Course Code	**24CHUA2201**
Course Title	**COSMETIC CHEMISTRY**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Intradepartmental Elective		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	To create awareness among the undergraduate students about the role of chemistry in day-to-day life, to know more about the cosmetics and other chemicals that they use, to obtain adequate knowledge and scientific information regarding basic principles of cosmetic chemistry.		

UNIT	Content	No. of Hours
I	**Cosmetic formulations-I** Thickening agents based on polymers, natural agents, starch, aminoacid and minerals. Waxes from animal, vegetable and mineral sources – Non-ionic thickeners and electrolytes. Surfactants: importance – general considerations-types of surfactants: anionic, cationic, non-ionic and amphoteric – Properties	9 Hours
II	**Cosmetic formulations-II** Preservatives: Consequences of microbial	7 Hours

	growth in cosmetics – sources of microbial contamination – Criteria for preservatives – Common preservatives – formlation of fragrances in cosmetic products – stability of fragrances.	
III	**Hair Care Products and Skin-care products** **Hair care products:** Shampoos – principal constituents – thickeners and foam stabilizers – perfumes – preservatives – conditioning agents – antidandruff shampoos. Hair cream – composition – hair dyes – types – constituents – dye removals. **Skin care products:** Skin cleansers – classifications – cold cream – cleansy milk – moisturizers – hand and body lotions – sun screen lotions – constituents Bath powders – soap and detergents – constituents – manufacture	10 Hours
IV	**Colour Cosmetics and Dental-care Products** Lipstick – constitutions – manufacturing method – lip glosses – nail polish – formulation – manufacture – face powder – constitution. Oral care product – product categories – toothpaste – toothpowder – oral rinses – mouth washes.	39Hours
V	**Nanocarrier-based formulations** Production, mechanism of action and applications of cosmeceutical nanocarriers – liposomes-nanoemulsions – lipid nanoparticles – nanocrystals. Characterization of nanocarriers.	9 Hours
References	Reference Books: 1. Cosmetic formulation – Principles and practice, Eds. H. A. E. Bensen, M.S. Roberts, V. R. L.-Silva and K. A. Walters, CRC Press, Taylor & Francis Group, LLC., 2019. 2. Modern Technology of Cosmetics, Asia Pacific Business Press Inc.,	

	New Delhi, 2004. 3. Cosmetic Science, Dr. Satya Prakash Singh, Dr. Vijay Nigam, Thakur Publication Private Limited., 2021.
Course Outcomes	On completion of the course, students should be able to CO1: Demonstrate the ingredients of cosmetic formulations CO2: Choose hair-care products upon checking the chemical ingredients CO3: Identify the ingredients of skin-care products and bath preparations CO4: Demonstrate the manufacturing process of colour cosmetics and dental care products CO5:Demonstrate the production, mechanism of action and applications of nanocarrier-based formulations

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	3
CO2	3	1	3	1	3
CO3	3	1	3	1	3
CO4	3	1	3	1	3
CO5	3	1	3	2	3

Semester	IV	Course Code	**24CHUA2202**
Course Title	**NANOSCIENCE AND ITS APPLICATIONS**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Intradepartmental Elective		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the	Understand		

course		
Course Objectives	To introduce some of the fundamentals and current state-of-the-art in nanotechnology, to get familiarized with the synthesis, characterization and applications of nanomaterials.	
UNIT	Content	No. of Hours
I	**Nanoscience** Definition of terms-nanoscale, nanomaterials, nanoscience, nanotechnology-scale of materials-natural and manmade-nanoscience practiced during ancient and modern periods- contributors to the field of nanoscience.	8 Hours
II	**Nanotechnology in Nature** The science behind the nanotechnology in lotus effect - self cleaning property of lotus- gecko foot-climbing ability of geckos-water strider - antiwetting property of water striders- spider silk-mechanical properties of the spider silk.	1 Hours
III	**Classification of Nanomaterials** Types and Classification - Different types of nanomaterials: nanoparticles, nanotubes, nanowires, and nanosheets. Classification based on material types: metals, semiconductors, and polymers. Synthesis and Fabrication -Methods of synthesis: top-down (e.g., milling) and bottom-up (e.g., chemical vapor deposition). Key fabrication techniques for creating nanostructures. .	9 Hours
IV	**Synthesis and characterization of Nanomaterials** Top down and bottom up approaches-synthesis of carbon nanotubes, quantum dots, gold and silver nanoparticles. Electron microscopy techniques-scanning electron microscopy, transmission electron microscopy, atomic force microscopy	9 Hours
V	**Application of Nanomaterials**	11 Hours

