B.Sc Chem.(H), Semester –VII (1)										
Sr. No.	**Category**	**Course Code**	**Course Title**	**Hours per week**			**Credits**	**Marks for Sessional**	**Marks for End Term Examination**	**Total**
				L	**T**	**P**				
1	DSC-A1 / Major	CHU-401-V	Inorganic Chemistry-V	4			4	25	75	100
2	DSC-A2 / Major	CHU-403-V	Organic Chemistry-VI	4			4	25	75	100
3	DSC-A3/ Major	CHU-405-V	Physical Chemistry-VI	4			4	25	75	100
4	DSC-A4/ Major	CHU-407-V	Inorganic Chemistry-V- Lab			4	2	30	70	100
5	DSC-A5/ Major	CHU-409-V	Organic Chemistry-VI - Lab			4	2	30	70	100
6	DSC-A6/ Major	CHU-411-V	Physical Chemistry-VI-Lab			4	2	30	70	100
DISCIPLINE SPECIFIC MAJOR										
7.	MIC-1 / Minor	CHU-413-V	Seminar	1			1	50		50
8.	MDC-1/ Multidisciplinary	CHU-415-V	Chemistry of Life Process	3			3	25	75	100
			Total				**22**			

B.Sc Chemistry Hons. (With Research), Semester – VII (2)										
Sr. No.	**Category**	**Course Code**	**Course Title**	**Hours per week**			**Credits**	**Marks for Sessional**	**Marks for End Term Examination**	**Total**
				L	**T**	**P**				
1.	DSC-A1 / Major	CHU-401-V	Inorganic Chemistry- V	4			4	25	75	100
2.	DSC-A2 / Major	CHU-403-V	Organic Chemistry- VI	4			4	25	75	100
3.	DSC-A3/ Major	CHU-405-V	Physical Chemistry- VI	4			4	25	75	100
DISCIPLINE SPECIFIC MAJOR										
4.	MIC-1 / Minor	CHU-413-V	Seminar	1			1	50		50
5.	MDC-1/ Multidisciplinary	CHU-415-V / CHU-417-V	Chemistry of life Process/ Research Resourcing	3			3	25	75	100
RESEARCH PROJECT / DISSERTATION										
6.	Research Project/ Dissertation	CHU-419-V	Research Project/ Dissertation			12	6	90	210	300
			Total				**22**			

B.Sc (H) Chemistry & Semester – VIII (1)										
Sr. No.	**Category**	**Course Code**	**Course Title**	**Hours per week**			**Credits**	**Marks for Sessional**	**Marks for End Term Examination**	**Total**
				L	**T**	**P**				
1.	DSC-A1 / Major	CHU-402-V	Inorganic Chemistry- VI	4			4	25	75	100
2.	DSC-A2 / Major	CHU-404-V	Organic Chemistry- VII	4			4	25	75	100
3.	DSC-A3/ Major	CHU-406-V	Physical Chemistry- VII	4			4	25	75	100
4.	DSC-A4/ Major	CHU-408-V	Inorganic Chemistry – VI-Lab			4	2	30	70	100
5.	DSC-A5/ Major	CHU-410-V	Organic Chemistry-VII - Lab			4	2	30	70	100
6.	DSC-A6/ Major	CHU-412-V	Physical Chemistry- VII-Lab			4	2	30	70	100
DISCIPLINE SPECIFIC MAJOR										
7.	MIC-1 / Minor	CHU-414-V	Seminar				1	50		50
8.	MDC-1/ Multidisciplinary	CHU-416-V / CHU-418-V	Computational Techniques/ Chemistry of Supramolecules				3	40	60	100
			Total				**22**			

B.Sc (H) Chemistry & Research Semester – VIII (2)										
Sr. No.	**Category**	**Course Code**	**Course Title**	**Hours per week**			**Credits**	**Marks for Sessional**	**Marks for End Term Examination**	**Total**
				L	**T**	**P**				
1.	DSC-A1 / Major	CHU-402-V	Inorganic Chemistry- VI				4	25	75	100
2.	DSC-A2 / Major	CHU-404-V	Organic Chemistry- VII				4	25	75	100
3.	DSC-A3/ Major	CHU-406-V	Physical Chemistry- VII				4	25	75	100
DISCIPLINE SPECIFIC MAJOR										
4.	MIC-1 / Minor	CHU-414-V	Seminar	1			1	50		50
5.	MDC-1/ Multidisciplinary	CHU-416-V / CHU-418-V	Computational Techniques/ Chemistry of Supramolecules	3			3	25	75	100
RESEARCH PROJECT / DISSERTATION										
6.	Research Project/ Dissertation	CHU-420-V	Research Project/ Dissertation				6	90	210	300
			Total				**22**			

Semester-VII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-401-V	INORGANIC CHEMISTRY- V	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

- Understand symmetry,grouptheory, and Stereochemistry
- Understand Metal-Ligand Equilibria in solution
- Understandthe bonding concepts involved in Coordination compounds
- Utilize this knowledge for complex formation of research interest.

Learning Outcomes:

- The objective of the course is to make the students understand the group theory, metal-ligand equilibria in solution and bonding behaviour in main group compound.

Course Content:

Unit-I **Symmetry and Group Theory in Chemistry-I:(15 Hrs)**

Symmetry and Group Theory in Chemistry-I: Definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relationand classes. Symmetry elements and symmetry operation, Point symmetry group. Schönflies symbols, representations of groups by matrices (representation for the *Cn, Cnv, Cnh, Dnh* etc. groups to be worked out explicitly).

Unit-II **Symmetry and Group Theory in Chemistry-II: (12 Hrs)**

Character of a representation, reducible and irreducible representations, The great orthogonality theorem (without proof) and its importance, Derivation of character tables of *C2v, C3v* and *D2h* Character tables and their use. Molecular asymmetry, dissymmetry and optical activity.

Unit-III **Metal-Ligand Equilibria in solution: (18 Hrs)**

Stepwise and overall formation constants and their interactions, trends in stepwise constants, factors affecting stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry. Substitution reactions in octahedral complexes, theories of trans effect with respect to Pt(II) complexes, brief account of electron transfer reactions, inert and labile complexes.

Unit-IV **Bonding in Main Group compounds and Metal-Ligand Bonding: (15 Hrs)**

VSEPR theory, dπ–pπ bonds, Bent rule and energetic of hybridization. Walsh Diagram, Limitation of crystal field theory, crystal field effects, John Teller distortion, nephelauxetic series, molecular orbital theory of octahedral, tetrahedral and square planar complexes (with and without π -bonding).

