Course	Details				
Code	ICH8CR01				
Title	ADVANCED INORGANIC CHEMISTRY-II				
Degree	Integrated M.Sc. Programme in Basic Sciences-Chemistry				
Branch(s)	Pure Chemistry				
Year/Semester	4/VIII				
Type	Core				
Credits	4	Hrs /Week	4	Total Hours	72

Specific objectives	To understand structural aspects of Inorganic Chemistry and its applications.
Course outcomes	• To understand and apply the solid state chemistry in inorganic compounds • To understand and apply the electric, magnetic and optical properties. • To understand inorganic chain and ring compounds, their properties and applications. • To understand the inorganic cage compounds and clusters and its applications. • To understand the Photochemistry of inorganic materials and its applications. • To understand Organometallic Polymers and its applications.

Module	Course Description	Hrs.
1.0	**Solid State Chemistry**	**18**
1.1	Structure of solids: Imperfections in solids-point defects, line defects and planedefects.Structure of compounds ofAX (Zinc blende, Wurtzite), AX_2 (Rutile, fluorite, antifluorite), A_mX_2 (Nickel Arsenide), ABX_3 (Perosvskite, Ilmenite). Spinels. Inverse spinel structures	6

1.2	Solid state reactions-diffusion coefficient, mechanisms, vacancy diffusion, thermal decomposition of solid-Type I reactions, Type II reactions.	6
1.3	Phase transition in solids: classification of phase transitions-first and second order phase transitions, Martensitic transformations, order-disorder transitions and spinodal decomposition. Kinetics of phase transitions, sintering. Growingsingle crystals-crystal growth from solution, growth from melt and vapor deposition technique.	6
2.0	**Electrical, Magnetic and Optical Properties**	**18**
2.1	Kronig-Penney model, Free electron theory, Zone theory and MO theory of solids. Energy bands-conductors and non-conductors, intrinsic and extrinsic semiconductors. Electrons and holes. Mobility of charge carriers. Hall Effect. Pyroelectricity, piezo electricity andferro electricity. Conductivity of pure metals.	4
2.2	Magnetic properties of transition metal oxides, garnets, spinels, ilmenites and perovskites, magnetoplumbites.	4
2.3	Optical properties-photoconductivity, photovoltaic effects, luminescence. Applications of optical properties	4
2.4	Super conductivity-Type I and Type II superconductors, Frolich diagram, Cooper pairs, theory of low temperature super conductors, junctions using superconductors, BCS theory of superconductivity (derivation not required). Super conducting cuprates - YBaCuoxidesystem, Meisner effect, conventional superconductors, organic superconductors, fullerenes, carbon nanotubes, high temperature superconductors.	6
3.0	**Inorganic Chains and Rings**	**9**
3.1	Silicones. Zeolites synthesis, structure and applications. Isopoly acids ofvanadium,molybdenumandtungsten.HeteropolyacidsofMoand W. Condensed phosphates-preparation, structure and applications.	4

	Phosphate esters in biological systems. Polythiazil-one dimensional conductors.	
3.2	Rings-topological approach to boron hydrides, Styx numbers. Structure and bonding in borazines, ring silicates and silicones, phosphorous-nitrogen compounds, phosphazenes. Heterocyclic inorganic ring systems-structure and bonding in phosphorous-sulphur and sulphur-nitrogen compounds. Homocyclic inorganic ring systems-structure and bonding insulphur, selenium and phosphorous compounds.	5
4.0	**Inorganic Cages and Clusters**	**9**
4.1	Synthesis, structure and bonding of cage like structures of phosphorous. Boron cageAluminium, indium and gallium clusters, cages and clusters of germanium, tin andlead, cages and clusters of tellurium, Mercuride clusters in amalgams.	5
4.2	Medicalapplications of boron clusters- nucleic acid precursors, DNA binders, application ofC_2B_{10} for Drug Design, Nuclear receptor ligands bearing C_2B_{10}cages.	4
5.0	**Inorganic Photochemistry**	**9**
5.1	Excited states in transition metal complexes:Intra-ligand excited states and metalcentredexcited states.Photochemical reactions:Substitution and redox reactions ofCr(III), Co(III), Rh(III) and Ru(II) complexes	3
5.2	Manganese-based photosystems for theconversion of water into oxygen, applications-synthesis and catalysis, chemicalactinometry and photochromism, metal-metal multiple bonds, dissociativephotochemistry, ligand loss.	3
5.3	Metal complex sensitizers,electron relay, semiconductor supported metal oxidesystems, water photolysis, nitrogen fixation and CO_2 reduction, dinitrogen splitting.	3
6.0	**Organometallic Polymers**	**9**
6.1	Polymers with organometallic moieties as pendant groups, polymers withorganometallic moieties in the main chain, condensation polymers based on ferroceneand on rigid rod polyynes, poly(ferrocenylsilane)s	5
6.2	Applications of Poly(ferrocenylsilane)s and related polymers, applications of rigid-rod polyynes, polygermanes and polystannanes, polymers prepared by ring opening polymerization, organometallic dendrimers.	4

References

01. L.V. Azaroff, Introduction to Solids, Mc Graw Hill, 1984.
02. A.R. West, Solid State Chemistry and its Applications, Wiley-India, 2007.
03. D.K. Chakrabarty, Solid State Chemistry, New Age Pub., 2010.
04. D.M. Adams, Inorganic Solids: An Introduction to Concepts in Solid State Structural Chemistry, Wiley, 1974.
05. C.N.R. Rao, K.J. Rao, Phase Transitions in Solids, McGraw Hill, 2010.
06. B.E. Douglas, D.H. McDaniel, J.J. Alexander, Concepts and Models of Inorganic Chemistry, 3rdEdn., John Wiley & sons,2006.
07. A. Earnshaw, Introduction to Magnetochemistry, Academic Press, 1968.
08. J.E. Huheey, E.A. Keiter, R.L. Keiter, Inorganic Chemistry Principles of strucReactivity, 4thEdn., Harper Collins College Pub.,1993.
09. F.A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann, Advanced Inorganic Chemistry, 6thEdn., Wiley-Interscience,1999.
10. K.F. Purcell, J.C. Kotz, Inorganic Chemistry, Holt-Saunders, 1977.
11. Matthias Driess, Heinrich Nöth, Molecular Clusters of the Main Group Elements, Wiley-VCH, 2004.
12. Applied photochemistry, R. C. Evans, P. Douglas, H. D. Burrows, Applied Photochemistry, Springer, 2013.
13. D.M. Roundhill, Photochemistry and Photophysics of Metal Complexes, Plenum Press, 1994.
14. A.W. Adamson, P.D. Fleischauer, Concepts of Inorganic Photochemistry, Wiley,1975.
15. V. Balzani, V. Carassiti, Photochemistry of Coordination Compounds, Academic Press, 1970.
16. Vadapalli Chandrasekhar, Inorganic and organometallic polymers, Springer, 2005.

Course	Details				
Code	ICH8CR02				
Title	ADVANCED ORGANIC CHEMISTRY - II				
Degree	Integrated M.Sc. Programme in Basic Sciences- Chemistry				
Branch(s)	Pure Chemistry				
Year/Semester	4/VIII				
Type	Core				
Credits	5	Hrs /Week	5	Total Hours	90

Specific objectives	To understand about the different reactions in Organic Chemistry.
Course outcomes	• To analyze some major reactions in organic synthesis • To understand some major reagents in organic synthesis • To remember some major asymmetric synthetic methods • To evaluate the possibilities of protecting groups in synthesis

Module	Course Description	Hrs
1	**Organic Synthesis via Oxidation and Reduction**	24
1.1	Survey of organic reactions with special reference to oxidation and reduction. Metal based and non-metal based oxidations of (a) alcohols to carbonyls [(Chromium-John's oxidation, Collin's oxidation, Sarrett oxidation), Manganese, aluminium and DMSO(Swern oxidation, Moffatt–Pfitzner oxidation, Kornblum oxidation, Corey-Kim oxidation)] based reagents (b) alkenes to epoxides (peroxides/peracids based)-Sharpless asymmetric epoxidation, Jacobsen epoxidation, Shi epoxidation (c) alkenes to diols (Manganese and Osmium based)- Prevost reaction and Woodward modification (d) alkenes to carbonyls with bond cleavage (Manganese based, ozonolysis)	18