	Nanosensors – Nanoscale organization: Self-assembly, template method, biological assembling and lithographic techniques – Characterization – Nanosensors based on optical properties and quantum size effects – electrochemical sensors – Nanobiosensors. Solar cells - smart materials-molecular electronics-biosensors - drug delivery and therapy-detection of cancerous cells.	
References	Reference Books: 1. T. Pradeep, Nano: The Essentials: Understanding Nanoscience and Nanotechnology, McGraw-Hill Professional Publishing, 2008. 2. J. Dutta, H.F. Tibbals and G.L. Hornyak, Introduction to Nanoscience, CRC press, Boca Raton, 2008.	
Course Outcomes	On completion of the course, students should be able to CO1:Recognize state of the art developments in the field of nanotechnology CO2: Describe useful properties and applications of nanotubes, quantum dots and nanoparticles.	

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	3
CO2	3	1	3	1	3

Semester	IV	Course Code	**24CHUA2203**
Course Title	**AGRICULTURAL CHEMISTRY**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Intradepartmental Elective		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to know the importance of agricultural chemistry and an exposure to analyze and find a suitable method to cultivate and to promote agricultural methods.		

UNIT	Content	No. of Hours
I	**Chemistry of soil** Composition of soil - Organic and Inorganic constituents. - Chemical aspects of soil - acid, alkali and saline soil. Nitrogen fixation in soils - biological nitrogen fixation.	8 Hours
II	**Plant Nutrients and Fertilizers** Plant nutrients - Sources and roles of macro and micro nutrients in plant growth - Nutritional deficiency in plants - symptoms, corrective measures - Fertilizers - classification of NPK fertilizers - natural and synthetic.	9 Hours
III	**Pesticides** Definition – Classification – organic and inorganic pesticides and its mechanism of action – Safe handling of pesticides, Fungicides - definition – classification – mechanism of action – sulfur, copper and mercury compounds.	10 Hours

IV	**Herbicides** Definition – classification – mechanism of action – Arsenic and boron compounds – urea compounds, nitro compounds and chloro compounds	39Hours
V	**Plant Growth Regulators** Definition - Classification - Structure and functions of - Abscisic acid - Auxins - Cytokinins - Ethylene - Gibberellins.	9Hours
References	Reference Books: 1. Tisdale, S.L., Nelson, W.L. and Beaton, J. D. Soil Fertility and Fertilizers, Macmillian Publishing Company, New York, 1990. 2. Hesse, P.R. A Textbook of Soil Chemical Analysis, John Murray, New York, 1971. 3. Buchel, K.H. Chemistry of Pesticides, John Wiley & Sons, New York, 1983. 4. Sree Ramula, U. S. Chemistry of Insecticides and Fungicides, Oxford and IBH Publishing Co., New Delhi, 1979.	
Course Outcomes	On completion of the course, students should be able to CO1: Describe the basics of soil CO2: Classify and explain plant nutrients and fertiliizers CO3:Predict the mechanism of pesticides and herbicides CO4: Describe the structure and functions of plant growth regulators	

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	3
CO2	3	1	2	2	1
CO3	3	2	3	3	2
CO4	3	1	3	2	3