Suggested Books/Reading:

1.	Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2.	Inorganic Chemistry, J.E. Huhey, Harper & Row.
3.	Chemical Applications of Group Theory; F.A. Cotton, Wiley, New York.
4.	Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5.	The Chemical bond; J.N.Murre l, SFA Kettle and JM. Tedder; Wiley, New York.
6.	Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe.
7.	Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDanie l and. J.J.Alexander; John Wiley and Sons.
8.	Inorganic Chemistry, A Modern Introduction; T Moeller, John Wiley and Sons.

Semester-VII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-403-V	ORGANIC CHEMISTRY-VI	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

- Describe reaction intermediates, energy profile diagrams and establish mechanism of organic reaction simultaneously understand effect of structure on reactivity and application of Hammett /Taft equations, Curtin-Hammett principles, Hammond postulates in theoretical treatment of organic reactions.
- Understand mechanistic details of different types of and factors affecting aliphatic nucleophilic substitution reactions and the terminology involved therein.
- Master stereo-chemical terms, inter-convert stereo-structural formulae of organic molecules, analyze configurations, create stereo-structures and correlate configuration by applying the concept of chemical correlation.
- Realize the concepts of prochirality, topicity and related terms, asymmetric synthesis, application of Cram's, Prelog and Horeaus rule.
- Describe stability of different configurations and conformations of acyclic and cyclic organic compounds, sugars, decalins.

Learning Outcomes:

- The objective of the course is to make the students understand the reaction Mechanism, aliphatic nucleophilic substitution, and stereochemistry.

Course Content:

Unit-I **Reaction Mechanism: Structure and Reactivity:(15 Hrs)**

Reaction Mechanism: Structure and Reactivity: Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, effect of structure on reactivity - resonance and field effects, steric effect, quantitative treatment-The Hammett equation and linear free energy relationship, substituent and reaction constants and Taft equation. Kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining reaction mechanisms. Generation, structure, stability and reactivity of carbocations, carbanions, carbenes and nitrenes.

Unit-II **Aliphatic Nucleophilic Substitution: (15 Hrs)**

Aliphatic Nucleophilic Substitution: The SN^2, SN^1, mixed SN^1 and SN^2, SN^i, $SN^{1'}$, $SN^{2'}$, $SN^{i'}$ and SET mechanisms. Reactivity-effects of substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophile, regioselectivity. The neighbouring group mechanisms, neighbouring group participation by n electrons, π and σ bonds, anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, common carbocation rearrangements.

Unit-III **Stereochemistry-I: (15 Hrs)**

Stereochemistry-I: Symmetry elements, D-L, R-S, E-Z and threo-erythro nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. conformational analysis, enantiomerism and diastereomerism of simple, cyclic (chair and boat configuration) and acyclic systems. Axial and planer chirality, optical somerism in allenes, biphenyls (atropoisomerism), spiranes, hemispiranes. elementary ideas about stereochemistry of tertiary amines, quaternary salts, sulphur and phosphorous compounds.

Unit-IV **Stereochemistry – II: (15 Hrs)**

Stereochemistry – II: Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogenecity, chirogenicity, pseudoasymmetry and prochiral centre. stereospecific and stereoselective reaction. Elementary idea of principle categories of asymmetric synthesis, Cram's rule and its modification, Prelog rule and horeaus rule.
Stereochemistry of sugars- C1 and 1C conformations of hexoses, c_2'-endo and c_3'-endo conformation of pentoses, homomorphous sugars, abnormal mutarotation and Δ-2 instability factor. Stereochemistry of decalins, Chemical correlation of configuration -determination of relative configuration of 2-butanol, isoserine, alanine, malic acid, lactic acid and mandelic acid.

Suggested Books/Reading:

1	Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.
2	Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
3	A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4	Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
5.	Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice -Hall.

6.	Modern Synthetic Reactions, H. O. House, Benjamin.
7.	Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional.
8.	Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
9.	Organic Chemistry, J. Clayden, N. Greeves, S.Warren, P. Wothers, Oxford Press.

Semester-VII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-405-V	PHYSICAL CHEMISTRY- VI	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

- Handle the thermodynamics of a chemical process.
- Understand the basic concept of quantum mechanics.
- Understand the basic concept of statistical mechanics.
- Apply Schrödinger equation for various chemical systems.

Learning Outcomes:

- The objective of the course is to make the students understand the Quantum Mechanics, Thermodynamics, and Statistical Mechanics.

Course Content:

Unit-I	**Quantum Mechanics - I:(15 Hrs)**

Quantum Mechanics – I: The postulates of quantum mechanics, Linear and Hermitian operators. Commutation of operators and Uncertainty Principle. Schrödinger equation, eigen function and eigen values, free particle, Schrödinger equation for a particle in a box, the degeneracy, particle in a box with a finite barrier, Schrödinger equation for linear harmonic oscillator and its solution, zero-point energy, Energy levels and wave-functions of Rigid rotator. Quantum Mechanical Tunneling: Tunneling through a rectangular barrier.

Unit-II	**Quantum Mechanics – II: (15 Hrs)**

Quantum Mechanics – II: Quantum-mechanical treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy. Radial and angular parts of the hydrogen atom wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. Radial and angular nodes and their significance. Average and most probable distances of electron from nucleus. Shapes of s, p and d atomic orbitals, nodal planes. Angular momentum and its directional quantization, Angular momentum operators, commutation relation.

Unit-III	**Thermodynamics: (15 Hrs)**

Thermodynamics: Brief recapitulation of first and second Law of thermodynamics. Entropy changes in reversible and irreversible processes; variation of entropy with temperature, pressure and volume, entropy concept as a measure of unavailable energy and criteria for the spontaneity of reaction; entropy of mixing; free energy functions and their significance, criteria for spontaneity of a process; partial molar quantities (Chemical Potential, free energy, volume, heat concept), Gibb's-Duhem equation. Concept of Fugacity, Activity, and their applications

Unit-IV	**Statistical Mechanics: (15 Hrs)**

Statistical Mechanics: Ensemble averaging, postulates of ensemble averaging. Microcanonical, canonical and grand canonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers). Distinguishable and Indistinguishable/ Identical Particles. Maxwell-Boltzmann statistics, Boltzmann distribution, derivation of the Boltzmann distribution expression, determination of the Boltzmann constant, Maxwell distribution law of velocities from Boltzmann distribution expression. Quantum statistics: Bose-Einstein statistics and Fermi-Dirac statistics, Bose-Einstein condensation & distribution function. Derivation of Fermi-Dirac distribution function and its comparison.