	(e) alkenes to alcohols/carbonyls without bond cleavage-hydroboration-oxidation, Wacker oxidation, selenium based allylic oxidation (f) ketones to ester/lactones- Baeyer-Villiger oxidation.	
1.2	Catalytichydrogenation (Heterogeneous: Palladium/Platinum/Rhodium and Nickel. Homogeneous: Wilkinson), Metal based reductions- Birch reduction, pinacol formation, acyloin formation, Enzymatic reduction using Baker's yeast.	6
2	**Modern Synthetic Methods**	**18**
2.1	Baylis-Hillman reaction, Henry reaction, Nef reaction, Hydroboration-oxidation reaction, Kulinkovich reaction, Ritter reaction, Sakurai reaction, Tishchenko reaction. Brook rearrangement. Tebbe olefination. Horner-Wadsworth-Emmons Reaction, Corey-Fuchs Reaction, Yamaguchi Esterification.	9
2.2	Metal mediated C-C and C-X coupling reactions: Heck, Stille, Suzuki, Negishi, Sonogashira, Nozaki-Hiyama-Kishi, Buchwald-Hartwig, Ullmann and Glaser coupling reactions. Miyaura borylation. Click reactions (Huisgen 1,3-dipolar addition). Multicomponent reactions-Ugireaction, Passerini reaction and Biginelli reaction.	9
3	**Synthetic Reagents**	**18**
3.1	Hydride transfer reagents from Group III and Group IV in reductions - LiAlH4, DIBAL-H, Red-Al, NaBH4 and NaCNBH3, selectrides, trialkylsilanes and trialkyl stannane. Aluminumisopropoxide (oxidation and reduction). Reagents such as DMP, NBS, 9-BBN, DDQ, DCC, DMAP, *m*-CPBA, Gilman reagent, PCC, PDC, DEAD (Mitsunobu reaction), DIAD, n-BuLi, *sec*-BuLi, *tert*-BuLi, LDA, Mosher's acid (chiral derivatisation)	18
4	**Stereoselective Transformations**	**12**

4.1	Enantioselective reaction, Diastereoselective reaction, Enantiomeric excess. Assymmetric induction-chiral auxiliaries and chiral pool. Resolution. Brown allylation and crotylation reactions, Diastereoselectivity of (*Z*) and (*E*) boron enolates, Zimmerman-Traxler transition state. Assymetric aldol condensation pioneered by Evans.Assymmetric Diels-Alder reactions. CBS reduction. Enantioselective catalytic hydrogenation developed by Noyori and Knowels. Jacobsen epoxidation.	12
5	**Construction of Carbocyclic and Heterocyclic Ring Systems**	**9**
5.1	Synthesis of four, five and six-membered rings, photochemical approaches for the synthesis of four membered rings-oxetanes and cyclobutanes, ketene cycloaddition (inter and intra molecular), Pauson-Khand reaction, Volhardt reaction, Bergman cyclization, Nazarovcyclization,cation-olefin cyclization and radical-olefin cyclization.	3
5.2	Inter-conversion of ring systems (contraction and expansion)-Demjenov reaction, Reformatsky reaction. Construction of macrocyclic rings-ring closing metathesis (Grubb's catalyst)	3
5.3	Formation of heterocyclic rings: 5-membered ring heterocyclic compounds with one or more than one hetero atom like N, S or O - pyrrole, furan, thiophene, imidazole, thiazole and oxazole.	3
6	**Protecting Group Chemistry**	**9**
6.1	Protection and deprotection of hydroxy, carboxyl, carbonyl, and amino groups. Chemo and regio selective protection and deprotection.	5
6.2	Protection and deprotection in peptide synthesis: common protecting groups used in peptide synthesis, protecting groups used in solution phase and solid phase peptide synthesis (SPPS).	4

References

1. M.B. Smith, Organic Synthesis, 3rd Edn.,Wavefunction Inc., 2010.
2. F.A. Carey, R. I. Sundberg, Advanced Organic Chemistry, Part A and B, 5th Edn., Springer, 2007
3. S. Warren, P. Wyatt, Organic Synthesis: The Disconnection Approach, 2nd Edn., Wiley, 2008.

4. I. Ojima, Catalytic Asymmetric Synthesis, 3rd Edn., John Wiley & Sons, 2010.
5. W. Carruthers, I. Coldham, Modern Methods of Organic Synthesis, 4th Edn., Cambridge University Press, 2004.
6. J. Clayden, N. Greeves, S. Warren P. Wothers, Organic Chemistry, Oxford University Press, 2001.
7. R. Noyori, Asymmetric Catalysis in Organic Synthesis, John Wiley & Sons, 1994.
8. L. Kuerti, B. Czako, Strategic Applications of Named Reactions in Organic Synthesis, Elsevier Academic Press, 2005.
9. R.O.C. Norman, J.M. Coxon, Principles of Organic Synthesis, 3rd Edn., Chapmann and Hall, 1993.
10. V.K. Ahluwalia, L.S. Kumar, S. Kumar, Chemistry of Natural Products, CRS Press, 2007.

Course	Details				
Code	**ICH8CR03**				
Title	**Advanced Physical Chemistry - II**				
Degree	**Integrated M.Sc. Programme in Basic Sciences- Chemistry**				
Branch(s)	Pure Chemistry				
Year/Semester	4/VIII				
Type	Core				
Credits	**4**	Hrs/Week	**4**	Total Hours	**72**

Specific objectives	To provide an insight into the Chemical Kinetics, Surface Chemistry and photochemistry
Course outcomes	1. To understand the basics of kinetics of a reaction, the underlying theories for different types of reactions, fast reactions, oscillating reactions, catalysis etc 2. To analyze the different theories for surface phenomena 3. To understand and evaluate the different techniques used to study surfaces 4. To apply the different techniques to molecular weight determination of macromolecules. 5. To understand the kinetics of photochemistry.

Module	Course Description	Hrs
1	**Chemical Kinetics**	**36**
1.1	Rate of reaction, rate equation, order and molecularity of reactions, determination of order of a reaction. Iintegrated rate expressions for first and second order reactions ($2A \rightarrow P$ and $A + B \rightarrow P$). Zero order reactions, pseudo order reactions, half life.	3
1.2	Theories of reaction rates: Collision theory, kinetic theory of collisions, steric factor, potential energy surfaces. Conventional transition state theory, thermodynamic formulation of the reaction rate-Eyring equation. Comparison of the two theories. Significance of $\Delta G^{\neq}$, $\Delta H^{\neq}$ and $\Delta S^{\neq}$, volume of activation. Effect of pressure and volume on velocity of gas reactions.	6
1.3	Unimolecular reactions: Lindemann- Hinshelwood mechanism, qualitative idea of RRKM theory	4

1.4	Chain reactions: Chain initiation processes, steady state treatment, kinetics of H_2-Cl_2 and H_2-Br_2 reactions, Rice-Herzfeld mechanism for decomposition of ethane and acetaldehyde, Goldfinger-Letort-Niclause rules, branching chains, Semenov- Hinshelwood mechanism of branching chains, upper and lower explosion limits, the H_2-O_2 reaction, kinetics of step growth, free radical, cationic and anionic polymerization reactions.	7
1.5	Fast reactions: Relaxation, flow and shock methods, flash photolysis, NMR and ESR methods of studying fast reactions.	3
1.6	Reactions in solution: Factors determining reaction rates in solutions, effect of dielectric constant and ionic strength, cage effect, Bronsted-Bjerrum equation, primary and secondary kinetic salt effect.	4
1.7	Acid-base catalysis: Specific and general catalysis, Skrabal diagram, Bronsted catalysis law, prototropic and protolytic mechanism with examples, acidity function.	3
1.8	Enzyme catalysis and its mechanism, Michaelis-Menten equation, effect of pH and temperature on enzyme catalysis.	3
1.9	Introduction to oscillating chemical reactions: autocatalysis, autocatalytic mechanism of oscillating reactions, the Lotka-Volterra mechanism, the brusselator, the oreganator, bistability.	3
2	**Surface Chemistry**	**27**
2.1	Adsorption – types of adsorption of gases by solids, factors influencing adsorption, thermodynamics of surfaces, Gibbs adsorption equation and its verification, surfactants and micelles, surface films, surface pressure and surface potential and their measurements and interpretation.	4
2.2	Application of low energy electron diffraction and photoelectron spectroscopy, ESCA and Auger electron spectroscopy, scanning probe microscopy-AFM and STM, ion scattering, SEM and TEM in the study of surfaces.	5
2.3	Surface Enhanced Raman Scattering, surfaces for SERS studies, chemical enhancement mechanism, surface selection rules, principle and application of SERS in surface chemistry.	3
2.4	Adsorption: The Langmuir theory, kinetic and statistical derivation, multilayer adsorption-BET theory, Use of Langmuir and BET isotherms for surface area determination. Application of Langmuir adsorption isotherm in surface catalysed reactions, the Eley-Rideal mechanism and the Langmuir-Hinshelwood mechanism, flash desorption.	6
2.5	Colloids: structure and stability, the electrical double layer, zeta potential, electrokinetic phenomena - sedimentation potential and streaming potential, Donnan membrane equilibrium.	4
2.6	Macromolecules: Different averages, methods of molecular mass determination -osmotic, viscosity, sedimentation and light scattering methods.	5