Semester	IV	Course Code	**24CHUA2204**
Course Title	**WATER QUALITY ANALYSIS**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Intradepartmental Elective		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to give an in-depth understanding of water quality parameters, ground water and surface water pollution and its control measures. In addition, the students will also learn the water treatment methods, sewage and industrial effluent treatment methods and water resources management.		
UNIT	Content		No. of Hours
I	**Water quality parameters and their determination** Physical, chemical and biological standards significance of these contaminants over the quality and their determinations - Electrical conductivity - turbidity - pH, total solids, TDS - alkalinity - hardness - chlorides - DO - BOD- COD - TOC - nitrate – sulphate, fluoride**.**		12 Hours
II	**Ground water and surface water pollution and control measures** Pollution-pollutants-sources Surface water and ground water pollution - Harmful effects-pollution of major rivers - protecting ground water from pollution - ground water pollution due to Fluoride, Iron, Chromium and Arsenic - sources, ill effects and treatment methods**.**		8 Hours

III	**Water treatment methods** Treatment for community supply - screening, sedimentation, coagulation, filtration - removal of micro organisms - chlorination, adding bleaching powder, UV irradiation and ozonation.	8 Hours
IV	**Sewage and industrial effluent treatment** Sewage - characteristics - purpose of sewage treatment - methods of sewage treatment - primary - secondary and tertiary - Role of algae in sewage treatment. Types of industrial wastes - treatment of effluents with organic and inorganic impurities.	9 Hours
V	**Water Management** Water resources management - rain water harvesting methods - percolation ponds - check dams - roof top collection methods - water management in sugar, paper and textile industries.	8 Hours
References	**Reference Books:** 1. Chemical and Biological Methods for Water Pollution Studies, R.K. Trivedy and P.K. Goel, Environmental Publications, 1986. 2. Engineering Chemistry, P.c. Jain and Monica Jain, Dhanpat Rai and Sons, 1993. 3. Environmental Chemistry, B.K. Sharma, Goel Publishing House, 4. Water Quality and Defluoridation Techniques, Rajiv Gandhi National Drinking Water Mission Publication, 1994.	
Course Outcomes	On completion of the course, students should be able to CO1: Analyze water samples CO2: Evaluate pollutants and their effect on environment and on human health CO3: Suggest water treatment methods for domestic and industrial purposes CO4: Describe the methods of sewage and industrial effluent treatment and water resource management	

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	3
CO2	3	2	3	2	3
CO3	3	1	3	1	3
CO4	3	1	3	1	3

Semester	I / III	Course Code	**24CHUB2101/24CHUB1101**
Course Title	**ALLIED CHEMISTRY–I**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to understand the structure and bonding of molecules, to have knowledge in crystal structures and their symmetry, to know basics of solutions and their properties, and to understand the concept of thermodynamics.		

UNIT	Content	No. of Hours
I	**Chemical Bonding** Introduction-Ionic bond- characteristics of ionic compounds-covalent bond-characterristics of covalent compounds- coordinate bond - characteristics of coordinate complexes- inert pair effect; Fajan's rule-Octet rule - basic concepts of hydrogen bond.- types of hydrogen bonding-sigma and pi -bonds. Concept of hybridization, structures	10 Hours

	of $BeCl_2$, BF_3, CH_4, PCl_5, and SF_6 – VSEPR Theory**.**	
II	**Solid State** Types of solids, symmetry of crystals, Miller Indices, unit cell, space lattice, Bragg's equation, classification of crystals on the basis of bonds, ionic crystals, molecular crystals, covalent crystals and metallic crystals. Structure of CsCl and NaCl, liquid crystals-applications**.**	8 Hours
III	**Dilute Solutions** Ways of expressing concentrations of solutions, Henry's law, solutions of solids in liquids, solubility and equilibrium concept. Colligative properties, definition, measurement of lowering of vapour pressure, elevation of boiling point, depression of freezing point and osmotic pressure, Raoult's law-derivation.	9 Hours
IV	**Nuclear Chemistry and Radioactivity** Types and properties of radiations, the group displacement law, rate of radioactive decay-types of radioactive decay- half-life period, nuclear fission and fusion reactions, artificial radioactivity, mass defect- n-p ratio and nuclear reactor**.**	8 Hours
V	**Thermodynamics** Thermodynamics terms-system-surroundings-intensive and extensive properties-state of a system-thermodynamic processes-reversible and irreversible processes-internal energy-first law of thermodynamics-enthalpy of a system-spontaneous process-entropy-entropy change for an ideal gas-Gibb's Helmholtz equations-free energy and work functions.	10 Hours
References	Reference Books:	