Suggested Books/Reading:

1	D. A. McQuarrie and J. D. Simon, "Physical Chemistry. A Molecular Approach" University Science Books, Sausalito 1997
2	Attila Szabo and Neil S. Ostlund, "Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory" Dover Books on Chemistry, 1996
3	D. A. McQuarrie, "Quantum Mechanics" University Science Books, Mill Valley, CA, 1983
4	D. A. McQuarrie, "Statistical Mechanics" Viva Books Pvt. Ltd.: New Delhi, 2003
5.	P.W. Atkins and Julio de Paula, "Physical Chemistry", 8th Ed., W. H. Freeman Publication, 2006.
6.	G.M. Barrow, "Physical Chemistry" Tata McGraw-Hill Education, 2008.
7.	R.K. Prasad, "Quantum Mechanics" New Age Publication, 2009.
8.	Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson (2013).

Semester-VII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-413-V	SEMINAR	50		1
		L – 1	T - 0	P - 0

Course Objectives:

- Learn to review and correlate the literature reports related to a particular topic.
- Acquire skills of presentations through computer program.
- Develop skills of effective verbal scientific communication.
- Develop the ability to present and defend their studies in an intellectual way.

Learning Outcomes:

- Student will be able to learn about recent topics related to Chemistry in any thrust area of subject (Experimental or theoretical).

Course description:

Students are required to deliver a Seminar on a recent topics related to Chemistry through power point presentation followed by Q/A session. Seminar may be delivered in any thrust area of subject (Experimental or theoretical). Every student shall be required to submit the topic of his/her seminar in consultation with Faculty members well in advance.

Semester-VII				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-415-V	**CHEMISTRY OF LIFE PROCESSES**	**25 + 75 = 100**	**3**	**3**
		L – 3	**T - 0**	**P - 0**

Course Objectives:

- Understand the metabolism and energy cycle of living beings.
- Corelate the metabolism of a body and chemical reactions responsible for it.
- Predict biochemistry of any metabolism
- Solve problems of genetic engineering.

Learning Outcomes:

- The objective of the course is to make the students understand the metabolic processes, Carbohydrates, Lipids, Proteins and Nucleic Acids.

Course Content:

Unit-I	**Introduction to metabolic processes:(12 Hrs)**

Introduction to metabolic processes: Catabolism and anabolism, ATP, currency of biological energy, energy rich and energy poor phosphates, role of NADH, NADPH, FADH2, TPP, coenzyme A, lipoic acid and biotin. Introduction to photosynthesis.

Unit-II	**Carbohydrates: (12 Hrs)**

Carbohydrates: Structure (excluding conformational analysis) and biological functions of monosaccharides(glucose, fructose and galactose) and their derivatives like glycosides, deoxy sugars, myoinositol. Disaccharides- sucrose, lactose andmaltose. Structure and biological functions of Structural polysaccharides (cellulose and chitin) and Storage polysaccharides (starch and glycogen). Heteropolysaccharides-Glucosaminoglycans/mucopolysaccharides

Unit-III	**Lipids and Proteins: (12 Hrs)**

Lipids: Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins - composition and function, role in atherosclerosis.Lipid metabolism - β-oxidation of fatty acids.
Proteins: Primary, secondary, tertiary and quaternary structures, enzymes, active sites, allosteric sites and mechanism of their action, e.g. Chymotrypsin

Unit-IV	**Nucleic Acids and Genetic Code: (9 Hrs)**

Nucleic Acids and Genetic Code: Structure of nucleotides, nucleosides, DNA (Watson-Crick model) and RNA, Replication of DNA (semi-conservative, conservative and dispersive replication Maselson-Stahl experiment), transcription, translation of genetic material, genetic code, universality of the code, codon, anticodon pairing.

Suggested Books/Reading:

1	Principles of Biochemistry, A. L. Lehninger, Worth Publishers.
2	Biochemistry, L.Stryer, W.H.Freeman.
3	Biochemistry, J. David Rawn, Neil Patterson.
4	Biochemistry, Voet and Voet, John Wiley.
5.	Outlines of Biochemistry, E. E.Conn and P. K. Stumpf, John Wiley.

Semester-VII				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-417-V	**RESEARCH RESOURCING**	**25 + 75 = 100**	**3**	**3**
		L – 3	**T - 0**	**P - 0**

Course Objectives:

- Understand the aim of research
- Understand about Intellectual Property Rights
- Learn about new useful techniques

Learning Outcomes:

- The objective of the course is to make the students understand the literature, scope of research and research design, intellectual property rights and techniques.

Course Content:

Unit-I **Literature:(8Hrs)**

Literature: Difference between Review Paper and Research paper, Definition and Importance: Author Index, Formula Index, H-index, I-index, Citations, Google Scholar Citations, Difference between Ist Author and Corresponding Author, Impact factor. E-journals, Journal access, Hot articles, E-books, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus.

Unit-II **Scope of Research and Research Design: (7Hrs)**

Scope of Research and Research Design: Meaning of research, research gap, objectives of research, basic steps ofresearch, criteria of good research, types of research, selection of research problem.Types of research design- exploratory, descriptive, diagnostic and Experimental, Meaning and importance of workshop, seminar, conference, symposium inresearch.

Unit-III **Intellectual Property Rights:(12Hrs)**

Intellectual Property Rights: Nature of intellectual property, categories of intellectual property. IPR as instrument of development, Advantages and disadvantages of Intellectual Property Rights, kind of works can be protected under copyright, Law relating to copyright in India : the Copyright Act, 1957, Copyright infringement, How to register a copyright in IndiaPatents: what can be patented, what cannot be patented, patent system in India. Types of patent applications, Design and copyright. Ownership of copyright and assignment of copyright. Trademark, International Cooperation on Intellectual property, Patent rights and technology transfer.