3	**Photochemistry**	9
3.1	Thermoluminescence, pulse radiolysis, hydrated electrons, photostationary state, dimerization of anthracene.	2
3.2	Principle of utilization of solar energy: solar cells, types of solar cells-amorphous silicon solar cell, cadmium telluride solar cell, copper indium gallium selinide solar cell.	3
3.3	Quenching of fluorescence and its kinetics, Stern-Volmer equation, concentration quenching, fluorescence and structure, delayed fluorescence, E-type and P-type, effect of temperature on emissions, two photon absorption spectroscopy, lasers in photochemical kinetics.	4

References

1. J. Rajaram, J.C. Kuriakose, Kinetics and Mechanisms of Chemical Transformations, MacmillanIndia, 2000.
2. K.J. Laidler, Chemical Kinetics, 3rd Edn., Harper & Row, 1987.
3. C. Kalidas, Chemical Kinetic Methods: Principles of Fast Reaction Techniques and Applications, New Age International, 2005.
4. J.W. Moore, R.G. Pearson, Kinetics and Mechanisms, John Wiley & Sons, 1981.
5. P.W. Atkins, Physical Chemistry, 9th Edn, Oxford University press, 2010
6. D.A. McQuarrie, J.D. Simon, Physical chemistry: A Molecular Approach, University ScienceBooks,1997
7. A.W. Adamson, A.P. Gast, Physical Chemistry of Surfaces, 6thEdn., John Wiley & sons, 1997.
8. G.M. Barrow, Physical Chemistry, 5thEdn., Tata McGraw Hill, 2007.
9. R.J. Silbey, R.A. Alberty, M.G. Bawendi, Physical Chemistry, 4th Edn., Wiley,2005
10. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co. Jalandhar.
11. K. L. Kapoor, A Textbook of Physical chemistry, Volume 4, Macmillan India Ltd.
12. Castellan, G.W. Physical Chemistry,4th Ed. Narosa (2004).
13. S. H. Marron and J. B. Lando, Fundamentals of Physical Chemistry, Macmillan Ltd.
14. G. K. Vemulapalli, Physical Chemistry, Prentice-Hall of India Pvt. Ltd. (1997)

15. K.K. Rohatgi-Mukherjee, Fundamentals of Photochemistry, 2nd Edn., New AgeInternational,1986.

16. G. Aruldhas, Molecular structure and Spectroscopy, PHI Learning, 2007.

Course	Details				
Code	ICH8ELB1				
TITLE	NANOCHEMISTRY				
DEGREE	Integrated M.Sc. Programme in Basic Sciences- Chemistry				
Branch(s)	Pure Chemistry				
Year/Semester	4/VIII				
Type	Core				
Credits	3	Hrs /Week	4	Total Hours	72

Specific objectives	To have fundamental knowledge pertaining to new phenomena in physical biological and Engineering sciences that occur at nano scale.
Course outcomes	• To understand the basic principles in Nanoscience. • To understand various characterization techniques • To understand the diversities in nano systems. • To analyze the applications of Metal and Organic nanoparticles and nanocomposites in various fields.

Module	Course Description	Hrs
1	**Nanoscience**	9
1.1	Introduction, Nanosized Voltmeter" for Mapping of Electric Fields in Cells, Nanoscopy-STM, AFM, STED optical microscopy, MFM, Nanocrystals –semiconductor nanocrystals, Nanowires and nanofibers, Nanolayers, Carbon nanostructures- fullerene-graphene, Nanostructures: Zero-, One-, Two- and Three- dimensional structure, Nanosized metals and alloys, semiconductors, ceramics, Concept of bulk versus nanomaterials and dependence of properties on size. Introduction to 'Top down' vs. 'Bottom up' approach of synthesis with suitable examples.	9
2	**Nanomaterials**	18

2.1	General introduction to nanomaterials and emergence of nanotechnology, Moore's law, synthesis and properties of fullerenes and carbon nanotubes, synthesis of nanoparticles of gold, silver, rhodium, palladium and platinum, techniques of synthesis-electroplating and electrophoretic deposition, conversion through chemical reactions and lithography. Thin films-chemical vapor deposition and atomic layer deposition techniques,	9
2.2	Diversity in nanosystems: self assembled monolayers on gold- growth process and phase transitions. Gas phase clusters- formation, detection and analysis. Quantum dots- preparation, characterization and applications. Nanoshells-types of systems, characterization and application	6
2.3	Evolving interfaces of nanotechnology- nanobiology, nanosensors. Nanomedicine	3
3	**Metal and Organic nanoparticles**	**9**
3.1	Metal nanoparticles: Size and shape control of metal Nanoparticles and their characterization; Study of their properties: Optical, electronic, magnetic; Surface plasmon band and its application; Role in catalysis, Alloy Nanoparticles, Organic nanoparticles: Size and shape control of nanoparticles and their characterization; inorganic-organic hybrid nanoparticles; Nanopolymers: Preparation and characterization of diblock Copolymer based nanocomposites; Applications of Nanopolymers in Catalysis	9
4	**Nanocomposites**	**9**
4.1	Ceramic/metal nanocomposites - nanocomposites by mechanical alloying – nanocomposites from sol – gel synthesis – nanocomposites by thermal spray synthesis – thin-film nanocomposites: multilayers and granular films – carbon nanotube-based nanocomposites – inorganic nanocomposites for optical applications – inorganic nanocomposites for electrical applications – percolation effects and transport phenomena in composite systems – nanoporous structures and membranes – nanocomposites for magnetic applications - nanocomposite structures having miscellaneous properties	9
5	**Nano Sensors**	**9**

5.1	Nanosensors: Introduction to sensors. Characteristics and terminology - static and dynamic characteristics. Micro and nano-sensors, Fundamentals of sensors, biosensor, micro fluids, Packaging and characterization of sensors, Sensors for aerospace and defense. Organic and inorganic nanosensors. Sensor for bio- medical applications. Bioelectronics, Nanoparticle-biomaterial hybrid systems for sensing applications. Gas sensor.	9
6	**Applications**	**18**
6.1	Applications: General applications of nano. Optical (Surface enhanced Raman Spectroscopy, Optical limiting etc), reactivity of metal nanoparticles and their applications in industrial catalysis, gas sensors, storage, drug delivery.	9
6.2	Applications to environment: nanotechnology for waste reduction and improved energy efficiency, nanotechnology based water treatment strategies. Nanoporous polymers and their applications in water purification, Nanotoxicology.	6
6.3	Applications in biology, nanomedicines. Materials for use in diagnostic and therapeutic applications, molecular nanomachines, society and nano	3

References

1. Hans-Eckhardt Schaefer, NanoScience, Springer, ISBN 978-3-642-10558-6, 2010.
2. T. Pradeep, Nano:The essentials, Tata McGraw-Hill Publishing Company Limited, NewDelhi,2007.
3. C.N.Rao ., A. Muller, A. K. Cheetham, Nanomaterials Chemistry, WileyVCH , 2007
4. P.C. Jain, M. Jain, Engineering Chemistry, 12th Edn., Dhanpat Rai Pub., 2006.
5. C.V. Agarwal, Chemistry of Engineering Materials, 9th Edn., B.S. Pub., 2006.
6. C.N.R. Rao, A. Govindaraj, Nanotubes and Nanowires, Royal Society of Chemistry, 2011.
7. Environmental Chemistry for a Sustainable World, Volume 1: Nanotechnology and Health Risk Editors: Lichtfouse, Schwarzbauer, Robert
8. Advances in Nanotechnology and the Environment, Juyoung Kim, CRC Press, Taylor and Francis Group.