	1. Atkins' Physical Chemistry, Peter Atkins, Julio de Paula, and James Keeler, Oxford University Press, UK 11th Ed., 2017. 2. Text book of Inorganic Chemistry, P.L. Soni, Sultan Chand & Sons, New Delhi, 20th Ed. 2000. 3. Essentials of Physical Chemistry, B. S. Bahl, G. D. Tuli and Arun Bahl, S. Chand & Company Ltd, New Delhi, 12th Ed. 2011. 4. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania, 5. Vishal Publishing Co., 47th Edn. 2016. 6. Selected Topics in Inorganic Chemistry, Malik, Tuli, Madan, S. Chand & Co. New Delhi, 2010.
Course Outcomes	On completion of the course, students should be able to . CO1: Describe basic concepts in chemical bonding CO2: Assign the structure of simple chemical molecules CO3: Interpret the types of crystal and symmetries present in molecules. CO4: Describe the terms used in dilute solutions CO5: Describe the basics of nuclear chemistry and functions of nuclear reactors CO6: Describe the laws of thermodynamics

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	1
CO2	3	2	2	2	1
CO3	3	2	3	3	2
CO4	3	1	3	3	3
CO5	3	1	3	1	3
CO6	3	1	3	1	3

Semester	II / IV	Course Code	**24CHUB2203/24CHUB1203**
Course Title	**ALLIED CHEMISTRY–II**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	: Understand		
Course Objectives	The objective of the course is to understand the nature of fuels, energy sources, to understand different types of polymers and its applications, to gain knowledge of nanomaterials, to know the basics of chemical kinetics and to understand the basic concepts of acids and bases.		

UNIT	Content	No. of Hours
I	**Fuels and Energy Sources** Classification, calorific value, characteristics of a good fuel, comparison between solid, liquid and gaseous fuels. Petroleum - classification - origin - refining of crude oil - cracking - synthetic petrol – knocking in petrol and diesel. Gaseous fuels - water gas and producer gas.	10 Hours
II	**Polymer Chemistry** Introduction – nomenclature, types of polymerization - plastics - classification of resins - – preparation, properties and uses of PE, PVC, PVA , PVAc and Nylon -6:6, PET, PAN- bakelite. Elastomers-vulcanization-synthetic rubbers-Buna-S and Buna-N	8 Hours

III	**Nanomaterials** Introduction to nanomaterials – definition - synthesis -Top down and bottom up approaches- synthesis of carbon nanotubes, characterization- applications of nanomaterials - Electron microscopy techniques-scanning electron microscopy and transmission electron microscopy.	7 Hours
IV	**Chemical Kinetics and Catalysis** Chemical Kinetics: reaction rates - rate, order and molecularity, pseudo first order reactions, integrated rate equation for first order reaction, half-life period, determination of order of reaction, simple collision theory, Arrhenius equation (derivation omitted). Catalysis: Types of catalysis - homogeneous, heterogeneous and enzyme catalysis.	10 Hours
V	**Acids and Bases** Acids – bases, Arrhenius, Bronsted- Lowry and Lewis concepts and relative strength of acids and base - pH scale-measurement of pH-, Henderson equation, acid base indicators-pH range of indicators- theory of indicators.	10 Hours