Unit-IV **Techniques: (18Hrs)**

Techniques: Introduction, Basic principles, instrumentation and applications of Cyclic Voltammetry. Mössbauer Spectroscopy, Purity of compounds by CHN analysis, ^{1}H NMR & C^{13}active inorganic compounds only, EPR Spectroscopy, F^{19} and P^{31} NMR

Suggested Books/Reading:

1	Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) Practical skills in chemistry. 2nd Ed. Prentice-Hall, Harlow.
2	Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
3	Topping, J. (1984) Errors of observation and their treatment. Fourth Ed., Chapman Hall, London.
4	Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3-5.
5.	Levie, R. de, How to use Excel in analytical chemistry and in general scientific dataanalysis. Cambridge Univ. Press (2001) 487 pages.
6.	Hibbert, D. B. & Gooding, J. J. (2006) Data analysis for chemistry. Oxford University Press.
7.	OSU safety manual 1.01.

Semester-VII				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-407-V	**INORGANIC CHEMISTRY-V-LAB**	**30 + 70 = 100**	**4**	**2**
		L – 0	**T - 0**	**P - 4**

Course Objectives:

- Fundamental understanding of Qualitative Analysis
- identify a given mixture of inorganic salts qualitatively by experiments.
- interpretation of the results
- to learn comprehensive laboratory techniques.

Learning Outcomes:

- The objective of the course is to make the students understand qualitative analysis, titrations and interpretation of the results

Course Content:

Unit-I	**Qualitative Analysis**

Qualitative Analysis: Less common metal ions- W,Tl,Mo,Se,Ti,Zr,Th,V,U,Ce,Be.(two metal ions in cationic/anionic forms)
Insolubles- Oxides (Al_2O_3, Cr_2O_3, SnO_2, TiO_2, SiO_2 WO_3,); Sulphates (Lead Sulphate, Barium Sulphate Strontium Sulphate and Calcium Sulphate); Halides (Calcium fluoride and silver halides)
(2 less common metal ions and 1 insoluble to be given)

Unit-II	**Titrations**

Titrations: Cerimetric / Iodometric / Oxidimetry titrations.

Suggested Books/Reading:

1	A Text Book of Macro and Semi-micro Quantitative Analysis, A.I.Vogel, Orient Longman.
2	A Vogel's Text Book of Quantitative Inorganic Analysis, J. Bassett, R.C. Denney, G.B. Jafferyand J. Menaham, Longman, London.
3	Synthesis and Characterization of Inorganic Compounds, W.B. Jolly, Prentice Hall, Englewood.
4	Synthesis and Physical Studies of Inorganic Compounds, C.F. Bell, Pergamon Press
5.	Inorganic Preparations; W.G. Palmer.
6.	Virtual Lab - https://vlab.amrita.edu

Semester-VII				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-409-V	**ORGANIC CHEMISTRY-VI- LAB**	**30 + 70 = 100**	**4**	**2**
		L – 0	**T - 0**	**P - 4**

Course Objectives:

- analyse a given mixture of compounds qualitatively in laboratory.
- Synthesis of various organic compounds in laboratory.
- analyse the monofunctional compounds.
- analyse common name reactions in laborartory.
- analyse the bifunctional compounds.

Learning Outcomes:

- The objective of the course is to make the students understand qualitative analysisandsynthesis of organic compounds.

Course Content:

Unit-I	**Qualitative Analysis**

Qualitative analysis of mono and bi-functional compounds.

Unit-II	**Synthesis**

Synthesis of organic compounds involving some of the following reactions: acylation reaction, Oxidation and reductions, Coupling reactions, Diels-Alder reaction, Nucleophilic substitution reaction, Condensation reaction, Diazotization reactions.

Suggested Books/Reading:

1	A Hand book of Organic Analysis -Qualitative and Quantitative by H.T. Clarke, and revised by B.Haynee, Edward Arnold, London 1975.
2	Vogel's Text Book of Practical Organic Chemistry by B.S. Furhen et. al, Longman-Group Ltd.
3	Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Limited, London 1959.
4	Elementary Practical Organic Chemistry by Arthur I. Vogel, Ex CBS Publishers and Distributors.
5.	Experiments in Organic Chemistry by Louis, F.Fieser, D.C. Heath and Company Boston, 1955.
6.	Virtual Lab - https://vlab.amrita.edu

Semester-VII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-411-V	PHYSICAL CHEMISTRY- VI- LAB	30 + 70 = 100	4	2
		L – 0	T - 0	P - 4

Course Objectives:

- Handle electrodes, conductivity meter and pH meter to perform physical property analysis.
- Determine rate and estimate molecular mass of polymer system.
- Determine rate constant for various chemical reactions.
- Determine the viscosity of liquids.

Learning Outcomes:

Student will be able to understand Conductometry, pH-metry,Chemical Kinetics and Viscosity lab techniques.

Course Content:

Unit-I **Conductometry**

i. Determine the strength of strong acid by conductometric titration with strong base.
ii. Determine the strength of weak acid by conductometric titration with strong base.
iii. Determine the strength of strong acid and weak acid in a mixture by conductometric titration with strong base.
iv. Study precipitation titration between KCl and $AgNO_3$conductometrically.
v. Determine the basicity of mono-, di-, and tri- basic acids conductometrically.
vi. Determine solubility and solubility product of sparingly soluble salts like PbSO4, $BaSO_4$.

Unit-II **pH-metry**

i. Determine the strength of strong acid by pH-metric titration with strong base.
ii. Determine the strength of weak acid by pH-metric titration with strong base.
iii. Determine the dissociation constant of acetic acid using pH-meter.

Unit-III **Chemical Kinetics**

i. Study the hydrolysis of methyl acetate in presence of hydrochloric acid.
ii. Study saponification of ethyl acetate by sodium hydroxide solution taking the initial concentration of ester and base to be different.

Unit-IV **Viscosity**

i. Determine the viscosity of liquids (environment friendly) using Ostwald viscometer.
ii. Study the variation of viscosity with concentration for a glycerol solution using Ostwald viscometer and thereafter determine the concentration of unknown solution of glycerol.
iii. Determination of molar mass of a polymer.

Suggested Books/Reading:

1. R.C. Das and Behera 'Experiments in Physical Chemistry' Tata McGraw- Hill, 1983.
2. Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
3. F. Daniel, 'Experimental physical Chemistry' McGraw Hill 1962.
4. M. Jaffar, 'Experimental Physical Chemistry' University Grants Commission 1989.
5. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
6. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
7. J.B. Yadav, "Advanced Practical Physical Chemistry" 29th Ed. Krishna Prakashan Media (p) Ltd, 2010.
8. J. N. Gurtu, Amit Gurtu, "Advanced Physical Chemistry Experiments" Pragati Prakashan, 2008.
9. Virtual Lab - https://vlab.amrita.edu

Semester-VII

Course code	Name of Course	Max Marks	Hrs. Per Week	Credit
CHU-419-V	RESEARCH PROJECT/DISSERTATION	90 + 210 = 300	12	6
			L – 0	T - 0	P - 12

Course Objectives:

- Learn to review the theoretical knowledge with actual world problem.
- Develop ability to check research gap in related field.
- Develop skills to solve the real problem.
- Develop skills of effective scientific presentation.