9. Chemical Sensors and Biosensors; Brian, R Eggins; Wiley; New York, Chichester, 2002.
10. Biosensors: A Practical Approach, J. Cooper & C. Tass, Oxford University Press, 2004.
11. P. M. Ajayan, L. S. Schadler, P. V. Braun - Nanocomposite Science and Technology, WileyVCH, 2003.
12. Metal Nanoparticles: Synthesis Characterization & Applications, Daniel L. Fedlheim, Colby A. Foss, Marcel Dekker, 2002
13. Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong,ying Wang, World Scientific, 2011.
14. Klabunde, K.J. (Ed.), "Nanoscale Materials in Chemistry", John Wiley & Sons Inc. 2001

Course	Details				
Code	ICH8ELB2				
Title	Pharmaceutical Chemistry				
Degree	Integrated M.Sc. Programme in Basic Sciences- Chemistry				
Branch(s)	Pure Chemistry				
Year/Semester	4/VIII				
Type	Core-Elective				
Credits	3	Hrs/Week	4	Total Hours	72

Specific objectives	To get an in depth knowledge about pharmaceutical chemistry
Course outcomes	• To understand the basic principles of drug discovery • To apply the relationship between structure and activity of various drug molecules • To analyze the mechanism of action of various classes of pharmaceutical agents

Module	Course Description	Hrs
1	**Principles of drug discovery**	18
1.1	Definition of the following terms: drug, pharmacophore, pharmacology, Pharmacopeia.	1
1.2	Principles of drug discovery- Introduction, drug discovery without lead – serendipity - Penicillins, Cisplatin, Librium (Chlordiazaperoxide), aspartame as examples. Selection of disease and drug targets. Bioassay and lead discovery. Drugs from natural sources and development.	4
1.3	Principles of drug design: agonist and antagonist drugs, structure pruning techniques in drug design (Morphine pharmocophore). Case studies of modifications of morphine and atropine.	5
1.4	Mechanism of action-action at extracellular site and cellular sites-Theories of drug-receptor interaction.	3
1.5	Drug metabolism studies- Phase I or Non-synthetic Reactions – Phase II or synthetic reactions-Effect of metabolism on the pharmacological activity of the drug-Absorption of drugs – Routes of administration of drugs-factors affecting absorption.	5
2	**SAR studies**	9
2.1	Introduction to structure activity relationship (SAR)- (i) Binding role of hydroxyl group, amino group, aromatic ring, double bond, ketones and amides. (ii) Variation of substituents – alkyl substituents, aromatic substituents, extension of structure, chain extension and contraction, ring expansion and contraction, ring variation, ring fusion, isosteres. (iii) simplification of the structure, rigidification, conformational blockers.	7
2.2	Case study of benzodiazepines (hypnotic).	2
3	**Antibacterials**	9

3.1	Sulpha drugs- mechanism of action, examples-prontosil, sulphathiazole, sulphafurazole.	2
3.2	Antibiotics- definition and mechanism of action of penicillin, streptomycin, chloramphenicol, erythromycin-tetracycline. SAR of chloramphenicol.	4
3.3	Antiseptics and disinfectants – definition and distinction – phenolic compounds, chloro compounds and cationic surfactants.	3
4	**Analgesics and drugs acting on CNS**	**18**
4.1	Analgesics: Basic idea of COX I & II inhibitors, definition and mechanism of action – narcotic and non-narcotic analgesics – morphine and its derivatives, pethidine and methodone – disadvantages and uses.	4
4.2	Antipyretic analgesics – salicylic acid derivatives-aspirin, paracetamol, ibuprofen.	2
4.3	Drugs affecting CNS – Definition, mechanism of action, distinction and examples for tranquilisers, antidepressants, sedatives, hypnotics, psychedelic drugs – LSD, Hashish – their effects.	4
4.4	General anaesthetics. Inhalation anaesthetics - ether, enflurane, halothane, nitrous oxide, cyclopropane. Intravenous anaesthetics - thiopentone sodium, ketamine.	4
4.5	Local anaesthetics: clinical application of local anaesthesia, coca and cocaine, hexylcaine, paraaminobenzoic acid derivative- benzocaine, procaine, tetracaine, chloroprocaine, anilides, lidocaine	4
5	**Antineoplastic agents**	**9**
5.1	Neoplasm-causes, therapeutic approaches. Alkylating agents- nitrogen mustards, nitrosourea, aziridines and aryl sulphonates. Antimetabolites-folic acid. Antagonists- purine and pyrimidine antagonists.	5
5.2	Antibiotics-anthracyclines, actinomycin D, bleomycin. Plant products- vinca alkaloids, taxol derivatives. Hormones and their antagonists-tamoxifen. Miscellaneous-procarbazine, cisplatin.	4
6	**Miscellaneous class of drugs**	**9**
6.1	Diuretics: common diuretics and their mechanism of action mercurial and nonmercurial diuretics, carbonic anhydrase inhibitors-acetazolamide and methazolamide, thiazide derivatives-hydrochlorothiazide, Loop diuretics- furosemide and ethacrynic acid, potassium sparing diuretics- amiloride, spironolactone.	4
6.2	Antihistaminic drugs: histamine and its biological role, H1 antagonists, aminoalkylethers, diphenhydramine and doxylamine, ethylenediamine derivatives-pyrilamine, phenothiazines-promethazine, trimeprazine, piperazine derivatives-cyclizines, miscellaneous compounds-cetrizine and cyproheptadine.	3
6.3	Hypogycemic agents: type 1 and type 2 diabetes, insulin, suphonyl ureas, tolbutamide, acetohexamide and glibenclamide, biguanides-metformin, thiazolidinediones- rosiglitazone.	2

References:

1. G.L Patrick, An Introduction to Medicinal Chemistry, 6th ed., Oxford University Press, 2017.
2. R.B. Silverman, The Organic Chemistry of Drug Design and Drug Action, 2nd ed., Academic Press, 2004.
3. T. Nogrady, D.F. Weaver, Medicinal Chemistry: A Molecular and Biochemical Approach, Oxford University Press, 2005.
4. Jayashree Ghosh, A Text Book of Pharmaceutical Chemistry, 3rd ed., S. Chand & Company Ltd., New Delhi, 2017.
5. G. Thomas, Fundamentals of Medicinal Chemistry, 1st ed., Wiley-Blackwell, 2003.
6. T.L. Lemke, D.A. Williams, Foye's Principles of Medicinal Chemistry, 4th ed., Lippincot Williams & Wilkins, 1995.
7. D. Sriram, P.Yogeeswari, Medicinal Chemistry, 2nd ed., Pearson Education India, 2010.
8. K.D. Tripathi, Essentials of Medical Pharmacology, 6th ed., Brothers Medical Publishers Pvt. Limited, 2008.
9. L.S. Goodman, A. Gillman, The Pharmacological Basis of Therapeutics, 10th Edn., McGraw Hill, 2001.
10. S.S. Kadam, Principles of Medicinal Chemistry, Vol. I & II, Pragati Books, 2008
11. A. Kar, Medicinal Chemistry, 4th ed., New Age International Pvt. Ltd., 2007.
12. C.O. Wilson, J.M. Beale, J. Block, Textbook of Organic Medicinal and Pharmaceutical Chemistry, 12th Edn., Lippincott Williams and Wilkins, 2010.

SEMESTER VIII

ICH8CP04 – PHYSICAL CHEMISTRY PRACTICALS

Credits-2 **Total Hours: 72 Hrs**

Objective of the Course

The learners should be able to apply the conceptual understanding acquired from the theory classes

(One question each from both parts A and B will be asked for the examination)

PART A

I. Adsorption

- Verification of Freundlich and Langmuir adsorption isotherm - Charcoal Acetic acid or Charcoal-Oxalic acid system
- Determination of concentration of given acid using the isotherm

II. Phase diagrams

- Construction of phase diagram of simple eutectics
- Effect of KCl/Succinic acid on Critical Solution Temperature of phenol water system
- Construction of phase diagram of three component system with one pair of partially miscible liquids

III Viscosity

1. Determination of viscosity of pure liquids
2. Verification of Kendalls equation-full experiment
3. Determination of composition of binary liquid mixture (toluene-nitrobenzene)
4. Determination of molecular weight of a polymer (polystyrene in toluene)

IV. Surface tension

1. Determination of the surface tension of a liquid by
   (a) Capillary rise method
   (b) Drop number method
   (c) Drop weight method
2. Determination of Parachor values
3. Determination of the composition of two liquids by surface tension measurements
4. Determination of CMC of surfactants by surface tension measurements

V. Chemical Kinetics

1. Determination of the rate constant of the hydrolysis of ester by sodium hydroxide
2. Determination of the rate constant of the hydrolysis of ester by acid
3. Kinetics of reaction between $K_2S_2O_8$ and KI.