References	Reference Books: 1. Essentials of Physical Chemistry, B. S. Bahl, G. D. Tuli and Arun Bahl, S. Chand & Company Ltd, New Delhi, 12th Ed.,2011. 2. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania, Vishal Publishing Co., 47th Edn.,2016. 3. Engineering Chemistry, Jain, P.C. and Monica Jain, Dhanphatrai and Sons, New Delhi, 15th Edn., 2006. 4. Nano: The Essentials: Understanding Nanoscience and Nanotechnology, T. Pradeep, McGraw-Hill Professional Publishing, New Delhi, 2008. 5. Atkins' Physical Chemistry, Peter Atkins, Julio de Paula, and James Keeler, Oxford University Press, UK 11th Ed., 2017. 6. Industrial Chemistry, Sharma B.K, Goel Publishing house, Meerut, UP. 2011. 7. Introduction to Nanoscience, J. Dutta, H.F. Tibbals and G.L. Hornyak, CRC press, Boca Raton, 2008.
Course Outcomes	On completion of the course, students should be able to CO1: Categorize fuels and energy sources CO2: Describe the types of polymerization methods as well as preparation and uses of few well-known polymers CO3: Describe the method of preparation and properties of amino acids CO4: Classify protein and demonstrate the primary and secondary structure of proteins. CO5: Solve the problems in chemical kinetics CO6: Differentiate strong and weak acids and bases CO7: Calculate the pH of a solution

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	3
CO2	3	1	2	1	3
CO3	3	2	3	2	3
CO4	3	1	3	1	3
CO5	3	3	3	3	3
CO6	3	1	2	1	3
CO7	3	2	3	2	3

Semester	**I/III**	Course Code	**24CHUB2102/24CHUB1102**
Course Title	**Allied Chemistry Practical–I**		
No.of Credits	1	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand and Analyse		
Course Objectives	The practical course is designed to develop skills in identification of elements by semi-micro inorganic qualitative analysis.		

Content	No. of Hours
Semi-micro qualitative analysis of inorganic salts containing the following cations and anions. Cations: Pb, Cu, Al, Fe, Zn, Ca, Ba, Mg and ammonium. Anions : Oxalate, Borate, Carbonate, Fluoride, sulphate and Phosphate.	3 Hours
References	Reference Books:

	1. Practical Chemistry by A.O. Thomas, Scientific Book Centre, Cannanore, 2003. 2. Basic Principles of Practical Chemistry, V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu, Sultan Chand & Sons, New Delhi, 2nd Ed.,2004 3. Vogel's Qualitative Inorganic Analysis, G. Svehla, Dorling Kindersley, India, 4th Ed., 2009.
Course Outcomes	On completion of the course, students should be able to CO1: Analyze inorganic salts qualitatively and identify cations and anions present in a given unknown mixture of salts.

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	2	3

Semester	**II/IV**	Course Code	**24CHUB2204/24CHUB1204**
Course Title	**Allied Chemistry Practical–II**		
No.of Credits	1	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand and Analyse		
Course Objectives	The objective of the practical course is to get expertise in the preparation of standard solutions, to understand basic principles and develop skill in titrimetric analysis.		

Content	No. of Hours
Experiments 1. Preparation of standard solutions 2. Estimation of sodium hydroxide 3. Estimation of hydrochloric acid 4. Estimation of oxalic acid 5. Estimation of potassium dichromate 6. Estimation of ferrous ammonium sulphate 7. Estimation of Zinc 8. Estimation of available chlorine 9. Estimation of hardness of water	3 Hours

References	Reference Books: 1. Vogel's textbook of quantitative chemical analysis Mendham, John.Denney, Ronald C.Barnes, John D.Thomas, M., 7th Ed., Prentice Hall, New York, 6th Ed., 2000. 2. Practical Chemistry by A.O. Thomas, Scientific Book Centre, Cannanore, 2003. 3. Basic Principles of Practical Chemistry, V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu, Sultan Chand & Sons, New Delhi, 2nd Ed. 2004.
Course Outcomes	On completion of the course, students should be able to CO1: Prepare standard solutions CO2: Demonstrate the principles of titrimetry CO3: Analyze titrimetric data systematically and estimate the amount of inorganic substances in a given solution..