Learning Outcomes:

- Student will be able to learn about various topics in Chemistry (Inorganic, Organic, Physical) in any thrust area of subject (Experimental or theoretical).

Course description:

Students are required to submit the research work report and deliver a presentation on a chosen topic related to Chemistry (Inorganic, Organic, Physical) through power point presentation followed by Q/A session. Every student shall be required to submit the topic of his/her research project in consultation with Faculty members well in advance.

Semester-VIII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-402-V	INORGANIC CHEMISTRY- VI	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

- Corelate structure of a metal compound and its magnetic properties.
- Design a complex with required magnetic properties.
- Explore more about complexes like boranes, carboranes, metal carbonylesetc and their applications.
- Insights and behaviour of metal clusters

Learning Outcomes:

- The objective of the course is to make the students understand the electronic Spectra, magnetic properties of transition metal complexes, metal л-Complexes and metal Clusters.

Course Content:

Unit-I	**Electronic Spectra and Magnetic Properties of Transition Metal Complexes -I:(16Hrs)**

Electronic Spectra and Magnetic Properties of Transition Metal Complexes -I: Electronic arrangements of microstates, calculation of the number of microstates in various electronic arrangements, spectroscopic term symbols, vector diagrams to indicates coupling of orbital angular momenta in p^2, p^3, d^2 configurations and spin orbit coupling for p^2 arrangement, spectroscopic terms, spectral terms of d^2 to d^8 metal ions, determining the ground state terms -Hund's rules, derivation of the term symbol for a closed subshell.

Unit-II	**Electronic Spectra and Magnetic Properties of Transition Metal Complexes -II: (18Hrs)**

Electronic Spectra and Magnetic Properties of Transition Metal Complexes -II: Interpretation of electronic spectra, Orgel diagrams, Tanabe-Sugano diagrams for transition metal complexes (d^1 –d^9 states), calculations of Dq, B and βparameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, magnetic moment calculations spin only, orbital contribution quenching of magnetic moment, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Circular Dichroism and Optical Rotatory Dispersion

Polarized light, fundamental symmetry requirements, for optical activity, interaction of polarized light with optically active matter, optical rotation, Cotton effect, configuration of Tris -chelated complexes.

Unit-III	**Metal л-Complexes: (14Hrs)**

Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; Carbonyl cations and anions and carbonyl hydrides; tertiary phosphine as ligand.

Unit-IV	**Metal Clusters: (12Hrs)**

Metal Clusters: Higher boranes, structure types, nido, arachano, closoetc structure prediction of boranes using styx formulae, Wades rule, Wades Mingo rules, Isolobal analogy,carboranes, metalloboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal bonds

Suggested Books/Reading:

1	Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2	Inorganic Chemistry, J.E. Huhey, Harper & Row.
3	Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
4	Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5.	Introduction to Ligand fields; B.N. Figgis, Wiley, New York.
6.	Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe.
7.	Introduction to Ligand Field Theory; C. J. Ballahyen, McGraw Hill, New York.
8.	Organometallic Chemistry; R.C.Mehrotra and A.Singh, New Age International.
9.	Concepts and Models of Inorganic Chemistry; B. Douglas, D.H.McDaniel and J.J.Alexander; John Wiley.
10.	The Organometallic Chemistry of the Transit ion Metals; R.H. Crabtree, John Wiley.

Semester-VIII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-404-V	ORGANIC CHEMISTRY- VII	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

- To know the concept of Aromatic Electrophilic Substitution and their applications and to understand the mechanisms of Aromatic Nucleophilic Substitution by diazonium salts, arynes
- To understand the concept of aliphatic electrophilic substitution reaction, carbocation rearrangement and elimination reactions. To know mechanistic details of different types of elimination reactions, Saytzeff and Hoffman rules and application of these in prediction of product formation in various elimination reactions.
- To describe the generation, structure, stability and reactivity of free radicals. To know the mechanisms of addition alkenes and alkynes.
- To study addition to C=O group of aldehydes, ketones and acids. To understand and reactivity of carbonyl compounds in various reactions. To learn various name reactions related to ketones and aldehydes.

Learning Outcomes:

- The objective of the course is to make the students understand the substitution reactions, elimination reactions and carbocation rearrangements, addition to Carbon-Carbon multiple bonds and addition to Carbon-hetero multiple bonds.

Course Content:

Unit-I	**Aromatic Electrophilic and Nucleophilic Substitution(15Hrs)**

Aromatic Electrophilic Substitution: The arenium ion, mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Vilsmeir reaction, Gattermann-Koch reaction.
Aromatic Nucleophilic Substitution: The $ArSN^1$, $ArSN^2$, and Benzyne mechanisms. Generation, structure and reaction of arynes. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. The von-Richter, Sommelet-Hauser, and Smiles rearrangements.

Unit-II	**Aliphatic Electrophilic Substitution, Elimination Reactions and Carbocation Rearrangements: (18 Hrs)**

Aliphatic Electrophilic Substitution: Bimolecular mechanisms - S_E^2 and S_E^i. The S_E^1 mechanism, Electrophilic substitution accompained by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.
Elimination Reactions: The E^2, E^1 and E^1cB mechanisms. Orientation of the double bond. Reactivity –effects of substrate structures, attacking base, the leaving group and the medium. Stereochemistry of E^2 Elimination, Reaction and Eclipsing Effects in E^2 Eliminations. Dehydration of Alcohols, Elimination not involving C-H Bonds, Mechanism and orientation in pyrolytic eliminations.
Carbocation Rearrangements: Wagner Meerwin rearrangement, Pinacol-pinacolone rearrangements, Aldehyde-Ketones, Demjanov ring expansion & contraction and Transannular rearrangement.

Unit-III	**Addition to Carbon-Carbon Multiple Bonds: (15Hrs)**

Addition to Carbon-Carbon Multiple Bonds: Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio – and chemo-selectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.
Free Radicals: General aspects of generation, structure, stability and reactivity of free radicals, types of free radical reactions, halogenation including allylic halogenation (NBS), autooxidation, decomposition of azo compounds and peroxides, coupling of alkynes, homolytic aromatic substitution, Sandmeyer reaction and Hunsdiecker react ion.