PART B

Computational chemistry experiments

VI. Experiments illustrating the capabilities of modern open source/ free computational chemistry packages in computing.

(a) Single point energy
(b) Geometry optimization
(c) Vibrational frequencies
(d) Population analysis
(e) Conformational analysis of ethane, transition state search
(f) Molecular orbitals, ionisation energy, electron affinity
(g) Dipolemoment, freevalence, bond order
(h) Determination of inversion barrier of simple molecules like NH_3, H_2O, H_2O_2
(i) Determination of Z-matrices /Cartesian coordinates of furan, thiophene, pyrrole and benzene using structure drawing programs like Chemsketch and wwMacMolPlt.

References

1. J.B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
2. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8thEdn., McGraw Hill, 2009.
3. J.H. Jensen, Molecular Modeling Basics, CRC Press, 2010.
4. GAMESS documentation available from: http://www. msg.ameslab.gov/gamess/documentation.html

SEMESTER VIII

ICH8CP05 – INSTRUMENTAL METHODS OF ANALYSIS

Credits-2 **Total Hours: 72 Hrs**

Objective of the Course

Analyse and apply the theoretical principles of various branches of physical chemistry whereby class room learning can be transformed to laboratory practice

I. Colorimetric estimation of Fe, Cu, Ni, Mn, Cr, NH_4^+, nitrate and phosphate ions.

II Polarimetry
1. Kinetics of the inversion of sucrose in presence of HCl.
2. Determination of the concentration of a sugar solution
3. Determination of the concentration of HCl
4. Determination of the relative strength of acids

III Refractometry
1. Identification of pure organic liquids and oils
2. Determination of molar refractions of pure liquids
3. Determination of concentration of solutions (KCl-Water, Glycerol—water)
4. Determination of molar refraction of solids
5. Study of complex formation between potassium iodide and mercuric iodide system

IV Conductance Measurements
1. Titration of a dibasic acid against strong base
2. Titration of a mixture of acids against a strong base
3. Titration of weak acid vs strong base
4. Verification of Onsagar equation
5. Determination of dissociation constant of a weak acid

V Potentiometry
1. Titration of strong acid vs strong base
2. Titration of weak acid vs strong base
3. Titration of a mixture of acids against a strong base
4. Application of Henderson equation
5. Determination of single electrode potential (Cu and Zn)

References

1. J.B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
2. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8thEdn., McGraw Hill, 2009.
3. B. Viswanathan, Practical Physical chemistry, Viva Pub., 2005.

Course	Details				
Code	ICH9CR01				
Title	Advanced Inorganic Chemistry- III				
Degree	Integrated M.Sc. Programme in Basic Sciences-Chemistry				
Branch(s)	Pure Chemistry				
Year/Semester	5/IX				
Type	Core				
Credits	4	Hrs /Week	4	Total Hours	72

Specific objectives	To explore the advanced techniques of Inorganic chemistry.
Course outcomes	• To understand and apply the group theory to coordination complexes. • To understand the different spectroscopic methods and apply it on different inorganic molecules. • To understand and apply inorganic photochemistry on different molecules. • To understand nanomaterials and its advanced applications. • To apply the analytical methods for environmental monitoring.

Module	Course Description	Hrs.
1.0	**Applications of Group Theory**	**36**
1.1	Transformation properties of atomic orbitals, hybridization schemes for sigma and pi bonding with examples**,** Symmetry Adapted Linear Combination of Atomic orbitals in tetrahedral, octahedral and sandwich complexes.	15
1.2	Ligand field theory-splitting of *d* orbitals in different environments using group theoretical considerations, construction of energy level diagrams, correlation diagrams, method of descending symmetry, formation of symmetry adapted group of ligands, M.O. diagrams, splitting terms for orbitals, energy levels, *d-d* transition-selection rules, vanishing integrals. Raman spectra of complexes with oxo anions as ligands, IR and Raman spectra using character tables in tetrahedral, octahedral and square planar complexes.	21
2.0	**Inorganic Spectroscopic Methods.**	**9**
2.1	Infrared and Raman Spectroscopy: structural elucidation of coordination compounds containing the following molecules/ions as ligands- NH_3, H_2O, CO, NO, OH^-, SO_4^{2-}, CN^-, SCN^-, $NO_2^-$and X^- (X=halogen).	3

2.2	Electron Paramagnetic Resonance Spectroscopy: EPR of d^1 and d^9 transition metal ions in cubic and tetragonal ligand fields, evaluation of g values and metal hyperfine coupling constants.	3
2.3	Mössbauer Spectroscopy: applications of Mössbauer spectroscopy in the study of Fe(III) complexes.	**3**
3.0	**Chemistry of Materials**	**9**
3.1	Ceramic Structures: Mechanical properties, clay products, refractories- characterization, properties and applications, non-silicon semiconductors as light emitting diodes, thermoelectric (TE) materials, applications of metals and alloys in hydrogen storage, inorganic organic hybrid composites- sol-gel ceramics, fillers in elastomers, polymer- modifiedceramics.	6
3.2	Synthetic strategies for inorganic material design: Direct Combination, low temperature techniques, combinatorial synthesis.	3
4.0	**Metal Organic Frame Works**	**9**
4.1	Introduction, porous coordination polymers, frameworks with high surface area, Lewis acid frameworks, soft porous crystals, design of metal organic frameworks and design of functional metal organic frameworks by post-synthetic modification.	6
4.2	Applications of metal organic frameworks- separation and purification of gases by MOFs, hydrogen storage, MOFs in the pharmaceutical world.	3
5.0	**Inorganic Supramolecular Chemistry**	**9**
5.1	Types of Supermolecules, examples of inorganic supermolecules, synthetic strategies for inorganic super molecules and coordination polymers, molecular polygons and tubes, molecular polyhedra.	4
5.2	Diamondoid networks, inorganic crystal engineering using hydrogen bonds, organometallic crystal engineering, supramolecular self-assembly caused by ionic interactions- hydrocarbyls, amides and phosphides.	5

References

1. F.A. Cotton, Chemical Applications of Group Theory, Wiley-Interscience, 1990.
2. V. Ramakrishnan, M.S. Gopinathan, Group Theory in Chemistry, Vishal Pub., 1985.
3. A.S. Kunju, G. Krishnan, Group Theory and its Applications in Chemistry, PHI Learning, 2010
4. K. Nakamoto, IR and Raman Spectra of Inorganic and Coordination Complexes, Part A-Theory and Applications in Inorganic Chemistry, 6th Edn., John Wiley &sons, 1997.
5. R.S. Drago, Physical Methods in Chemistry, Saunders College, 1992.
6. R.L. Dutta, A. Syamal, Elements of Magnetochemistry, Affiliated East-West Press, New Delhi, 1993.
7. C.N. Banwell, E.M. McCash, Fundamentals of Molecular Spectroscopy, 4thEdn., Tata

McGraw Hill, 1994.
8. A. K. Bridson, Inorganic Spectroscopic Methods, Oxford University Press, 1998.
9. Bradley D. Fahlman, Materials Chemistry, 3rd Edition, Springer, 2018.
10. Hee-Gweon Woo, Hong Li, Advanced Functional Materials, Springer, 2011.
11. John. N. Lalena, David A. Cleary, Principles of Inorganic Materials Design, Wiley, 2010.
12. David Farrusseng, Metal-Organic Frameworks. Wiley-VCH, 2011.
13. Fahmina Zafar and Eram Sharmin, Metal-Organic Frameworks, ExLi4EvA, 2016.
14. WaiKee Li, Gong-Du Zhou, Thomas Chung WaiMak, Advanced Structural Inorganic Chemistry, International Union of Crystallography, 2008.
15. Ionel Haiduc, Frank T. Edelman, Supramolecular Organometallic Chemistry, Wiley- VCH, 1999.
16. J. E. Mark, H. R. Allock, R. West, Inorganic Polymers, 2nd Edition, Oxford University Press, 2005.