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3
CO2	3	1	1	3	3
CO3	3	3	1	3	3

Semester	I	Course Code	**24CHUM1101**
Course Title	**POLYMER SCIENCE**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	**MULTIDISCIPLINARY COURSES**		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to impart knowledge about the importance of polymers, to understand various polymerization techniques and characterization of polymers, to enable a student to understand polymer structure, properties and to know the polymer processing techniques and properties commercially available polymers.		
UNIT	Content		No. of Hours
I	**Polymers** Monomers, repeat units, degree of polymerization - Linear, branched and network polymers. Classification of polymers. Polymerization: condensation, addition, radical chain-ionic and co-ordination and co-polymerization.		7 Hours
II	**Polymer Characterization** Average molecular weight concept. Number, weight and viscosity-average molecular weights. The practical significance of molecular weight. Measurement of molecular weights. viscosity, and light scattering methods.		9 Hours
III	**Structure and Properties** Configurations of polymer chain. Morphology of crystalline polymers, strain-induced morphology. Polymer structure and physical properties-chain flexibility and other steric factors. Branching and cross linking		12 Hours

IV	**Polymer Processing** Compounding of plastics- Processing techniques: Calendering, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermo forming, foaming, reinforcing and fibre spinning.	9 Hours
V	**Properties of Commercial Polymers** Fire retarding polymers and electrically conducting polymers. Biomedical polymers- contact lens, dental polymers, artificial heart, kidney, skin and blood cells.	8 Hours
References	Reference Books: 1. Textbook of Polymer Science, F.W. Billmeyer, Johny Eastern Ltd., 1992. 2. Polymer Science, V.R. Gowariker, N.V. Viswanthan and J. Sreedhar. Wiley-Eastern, 1988	
Course Outcomes	On completion of the course, students should be able to CO1: Classify polymers and describe different types of polymerizations reactions CO2: Characterize polymers based on available experimental data CO3: Describe the structure and properties of polymers CO4: Demonstrate the properties of commercially available polymers CO5: Describe the types of polymer processing methods	

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	3
CO2	3	2	3	2	3
CO3	3	1	3	1	3
CO4	3	1	3	1	3
CO5	3	1	3	1	3

Semester	I	Course Code	**24CHUM1102**
Course Title	**ORGANIC CHEMISTRY FOR HOME SCIENCE**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	**MULTIDISCIPLINARY COURSES**		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to develop an understanding of food components such as carbohydrates, aminoacids, proteins, to obtain preliminary knowledge on dyes, leathers, fibers, to provide comprehensive introduction to sulpha drugs, antibiotics, fuels and to know synthesis and applications of polymers.		
UNIT	Content		No. of Hours
I	**Carbohydrates** Introduction – classification-preparation and properties of glucose and fructose structure of glucose (configuration-not expected) mutarotation- interconversion of aldose and ketose. Increasing and decreasing the length of the carbon chain in sugars – polysaccharides-		9 Hours

	preliminary study of starch and cellulose. Industrial applications of starch and cellulose.	
II	**Amino Acids and Proteins** Classification-preparation and properties of amino acids, isoelectronic point-tests for amino acids-polypeptides, peptide linkage, proteins – classification-denaturation of proteins, colour reactions, biological significance of proteins, structure of proteins, primary structure of proteins, end group analysis, preliminary study of secondary structure, introduction to DNA and RNA.	12 Hours
III	**Dyes, Leather and Fibers** Introduction-structural features of a dye-classification of dyes, preparation of methyl orange, fluoresce in, malachite green, alizarin and uses (both textile and non-textile). Leather: Basic principles in tanning and dyeing of leather, types of tanning (chrome and vegetable tanning) Fibers: Synthetic fibers derived from cellulose, nylon and terylene.	9 Hours
IV	**Sulpha Drugs, Antibiotics and Fuels** Introduction to sulpha drugs - sulphanilamide, sulphameracine, sulphaguanidine - preparation, mode of action of sulpha drugs. Antibiotics: very brief study of chloramphenicol, penicillin and tetracycline-their uses (detailed chemistry not required). **Fuels:** Classification, characteristics of a good fuel. Composition and uses of LPG, producer gas, water gas, method of production of gobar gas. Petroleum – knocking-use of tetraethyl lead diesel-octane and cetane number. Synthetic petrol, Bergius process.	8 Hours
V	**Polymers**	9 Hours