Unit-IV	**Addition to Carbon-Hetero Multiple Bonds: (12 Hrs)**

Addition to Carbon-Hetero Multiple Bonds: Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters, Reformatsky reaction, Dieckman reaction, Cannizzaro reaction, Robinson-Mannich reaction.

Suggested Books/Reading:

1	Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.
2	Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
3	A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.

4	Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
5.	Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice -Hall.
6.	Modern Organic Reactions, H. O. House, Benjamin.
7.	Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional.
8.	Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
9.	Organic Chemistry, J. Clayden, N. Greeves, S.Warren, P. Wothers, Oxford Press.

Semester-VIII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-406-V	PHYSICAL CHEMISTRY - VII	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

- Calculate energy of activation.
- Understand enzyme catalysis.
- Understand and apply electrochemistry.
- Apply adsorption models to various chemical systems.

Learning Outcomes:

- The objective of the course is to make the students understand the Chemical Kinetics, Electrochemistry and Surface Chemistry and Porous Materials.

Course Content:

Unit-I **Chemical Kinetics I: (15Hrs)**

Chemical Kinetics I: London-Eyring-Polanyi method of calculation of energy of activation. Application of activated complex theory of reaction rates. Temperature dependence of pre-exponential factor. Thermodynamic aspects of reaction rates. Chain reactions: Photochemical and thermolytic reactions. Steady-state approximation, General treatment of chain reactions (ortho -para hydrogen conversion and hydrogen - halogen reactions), apparent activation energy of chain reactions, chain length, Branching chain reactions leading to explosions; explosion limits, H2 - O2 reaction. Kinetics of one-substrate one-enzyme reactions: Michaelis-Menton treatment, evaluation of Michaelis's constant for enzyme: Lineweaver-Burk plot, Eadie plot. Competitive and Non-competitive Inhibition.

Unit-II **Electrochemistry - I: (15Hrs)**

Electrochemistry – I: Ion - Ion Interactions: The Debye -Huckel theory of ion- ion interactions: potential and excess charge density as a function of distance from the central ion, Debye Huckel reciprocal length, ionic cloud and its contribution to the total potential, Debye – Huckel limiting law of activity coefficients and its limitations, ion - size effect on potential, ion - size parameter and the theoretical mean - activity coefficient in the case of ionic clouds with finite - sized ions. Debye - Huckel -Onsager treatment for aqueous solutions and its limitations Debye- Huckel- Onsager theory for non-aqueous solutions.

Unit-III **Electrochemistry – II: (15Hrs)**

Electrochemistry – II: Ion Transport in solutions: Ionic movement under the influence of an electric field, mobility of ions, ionic drift velocity and its relation with current density, Einstein relation between the absolute mobility and diffusion coefficient, the Stokes- Einstein relation, the Nernst-Einstein equation, Walden's rule, the Rate-Process approach to ionic migration, the Rate process equation for equivalent conductivity, total driving force for ionic transport, Nernst - Planck Flux equation, ionic drift and diffusion potential, the Onsager phenomenological equations. Planck- Henderson equation for the diffusion potential.

Unit-IV **Surface Chemistry and Porous Materials: (15Hrs)**

Surface Chemistry and Porous Materials: Gibb's adsorption equation, Langmuir adsorption isotherm and its kinetic derivation for non-dissociative and dissociative adsorption, BET adsorption isotherm, its kinetic derivation and applications Heterogeneous catalysis, surface heterogeneity, surface catalyzed unimolecular and bimolecular reactions, activation energy for surface reactions. Comparison of homogeneous and heterogeneous reaction rates. Porous Structures, Types of Pores, Porous materials – Metal Organic Frameworks, Current trends, and applications. Hysteresis Curve: Adsorption-Desorption characteristics. Pore size, surface charge interactions with guest molecules and cross-channel pore adsorption.

Suggested Books/Reading:

1	D. A. McQuarrie and J. D. Simon, "Physical Chemistry. A Molecular Approach" University Science Books, Sausalito 1997.
2	K. J. Laidler and J. H. Meiser, "Physical Chemistry" 3rd Ed. Houghton Mifflin Company, Boston 1999.
3	K. J. Laidler, "Chemical Kinetics" Pearson Education India; 3rd Ed., 2003.
4	Houston, P. Chemical Kinetics and Reaction Dynamics. New York, NY: McGraw-Hill, 2001.
5.	Ira N. Levine, "Physical Chemistry" Tata McGraw-Hill Education, 2011.
6.	P.W. Atkins and Julio de Paula, "Physical Chemistry", 8th Ed., W. H. Freeman Publication, 2006.
7.	G.M. Barrow, "Physical Chemistry" Tata McGraw-Hill Education, 2008.
8.	John O'M. Bockris and Amulya K.N. Reddy, "Volume 1: Modern Electrochemistry: Ionics" Springer, 2nd Ed., 1998.

9.	John O'M. Bockris and Amulya K.N. Reddy, "Modern Electrochemistry 2B: Electrodics in Chemistry, Engineering, Biology and Environmental Science" Springer, 2nd Ed., 2000.
10.	A. J. Bard and L.R. Faulkner, "Electrochemical Methods Fundamentals and Applications", Wiley, 2nd Ed. 2000.
11.	J. Rajaram and J. C. Kuriacose, "Kinetics and mechanism of chemical transformation" Macmillan Publishers India Limited, 2000.
12	Sawyer, Sobkowaik, and Roberts, "Electrochemistry for Chemists", 2nd Ed.,1996.
13	Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson (2013).
14	Julian R.H. Ross, "Heterogeneous Catalysis: Fundamentals and Applications, Wiley-VCH; 2nd Revised Edn., 2007.
15.	A. W. Adamson and A. P. Gast, "Physical Chemistry of Surfaces", 6th Edn., John Wiley & Sons, Inc. 1997.

Semester-VIII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-416-V	COMPUTATIONAL TECHNIQUES	25 + 75 = 100	3	3
		L – 3	T - 0	P - 0

Course Objectives:

- Calculate energy of activation.
- Understand enzyme catalysis.
- Understand and apply electrochemistry.
- Apply adsorption models to various chemical systems.

Learning Outcomes:

- The objective of the course is to make the students understand the Quantum Computational Chemistry, Molecular Dynamics and Basic Statistics.