Course	Details				
Code	ICH9CR02				
Title	Advanced Organic Chemistry-III				
Degree	Integrated M.Sc. Programme in Basic Sciences-Chemistry				
Branch(s)	Pure Chemistry				
Year/Semester	5/IX				
Type	Core				
Credits	4	Hrs /Week	4	Total Hours	72

Specific objectives	To explore the advanced techniques of Organic chemistry.
Course outcomes	• To analyse and interpret molecular recognition and supramolecular chemistry. To understand and analyze the structure-function correlations from supramolecular perspective. • To learn the method of biosynthesis and biomimetic synthesis. • To learn the principles of protecting group chemistry. • To know about the basics of disconnection approach or retrosynthetic analysis, the requirement of disconnection approach and the need of disconnection approach.

Module	Course Description	Hrs
1	**Molecular Recognition and Supramolecular Chemistry**	**27**
1.1	Introduction to supramolecular chemistry: Host, Guest, Host-Guest complex, Lock and key principle, Preorganisation, Complementarity.	4
1.2	Molecular recognition, forces involved in molecular recognition.	3
1.3	Cation binding Hosts: Crown ethers, Lariat ethers, Podands, Cryptands, Spherands, Calixarenes	3

1.4	Anion binding hosts: Cyclophanes. A naturally occurring cyclic host: Cyclodextrin - industrial applications.	3
1.5	Molecular clefts and tweezers. Macrocyclic polyamines – Nitrogen based cyclic hosts.	3
1.6	Ion Pair Receptors - Contact Ion Pairs, Cascade Complexes, Remote Anion and Cation Binding Sites, Symport and Metals Extraction	4
1.7	Hosts For Neutral Guest - Clathrates, Inclusion Compounds, Zeolites, Intercalates, Coordination Polymers, Guest Binding by Cavitands and Cyclodextrins.	4
1.8	Naturally occurring Siderophores. Rhodopsin – A Supramolecular photonic device.	3
2	**Biosynthesis and Biomimetic Synthesis**	**9**
2.1	Basic principles of the biosynthesis of terpenes, steroids, alkaloids, carbohydrates, proteins and nucleic acids, biosynthesis of cholesterol, α-terpineol, morphine, glucose and phenyl alanine, biogenesis of isoprenoids and alkaloids, biomimetic synthesis of progesterone (Johnson synthesis).	9
3	**Protecting Group Chemistry**	**9**
3.1	Protection and deprotection of hydroxyl, carboxyl, carbonyl, and amino groups. Chemo and region selective protection and deprotection.	4
3.2	Protection and deprotection in peptide synthesis: common protecting groups used in peptide synthesis, protecting groups used in solution phase and solid phase peptide synthesis (SPPS).	5
4	**Chemistry of Natural Products and Biomolecules**	**18**
4.1	Synthesis of camphor, atropine, papaverine, quinine, cyanin, quercetin, β-carotene, testosterone, biosynthesis of PGE2 and PGF2α.	6

4.2	Structure of proteins, nucleic acids and methods for primary structure determination of peptides (N-terminal - Sanger's method and Edmond's method; C-terminal - Akabora method and carboxy peptidase method),replication of DNA, flow of genetic information, protein biosynthesis, transcription and translation, genetic code, regulation of gene expression, DNA sequencing, The Human Genome Project, DNA profiling and the Polymerase Chain Reaction (PCR).	12
5	**Retrosynthetic Analysis**	**9**
5.1	Basic principles and terminology of retrosynthesis: synthesis of aromatic compounds, one group and two group C-X disconnections; one group C-C and two group C-C disconnections.	3
5.2	Amine and alkene synthesis: important strategies of retrosynthesis, functional group transposition, important functional group interconversions	3
5.3	Retrosynthesis of D-luciferin, Longifoline, Reserpine, Juvabione, Aphidicolin, Taxol.	3

References

1. J.M. Lehn, Supramolecular Chemistry: Concepts and Perspectives, VCH, 1995.
2. F. Vogtle, Supramolecular Chemistry: An Introduction, Wiley, 1993.
3. J W Steed & J L Atwood, Supramolecular Chemistry, Wiley, 2nd Edition, 2009
4. J. W. Steed & J. L. Atwood, Supramolecular Chemistry, 1st Edition, John Wiley, 2009.
5. K. Ariga, T. Kunitake, Supramolecular Chemistry – Fundamentals and Applications, Springer, 2006
6. W. Carruthers, I. Coldham, Modern Methods of Organic Synthesis, Cambridge University Press, 2004.
7. J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, Oxford University Press, 2004.
8. R.O.C. Norman, J.M. Coxon, Principles of Organic Synthesis, Blackie Academic and Professional, 1993.
9. J.M. Berg, J.L. Tymoczko, L. Stryer, Biochemistry, 6th Edn., W.H. Freeman, 2010.
10. A.L. Lehninger, D.L. Nelson, M.M. Cox, Lehninger Principles of Biochemistry, 5th Edn., W.H. Freeman, 2008.
11. S.V. Bhat, B.A. Nagasampagi, M. Sivakumar, Chemistry of Natural Products, Narosa, 2005.

12. V.K. Ahluwalia, Oxidation in Organic Synthesis, CRC Press, 2012.
13. M.B. Smith, Organic Synthesis, 3rd Edn.,Wavefunction Inc., 2010.
14. F.A. Carey, R. I. Sundberg, Advanced Organic Chemistry, Part A and B, 5th Edn., Springer, 2007.
15. S. Warren, P. Wyatt, Organic Synthesis: The Disconnection Approach, 2nd Edn., Wiley, 2008.
16. www.arkat-usa.org (Retrosynthesis of D-luciferin).
17. S. Warren, Organic Synthesis: The Disconnection Approach:, Wiley India Pvt Ltd, 2007
18. P. Wyatt, S. Warren, Organic Synthesis: Strategy and Control, Wiley India Pvt Ltd, 2007
19. E. J. Corey, Xue-Min Cheng, The Logic of Chemical Synthesis, Wiley, 1995
20. K. C. Nicolaou, E.J. Sorenson, Classics in Total Synthesis I, II and III, Wiley, 1996
21. J. Fuhrhop, G. Penzlin, Organic Synthesis Concepts, Methods, Starting Materials, Wiley, 2003

Course	Details				
Code	**ICH9CR03**				
Title	**Advanced Physical Chemistry - III**				
Degree	**Integrated M.Sc. Programme in Basic Sciences- Chemistry**				
Branch(s)	Pure Chemistry				
Year/Semester	5/IX				
Type	Core				
Credits	**5**	Hrs/Week	**5**	Total Hours	**90**

Specific objectives	To study the laws and principles of crystallography, electroanalytical techniques, electrochemistry, diffraction and spectroscopic techniques
Course outcomes	1. To apply the different methods to study crystal structure 2. To understand the theories of ions in solutions, overvoltage, fuels cells, capacitors. 3. To apply the various electrochemical techniques, spectroscopic technique and diffraction techniques for analysis.

Module	Course Description	Hrs
1	**Crystallography**	**18**
1.1	Translational symmetry, glide planes and screw axes, space groups, simple cases like triclinic and monoclinic systems, interplanar spacing and method of determining lattice types, reciprocal lattices.	4
1.2	Methods of characterizing crystal structure, rotating crystal method, powder X-ray diffraction method, determination of structure of sodium chloride by powder method, comparison of the structures of NaCl and KCl, brief outline of single crystal X-ray diffraction and crystal growth techniques.	10
1.3	Structure factor: Atomic scattering factor, coordinate expression for structure factor, structure by Fourier synthesis.	4
2	**Advanced Electrochemistry**	**36**
2.1	Theories of ions in solution, Drude and Nernst's electrostriction model and Born's model, Debye-Huckel theory, derivation of Debye-Huckel-Onsager equation, validity of DHO equation for aqueous and non aqueous solutions, Debye-Falkenhagen effect, conductance with high potential gradients, activity and activity coefficients in electrolytic solutions, ionic strength, Debye-Huckel limiting law and its various forms, qualitative and quantitative tests of Debye-Huckel limiting equation, deviations from the DHLL, ion association, triple ions and conductance minima.	12