	Different types of polymerization-addition, condensation, ionic and free radical polymerization-mechanisms, synthesis and applications of the following polymers-PVC, polyester, polythene, Teflon, and polystyrene – rubber-natural rubber, vulcanization of rubber-synthetic rubber-neoprene.	
References	Reference Books: 1. Bahl and Arun Bahl, Text book of Advanced Organic Chemistry, S. Chand & Co., New Delhi, 1991. 2. Textbook of Polymer Science, F.W. Billmeyer, Johny Eastern Ltd., 1992. 3. Polymer Science, V.R. Gowariker, N.V. Viswanthan and J. Sreedhar. Wiley-Eastern, 1988.	
Course Outcomes	On completion of the course, students should be able to CO1: Describe the chemistry of carbohydrates CO2: Classify protein and demonstrate the primary and secondary structure of proteins CO3: Classify dyes and describe the synthesis of most popular dyes and demonstrate the tanning process CO4: Describe the mode of action of sulpha drugs and antibiotics CO5: Classify polymers and describe different types of polymerizations reactions and demonstrate the properties of commercially available polymers	

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	3
CO2	3	1	3	1	3
CO3	3	1	3	1	3
CO4	3	1	3	1	3
CO5	3	1	3	1	3

Semester	I	Course Code	**24CHUM1103**
Course Title	**CHEMISTRY IN THE SERVICE OF MANKIND**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	**MULTIDISCIPLINARY COURSES**		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	: Understand		
Course Objectives	The objective of the course is to provide comprehensive overview of fuels and energy sources, to familiarize with polymers, polymerization techniques and fertilizers, to provide an overview of vitamins and drugs, to understand the types of surface coatings, to have the knowledge about small and large scale industrial processes		

UNIT	Content	No. of Hours
I	**Fuels and Energy Resources** Types of fuels - liquid fuels - petroleum products – gaseous fuel - coal gas, producer gas and bio gas - Rocket fuels - solid and liquid propellants - nuclear fuels - difference between nuclear and chemical fuels. Renewable sources of energy - solar energy, wind energy and tidal energy.	7 Hours
II	**Polymers and Fertilizers** Chemistry of some important polymers - synthetic fibres -nylons, polyester - synthetic rubber - polyurethane rubber – reclaimed rubber - sponge, foam rubber, thermocole - polymerization techniques- bulk, solution, suspension, emulsion polymerization. Plant nutrients: need and requirements - natural and artificial fertilizer - urea, triple super phosphate, muriate of potash – complex fertilizers.	12 Hours

III	**Vitamins and Drugs** Vitamins - Water soluble vitamins - Vitamin B and C - fat soluble vitamins - A, D, E & K - sources - physiological functions and deficiency symptoms. Drugs - some important drugs – antibacterials – sulphonamide - antipyretics - aspirin - antimalarials - paludrine - antibiotics - penicillin.	8 Hours
IV	**Surface Coatings** Pretreatment of the surface metallic coating, galvanizing, tinning, inorganic coatings, organic coatings, oil paints, water paints, special paints, enamels and lacquers.	9 Hours
V	**Industrial Processes** Small scale units - manufacture of candles, safety matches, soap and naphthalene balls, shoe polish, cum paste, writing/fountain pen ink, Chalk crayons, plaster of paris and silicon carbide crucibles. Large scale units - manufacture of pulp and paper, sugar, glass, ceramics and cement.	9 Hours
References	Reference Books: 1. Industrial Chemistry by B.K. Sharma, Goel Publishing House, 12th Edn., 2001. 2. Engineering Chemistry by P.C. Jain and Monica Jain, Dhanphatrai and Sons, 15th Edn., 2006. 3. Chemical Process Industries by Shrive, George and T Austin, McGraw Hill Book Co., 1984.	
Course Outcomes	On completion of the course, students should be able to CO1: Classify fuels and energy source CO2: Describe the chemistry of some important polymers and fertilizers CO3: Categorize vitamins and drugs CO4: Categorize the types of surface coatings methods CO5: Describe small and large scale industrial processes	