Course Content:

Unit-I **Quantum Computational Chemistry: (12Hrs)**

Quantum Computational Chemistry: Scope of computational chemistry, Restricted and Unrestricted Hartree-Fock, Basis Sets: Slater and Gaussian Type Orbitals, Polarization and Diffuse Functions, Split-valence Sets, Core-valence Sets; Potential energy surfaces: Geometry optimization, local and global minima, transition state theory, and pair potentials.

Unit-II **Fundamentals of Molecular Dynamics: (12Hrs)**

Introduction to Computer Simulation – Visual Representation of Molecular Systems using VMD, Lennard Jones potentials – Bonding Potentials and Force-Fields, Phase Space, Periodic Boundary Conditions, Minimum Image convention. Propagation of Newton's Equation, Time Step and Energy Minimization

Unit-III **Molecular Dynamics Algorithms and Application to water: (12Hrs)**

Molecular Dynamics Algorithms and Application to water: MD algorithms, Thermostats - types and temperature fluctuations, Treatment of Statistical Mechanical Ensembles – Averages – Fluctuations – Time Correlation Function – Radial Distribution Function, Mean-Square Displacement - Diffusion coefficient. Simulations of water molecules. Structure and physical property of water: Aspects from simulations and limitations of experiment.

Unit-IV **Basic Statistics: (9Hrs)**

Basic Statistics: Mean, Median, Mode, Variance, Standard deviation, Moments, Properties and effect of change of origin and scale; using computational techniques
Probability: rules of probability, conditional probability, independent events, Bays theorem, Random variable, Discrete and continuous random variable; using computational techniques.

Suggested Books/Reading:

1	M. P. Allen and D. J. Tildesley, "Computer Simulations of Liquids" Oxford Science Publications, 1989.
2	Attila Szabo and Neil S. Ostlund "Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory" Dover Books on Chemistry, 1996.
3	Mark Tuckerman, "Statistical Mechanics: Theory and Molecular Simulation" by Oxford Graduate Texts, 2010.
4	Andrew R. Leach, "Molecular Modeling: Principles and Applications" Addison Wesley Publishing Company, 1997.
5.	Daan Frenkel, "Understanding Molecular Simulation: From Algorithms to Applications" Computational Science Series, Vol 1, 2001.
6.	Frank Jensen, "Introduction to Computational Chemistry" John Wiley & Sons, 2007.
7.	Richard M. Martin, "Electronic Structure: Basic Theory & Practical Methods" Cambridge University Press.
8.	Errol Lewars "Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics" Kluwer Academic Publishers, New York, 2004

Semester-VIII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-418-V	CHEMISTRY OF SUPRAMOLECULES	25 + 75 = 100	3	3
		L – 3	T - 0	P - 0

Course Objectives:

- learn the basic concepts of supramolecular chemistry
- understand the concept of self-assembly
- analyse the role of supramolecular chemistry in nature
- acquire the knowledge of recent advancement in supramolecules

Learning Outcomes:

- The objective of the course is to make the students understand the Host Guest Chemistry, Self Assembly and supramolecular catalysis, Molecular Devices.

Course Content:

Unit-I **Basic Concepts: (12Hrs)**

Basic Concepts: Terminology and definitions in supramolecular chemistry, Chemical interactions leading to supramolecular assemblies, nature of supramolecular interactions: Ion pairing, ion-dipole and dipole-dipole interactions; hydrogen bonding; cation-pi, anion pi, pi-pi interactions and Van der Waal forces. Solvent and solution properties, solvation and hydrophobic effect.

Unit-II **Host Guest Chemistry: (12Hrs)**

Host Guest Chemistry: Macrocyclic effect and their thermodynamic origin, Step-wise and overall binding constant in host-guest chemistry, kinetic and thermodynamic selectivity. Principle of molecular recognition, host-guest complementarity, Synthesis and structure of crown ethers, lariat ethers, podands, cryptands, spherands, calix[4]arenes, cyclodextrins, cyclophanes, cryptophanes, carcerands, and hemicarcerands, host-guest interactions, pre-organization and complementarity, lock and key analogy, binding of cationic, anionic, ion pair and neutral guest molecules.

Unit-III **Self Assembly and supramolecular catalysis: (12 Hrs)**

Self Assembly and supramolecular catalysis: Self-assembly of molecules: Design, synthesis and properties of the molecules, self-assembling by H-bonding, metal-ligand interactions and other weak interactions, metallomacrocycles, catenanes, rotaxanes, helicates and knots, examples of recent developments in supramolecular chemistry. Organocatalysis mediated through hydrogen bonding, preconcentration, self-assembly of catalysts and preorganisation of catalyst-substrate systems. Influence of organisation (effective molarity) on catalysis, Catalytic acyl transfer, acid-base catalysis, catalysis hydrolysis as ATPase mimic.

Unit-IV **Molecular Devices: (9 Hrs)**

Molecular Devices: Molecular devices: Molecular electronic devices, molecular wires, molecular rectifiers, molecular switches, molecular logic. Relevance of supramolecular chemistry to mimic biological systems: ion channel mimics. Importance of molecular recognition in nucleic acids and protein. Applications of supramolecular complexes in medicine- targeted drug delivery.

Suggested Books/Reading:

1	J.M. Lehn, Supramolecular Chemistry-Concepts and Perspectives, Wiley-VCH, 1995.
2	2. P. D. Beer, P. A. Gale and D. K. Smith, Supramolecular Chemistry, Oxford University Press, 1999.
3	J. W. Steed and J. L. Atwood, Supramolecular Chemistry, 1st Ed., Wiley, 2000.
4	J.W. Steed, Core Concepts in Supramolecular Chemistry and Nanochemistry, 1stEd., John Wiley & Sons, 2007.

Semester-VIII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-408-V	INORGANIC CHEMISTRY-VI- LAB	30 + 70 = 100	4	2
		L – 0	T - 0	P - 4

Course Objectives:

- analyse a given salt quantitatively
- synthesise an inorganic complex on his own
- design and synthesize a complex of interest
- experimental part and interpretation of the results

Learning Outcomes:

- Student will be able to learn about Titrimetric Analysis and Acid-BaseTitrations.

Course Content:

Unit-I **Titrimetric Analysis**

Quantitative Analysis
Separation of the metal ions and determination of any one of them using volumetric/gravimetric methods.
Cu-Ni, Cu-Zn, Cu-Al, Ca-Ba, Fe -Mg, Fe-Ni etc.