2.2	Electrochemical cells, concentration cells and activity coefficient determination, liquid junction potential, evaluation of thermodynamic properties, the electrode double layer, electrode-electrolyte interface, different models of double layer, theory of multilayer capacity, electro capillary, Lippmann equation, membrane potential.	10
2.3	Fuel cells- Theory and working of fuel cells- methanol fuel cell, H_2-O_2 fuel cell and solid oxide fuel cells.	4
2.4	Overvoltage: hydrogen and oxygen overvoltage, theories of overvoltage, Tafel equation and its significance, Butler-Volmer equation for simple electron transfer reactions, transfer coefficient, exchange current density, rate constants	6
2.5	Capacitors : Types of capacitors and its working	4
3	**Electroanalytical Techniques**	**21**
3.1	Voltametry: Cyclic voltametry, ion selective electrodes, anodic stripping voltametry.	3
3.2	Polarography-decomposition potential, residual current, migration current, supporting electrolyte, diffusion current, polarogram, half wave potential, limiting current density, polarograph, explanation of polarographic waves	4
3.3	The dropping mercury electrode, advantages and limitations of DME, quantitative analysis- pilot ion procedure, standard addition methods, qualitative analysis determination of half wave potential of an ion, advantages of polarography.	5
3.4	Amperometric titrations: General principles of amperometry, instrumentation, application of amperometry in the qualitative analysis of anions and cations in solution, merits and demerits of amperometric titrations	4
3.5	Coulometry: Coulometer-Hydrogen Oxygen coulometers, silver coulometer, coulometric analysis with constant current, coulometric tritrations, application of coulometric titrations-neutralization titrations, complex formation titrations, redox titrations, advantages of coulometry	5
4	**Fluorescence Spectroscopy**	**9**
4.1	Instrumentation: light source, monochromator, optical filters, photomultiplier tube, polarizers, fluorescence sensing, mechanism of sensing, sensing techniques based on collisional quenching, energy transfer and electron transfer, examples of pH sensors. Novel fluorephores: long life time metal-ligand complexes.	9
5	**Diffraction Methods**	**6**
5.1	Electron diffraction of gases, Wierl's equation, Neutron diffraction method, Comparison of X-ray, electron and neutron diffraction methods.	6

References

1. L.V. Azaroff, Introduction to Solids, Mc Graw Hill, 1984.
2. D.K. Chakrabarty, Solid State Chemistry, New Age Pub., 2010.
3. A.R. West, Basic Solid State Chemistry, John Wiley & Sons, 1999
4. S. Glasstone, Introduction to Electrochemistry, Biblio Bazar, 2011.
5. D. R. Crow, Principles and Applications of Electrochemistry, 4th Edn., S.Thornes, 1994.
6. B.K. Sharma, Electrochemistry, Krisna Prakashan, 1985.
7. John O'M Bockris and Amulya K.N. Reddy, Modern Electrochemistry Vol I & II Springer International Edn.2006.
8. R.J. Silbey, R.A. Alberty, M.G. Bawendi, Physical Chemistry, 4th Edn., Wiley,2005.
9. G.M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill, 2007.
10. K.J. Laidler, J.H. Meiser, B.C. Sanctuary, Physical Chemistry, 4th Edn., Houghton Mifflin, 2003.
11. P.W. Atkins, Physical Chemistry, ELBS, 1994.
12. G.W. Castellan, Physical Chemistry, Addison-Wesley, 1983.
13. A. Yu, V. Chabot, J. Zhang, Electrochemical Supercapacitors for Energy Storage and delivery: Fundamentals and Applications, CRC Press, 2013
14. A. Balakrishna, K.R.V. Subramanian, Nanostructured Ceramic Oxides for Supercapacitor Applications, CRC Press, 2014
15. A.I. Vogel, A Text Book of Quantitative Analysis including Instrumental Analysis, John Wiley & Sons, 1961.
16. H.H. Willard, J.A .Dean, L.L. Merritt, Instrumental Methods of Analysis, Van Nostrand, 1965.
17. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, 8th Edn., Saunders College Pub., 2007.
18. B. Valeur, Molecular Fluorescence: Principles and Applications, Wiley-VCH 2002.
19. J. R. Lakowicz, Principles of Fluorescence Spectroscopy, 3rd Edn., Springer, 2006.
20. H. Kaur, Spectroscopy, 6th Edn., Pragati Prakashan, 2011.

Course	Details				
Code	**ICH9ELC1**				
Title	**Chemical Biology**				
Degree	**Integrated M.Sc. Programme in Basic Sciences-Chemistry**				
Branch(s)	**Pure Chemistry**				
Year/Semester	**V/IX**				
Type	**Core-Elective**				
Credits	**3**	**Hrs/Week**	**4**	**Total Hours**	**72**

Specific objectives	To gain insight of the chemistry in biology
Course outcomes	• To understand the chemical basis for biological phenomena • To understand enzyme kinetics and their application to the elucidation of catalytic mechanisms • To understand the structural determination of biomolecules and molecular recognition. • To understand tools and techniques in molecular biology

Module	Course Description	Hrs
1	**Introduction to Chemical Biology**	**18**
1.1	Molecules of Life and the Fundamentals of Living Systems: Central dogma, Structure, function and chemistry of biological macromolecules including amino acids, proteins, nucleic acids and carbohydrates, DNA origami, transcription, translation and unnatural amino acids. Structural forces in biological macromolecules	9
1.2	Chemical and biological synthesis: Introduction to synthesis in chemical biology, Chemical synthesis of peptides and proteins, Chemical synthesis of nucleic acids, Chemical synthesis of oligosaccharides, Chemical synthesis of lipids, biological synthesis of biological macromolecules, Directed biological synthesis of proteins	9
2	**Kinetics and catalysis in Biology**	**9**
2.1	Chemical kinetics and thermodynamics in biology, Catalysis in chemical biology, Steady state kinetic schemes, Pre-steady-state kinetics, Theories of biocatalysis, Electron transfer. Enzymes: Proximity effects Orientation of the substrates, Rate acceleration, Enzyme kinetics: Steady state and pre-steady state (stop-flow methods), derivation and detailed kinetic analysis of different inhibition modes; introduction to basic drug design based on inhibitors; Catalysis: Covalent catalysis, non-covalent catalysis, catalyst in electrostatic binding mode, general acid-general base catalysis, specific acid/base catalysis.	9

3	**Structure Determination of Biomolecules**	**18**
3.1	Electronic and vibrational spectroscopy in chemical biology: UV–visible spectroscopy, Circular dichroism spectroscopy, Vibrational spectroscopy, Fluorescence spectroscopy, Probing metal centres by absorption spectroscopy. Bioluminescence. Magnetic resonance in chemical biology, Biological macromolecule structural information, EPR spectroscopy - key principles,	9
3.2	Diffraction and microscopy in chemical biology, Key principles of X-ray diffraction, Structural information from X-ray diffraction, Neutron diffraction, Key principles of electron microscopy. Key principles of scanning probe microscopy, Mass spectrometry and proteomics: Mass spectrometry in chemical biology, Key principles in mass spectrometry, Structural analysis of biological macromolecules and lipids by mass spectrometry, The challenge of proteomics, Genomics – assigning function to genes and protein	9
4	**Molecular recognition and binding**	**9**
4.1	Molecular recognition and binding in chemical biology, Theoretical models of binding, Analysing molecular recognition and binding, Biological molecular recognition studies	9
5	**Molecular biology as a toolset for chemical biology**	**18**
5.1	Key concepts in molecular biology, Tools and techniques in molecular biology, Cloning and identification of genes in DNA, Integrating cloning and expression, Site-directed mutagenesis	9
5.2	Molecular Selection and Evolution: Chemical biology and the origins of life, Molecular breeding; natural selection acting on self-organisation, Directed evolution of protein function, Directed evolution of nucleic acids , Catalytic antibodies	9

References

1. B. Konforti, D. Wemmer, J. Kuriyan The Molecules of Life First Edition,, Garland Science Publishers, 2013
2. D.L. Nelson, M.M. Cox, Lehninger Principles of Biochemistry, 6th edition, W.H. Freeman publisher, 2012
3. D.V. Vranken, G.A. Weiss, Introduction to Bioorganic Chemistry and Chemical Biology, 1st edition, Garland Science: New York, 2013.
4. A. Miller, J. Tanner, Essentials of Chemical Biology Structure and Dynamics of Biological Macromolecules. John Wiley & Sons Inc, 2008
5. C. M. Dobson, J. A. Gerrard, A. J. Pratt, Foundations of Chemical Biology, Oxford University Press, 2001.
6. H. Lodish, A. Berk, C.A. Kaiser, M. Krieger, A. Bretscher, H. Ploegh, K. C. Martin, M. Yaffe, A. Amon, Molecular Cell Biology 7th Edition, Macmillan publishers, 2013

Course	Details				
Code	ICH9ELC2				
Title	Food Science and Technology				
Degree	Integrated M.Sc. in Basic Sciences-Chemistry				
Branch(s)	Pure Chemistry				
Year/Semester	5/IX				
Type	Core- Elective				
Credits	3	Hrs /Week	4	Total Hours	72