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	3
CO2	3	1	2	1	3
CO3	3	2	3	1	3
CO4	3	2	3	1	3
CO5	3	1	3	1	3

Semester	I	Course Code	**24CHUM1104**
Course Title	**FOOD ADULTERATION AND ANALYSIS**		
No.of Credits	3	No. of contact hours per week	3
New Course/Revised Course	Revised Course	If revised, Percentage of Revision effected	20%
Category	**MULTIDISCIPLINARY COURSES**		
Scope of the Course	Basic Skill		
Cognitive Levels addressed by the course	Understand		
Course Objectives	The objective of the course is to learn about the food laws and general composition and quality criteria of the food products, to know the importance of toxicology and also the analysis of common adulterants.		
UNIT	Content		No. of Hours
I	**Food Laws and regulations** Food Laws and regulations (Mandatory) - Food Safety and Standards Act, 2006 (FSSA), Edible Oils Packaging (Regulation) Order, 1998, Environment (Protection) Act, 1986, Fruit Products Order, 1955 (FPO), Meat Food Products Order, 1973 (MFPO), Milk and Milk Product Order, 1992 (MMPO),		7 Hours

	Solvent Extracted Oil, De-oiled Meal-Introduction to various food laws (Voluntary) - Agmark Standards (AGMARK), Codex Alimentarius Standards, BIS Standards and Specifications, Consumer Protection Act, 1986-Codex standards for Cereals & Pulses- Codex standards for Fruits and Vegetables-Role of voluntary agencies and legal aspects of consumer protection	
II	**Dairy Products** General Composition and quality –Dairy products -Oil and Fats-Spices and condiments -Food Grains-Flours-Canned Foods-Fruit and Vegetables products-Meat and poultry-Sugar- Beverages-Alcoholic and Non Alcoholic drinks	8 Hours
III	**Toxicity in food** Importance of food toxicology -naturally occurring toxins in various foods -microbial and parasitic-food poisoning and food infections or food borne illness-mycotoxins – aflatoxin-bacterial toxin-residual chemical contaminants-pesticides-heavy metals, hormones in food.	9 Hours
IV	**Food Additives** Comparison of adulterants and additives–food additives-antioxidants-Natural oxidants- synthetic oxidants-colour-stabilizer-surface active agents-artificial sweetener-flavor enhancers- Intentional adulterants-Incidental adulterants	9 Hours
V	**Food Analysis** Analysis of adulterants- morphological and anatomical characterization-physical techniques-chemical/biochemical techniques-electrophoresis and immunology based techniques-molecular techniques-PCR and sequencing based techniques**.**	12 Hours
References	Reference Books:	

	1. Dr. Jagmohan Negi. Edition. 2004. Food & Beverage Laws - Food Safety and Hygiene. Media : Hard Back. ISBN : 9788182040007. 2. A. Sood. 1999. Toxicology. Published by Sarup & Sons, New Delhi. 3. R.K. Trivedy. 2001. Aquatic pollution and toxicology. 1st ed. Jaipur : ABD Publishers : Distribution, Oxford Book Co. 4. S.B. Vohora, V.R. Agrawal. Toxicology and Environmental Health. 2000. Asiatech Publishers Inc. 5. The Food Safety and Standards act, 2006 along with Rules & Regulations 2011, Commercial Law Publishers (India) Pvt. Ltd. 6. Patricia and Curtis A, An operational Text Book, Guide to Food Laws and Regulations. 7. Takayuki Shibamoto, Leonard Bjeldanes, Introduction to food toxicology 1st edition Published by Science Elsevier.
Course Outcomes	On completion of the course, students should be able to CO1: Describe the food laws CO2: Discuss the general composition and quality of food CO3: Determine the toxins and adulterants of food CO4: Describe the food additives CO5: Demonstrate the basic food analysis methods

Mapping of CO with PSO

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	3
CO2	3	2	3	1	3
CO3	3	2	3	1	3
CO4	3	2	3	1	3
CO5	3	2	3	1	3