Unit-II **Acid-Base Titrations**

Preparations:
Preparation of selected inorganic compounds and their spectroscopic studies.
1. $Hg[Co(SCN)_4]$
2. $Ni(dmg)_2$
3. $[Cu(NH_3)_4]SO_4 H_2O$
4. Prussian Blue and Turnbull's Blue.
5. $Na[Cr(NH_3)_2(SCN)_4]$
6. $Mn(acac)_3$
7. $[Ni(NH_3)_6]Cl_2$
8. $VO(acac)_2$

Suggested Books/Reading:

1.	A Text Book of Macro and Semi-micro Quantitative Analysis, A.I.Vogel, Orient Longman.
2.	A Vogel's Text Book of Quantitative Inorganic Analysis, J. Bassett, R.C. Denney, G.B. Jaffery and J. Menaham, Longman, London.
3.	Synthesis and Characterization of Inorganic Compounds, W.B. Jolly, Prentice Hall, Englewood.
4.	Synthesis and Physical Studies of Inorganic Compounds, C.F. Bell, Pergamon Press
5.	Inorganic Preparations; W.G. Palmer.

semester-VIII				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-410-V	**ORGANIC CHEMISTRY-VII-LAB**	**30 + 70 = 100**	**4**	**2**
		L – 0	**T - 0**	**P - 4**

Course Objectives:

- analyse a given salt quantitatively
- synthesise an inorganic complex on his own
- design and synthesize a complex of interest
- experimental part and interpretation of the results

Learning Outcomes:

- Student will be able to learn about Titrimetric Analysis and Acid-Base Titrations.

Course Content:

Unit-I	**Experiments**

Experiments

1. Qualitative analysis of mixture of organic compounds
2. Purification of organic compounds involving fractional crystallization, fractional distillation, steam distillation, sublimation and extraction.

Suggested Books/Reading:

1	A Hand book of Organic Analysis -Qualitative and Quantitative by H.T. Clarke, and revised by B.Haynee, Edward Arnold, London 1975.
2	Vogel's Text Book of Practical Organic Chemistry by B.S. Furhen et. al, Longman-Group Ltd.
3	Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Limited, London 1959.
4	Elementary Practical Organic Chemistry by Arthur I. Vogel, Ex CBS Publishers and Distributors.
5	Experiments in Organic Chemistry by Louis, F.Fieser, D.C. Heath and Company Boston, 1955.

Semester-VIII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-412-V	PHYSICAL CHEMISTRY-VII-LAB	30 + 70 = 100	4	2
		L – 0	T - 0	P - 4

Course Objectives:

- Use refractive index, refractivity, and molar refractivity properties of liquids in analysis.
- Solve wet-lab practical difficulties related to kinetics of inversion.
- Use electrode potential for various applications
- Use distribution properties of two liquids.

Learning Outcomes:

- Student will be able to learn about Refractometry, Polarimetry, PotentiometryandDistribution Law.

Course Content:

Unit-I **Refractometry**

Refractometry

i. Determine the refractive index of simple organic liquids (environment friendly).
ii. Determine the refractivity and molar refractivity of some organic liquids to determine the molar refractivity's for CH_2, C, H and Cl.
iii. Study the variation of refractive index with concentration for KCl solution and thereafter determine the unknown concentration of given KCl solution.

Unit-II **Polarimetry**

Polarimetry

i. Study the variation of angle of optical rotation with the concentration of any optically active substance (sucrose or glucose) and determine the unknown concentration of given solution.
ii. Determine the specific and molecular rotation of sucrose or glucose at number of concentrations.
iii. Study the kinetics of inversion of cane sugar (sucrose) in presence of an acid.

Unit-III **Potentiometry**

i. Determine the standard electrode potential of Cu and Zn.
ii. Determine the strength of a given solution of ferrous ammonium sulphate by potentiometric titration with $K_2Cr_2O_7$ solution.
i. Study the precipitation titration between KCl and $AgNO_3$ potentiometrically.
iv. Determine the strength of iodide, bromide and chloride in a mixture by potentiometric titration with silver nitrate.

Unit-IV **Distribution Law**

Distribution Law

i. Determine distribution coefficient of ammonia between chloroform and water.
ii. Determine the formula of the complex formed between copper (II) ion and ammonia using distribution method.

Suggested Books/Reading:

1	Practical Physical Chemistry, A. M. James and F. E. Prichard, Longman.
2	Findley's Practical Physical Chemistry, B. P. Lavitt, Longman.
3	Practical Physical Chemistry, S. R. Palit and S.K. De, Science.
4	Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.
5	Experiments in Physical Chemistry, D. P. Shoemaker
6	Experiments in Physical Chemistry, D. V. Jahagirdhar.
7	Senior Practical Physical Chemistry by B. D. Khosla, V. Garg and A. Gulati.
8	Advanced Practical Physical Chemistry, J. B. Yadav, Goel Publishing House

Semester-VIII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-414-V	SEMINAR	50		1
		L – 1	T - 0	P - 0

Course Objectives:

- Learn to review and correlate the literature reports related to a particular topic.
- Acquire skills of presentations through computer program.
- Develop skills of effective verbal scientific communication.
- Develop the ability to present and defend their studies in an intellectual way.

Learning Outcomes:

- Student will be able to learn about recent topics related to Chemistry in any thrust area of subject (Experimental or theoretical).

Course description:

Students are required to deliver a Seminar on a recent topics related to Chemistry through power point presentation followed by Q/A session. Seminar may be delivered in any thrust area of subject (Experimental or theoretical). Every student shall be required to submit the topic of his/her seminar in consultation with Faculty members well in advance.

Semester-VIII

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-420-V	RESEARCH PROJECT/ DISSERTATION	90 + 210 = 300	12	6
		L - 0	T - 0	P - 12

Course Objectives:

- Learn to review the theoretical knowledge with actual world problem.
- Develop ability to check research gap in related field.
- Develop skills to solve the real problem.
- Develop skills of effective scientific presentation.

Learning Outcomes:

- Student will be able to learn about various topics in Chemistry (Inorganic, Organic, Physical) in any thrust area of subject (Experimental or theoretical).

Course description:

Students are required to submit the research work report and deliver a presentation on a chosen topic related to Chemistry (Inorganic, Organic, Physical) through power point presentation followed by Q/A session. Every student shall be required to submit the topic of his/her research project in consultation with Faculty members well in advance.