Specific objectives	To develop the skills for structure, functions, metabolism of various components of food and their role in body
Course outcomes	• Students will have a thorough understanding of structure and classification various components of food and food processing techniques. • The students will know the process of complete digestion and assimilation of food component

Module	Course Description	Hrs
1	**Food Chemistry**	**9**
1.1	Food chemistry- definition, scope and importance; water in food, water activity and shelf life of food; chemistry and stability of water and fat soluble vitamins; chemical properties of minerals and their bioavailability, enrichment and fortification.	9
2	**Carbohydrate chemistry**	**12**
2.1	Carbohydrates-classification, physical and chemical properties of sugars, functional properties and uses of pectic substances, gums and dietary fibre in food	5
2.2	Browning reaction in food: enzymatic and non-enzymatic browning, their occurrence and applications in food; starches: functionality of starch in foods, gelatinization and retrogradation of starches, modified starches, resistant starches.	7
3	**Lipid Chemistry**	**12**

3.1	Lipids classification, properties- lipolysis, auto-oxidation, rancidity and flavour reversion.	4
3.2	Thermal decomposition and effect of ionizing radiations; modification of fats and oils (hydrogenation and interesterification); role of food lipids in flavour, nutritional aspects of natural and modified fats; fat mimetics.	8
4	**Protein Chemistry**	**9**
4.1	Proteins : structures of protein and amino acids; physical, chemical and functional properties of proteins, functional properties of food proteins, modification of food protein in processing and storage and its implications, texturized, denaturation of protein, gel formation.	9
5	**Enzymes**	**9**
5.1	Enzymes- sources, properties, role of enzymes in dairy, starch and sugar, juice/beverage, and meat industry; natural flavors in food and their retention in processed foods.	9
6	**Food Processing**	**12**
6.1	Scope and importance of food processing; historical developments in food processing; food spoilage: microbial, physical, chemical & miscellaneous.	3
6.2	Heat preservation and processing: heat resistance of microorganisms, thermal death curve, types of heat treatments and effects on foods, canning of foods, cans and container types, spoilage of canned foods, heat penetration, brief concept of different heat processing methods: blanching, roasting, frying, baking etc	9
7	**Storage of foods**	**9**
7.1	Refrigeration storage: requirements of refrigeration storage, changes of foods during refrigeration storage, refrigeration load, chilling and refrigeration, cold storage.	4
7.2	Freezing and frozen storage: freezing curves, slow and quick freezing, factors determining freezing rate, freezing methods, changes in food during freezing, frozen food storage, freeze drying in food processing	5

References

1. Meyer, L.H., Food Chemistry, Van Nostrand, Reinhold Company Publication, New York, London, 1998
2. Alias C., Lindeu G, Food Biochemistry, Ellis Horwood, New York, 1991
3. Pomeranz, Y, Meloon, R., Food Analysis: Theory and Practice, Westport, An AVI Publication, New York, Sydney, Toronto, 1995
4. Fennema, R.O, Food Chemistry, Second Edition, Food Science & Technology series, Marcel Dekker, INC., New York, 1997
5. Norman, N.P, Joseph, H.H., Food Science, Fifth edition, CBS Publication, New Delhi., 1997
6. Kalia M., Sangita, Food Preservation and Processing, First edition, Kalyani Publishers, New Delhi, 1996
7. Sivasankar, B., Food Processing and Preservation, Prentice Hall of India Pvt.Ltd., New Delhi, 2002.
8. Khetarpaul N., Food Processing and Preservation, Dya Publishing House , New Delhi, 2005

SEMESTER IX

ICH9CP04 - INORGANIC CHEMISTRY PRACTICALS-II

Credit: 2 **Contact Lab Hours: 72**

Objective of the Course

They must be able to apply theoretical learning to separate simple binary mixtures of metallic ions in solution, analysis of alloys and application of paper chromatography to separate a mixture of three cations.

PART I

Estimation of simple binary mixtures (like Cu-Ni, Cu-Zn, Fe-Cr, Fe-Cu, Fe-Ni, Pb-Ca) of metallic ions in solution by volumetric and gravimetric methods.

PART II

Analysis of one of the alloys of brass, bronze and solder.

OR

Analysis of one of the ores from hematite, chromite, dolomite, monazite, illmenite.

PART III

Paper chromatographic separation of a mixture of 3 cations. **(any two)**

(a) Separation of Ag(I), Pb(II) and Hg(II) ions
(b) Separation of Ni(III), Co(II) and Zn(II)ions
(c) Separation of Ni(III), Co(II) and Cu(II)ions
(d) Separation of Ba(II), Sr(II) and Ca(II) ions

PART IV

(a) Preparation of cis and trans-Dichlorobis(ethylenediamine)cobalt(III) chloride and kinetic study of cis to trans isomerisation using a UV-vis spectrophotometer.
(b) Synthesize the following complexes of Ni(II) (a d^8 system) and prepare 0.05M solutions of the complexes in the solvents specified.

S.No.	Complex	Solvent and Blank	Concentration
1	$[Ni(bipy)_3]SO_4.6H_2O$	Water	0.05M
2	$[Ni(en)_3]Cl_2.2H_2O$	20% en	0.05M
3	$[Ni(NH_3)_6]Cl_2$	Aqueous NH_3	0.05M
4	$[Ni(H_2O)_6]SO_4$	Water	0.05M
5	$[Ni(DMSO)_6](ClO_4)_2$	DMSO	0.05M
6	$K_4[Ni(NCS)_6]4H_2O$	10M KSCN in water	0.05M

Record the electronic spectrum of each solution in the region 200 – 1100 nm.

Calculate Δ values for any three complexes. Arrange the ligands in the spectrochemical series i.e. in the order of increasing Δ. **(any three)**

(c) Estimation of equilibrium constant of the reaction, $Fe^{3+} + SCN^{-} \leftrightarrow FeSCN^{2+}$ with the help of a colorimeter or UV-vis spectrophotometer.

References

1. A.I. Vogel, A Text Book of Quantitative Inorganic Analysis, Longman, 1966.
2. I.M. Koltoff, E.B. Sandell, Text Book of Quantitative Inorganic Analysis, 3rd Edn., Mc Millian, 1968.
3. G. Pass, H. Sutcliffe, Practical Inorganic Chemistry, Chapman & Hall, 1974.
4. H.Furman, Standard Methods of Chemical Analysis: Volume 1, Van Nostrand, 1966.
5. F.J. Welcher, Standard Methods of Chemical Analysis: Vol. 2, R.E. Kreiger Pub.,2006
6. J. Singh, R. K. P. Singh, J. Singh, LDS Yadav, I. R. Siddiqui, J. Shrivastava, Advanced
7. Practical Chemistry, Pragati Prakasan, 2014.
8. Journal of Chem. Ed. , 1962, 39, 634.
9. J.C.S. 1953, 2696.
10. Cotton, J. Chem. Educ.1964, 41, 466.
11. Sutton, J. Chem. Educ. 1960, 37, 498.
12. Manch & Fernelius, J. Chem. Educ. 1961, 38, 192.

SEMESTER IX

ICH9CP05 - ORGANIC CHEMISTRY PRACTICALS-II

Credits: 2 **Contact Lab Hours: 72**

PART I

Preparation involving two step Synthetic Sequences by Chemical Methods (Any five)

(1) Meta nitrobenzoic acid from methyl benzoate
(2) Para nitroaniline from acetanilide
(3) 1,3,5-tribromoaniline from acetanilide
(4) Para bromoaniline from acetanilide
(5) Benzanilide from benzophenone
(6) Schiff's base from aniline
(7) Paracetamol from phenol
(8) Phenol from aniline
(9) Methyl red from anthranilic acid
(10) Para nitrobenzoic acid from toluene

PART II

Spectrophotometric (UV-Vis) estimations of organic compounds (eg: Nitro compounds, azo compounds etc.) (any one)

PART III

Preparation involving Multistep Synthetic Sequences by the Green Alternatives of Chemical Methods (any Four)

(1) 1,1-bis -2-naphthol from 2-naphthol
(2) Benzopinacol from benzophenone
(3) Benzopinacolone from Benzopinacol
(4) o-Methyl acetanilide from o-toludine
(5) Acetanilide from aniline

PART IV

Microwave assisted Organic Synthesis (Any Four)

(1) Benzoic acid from ethyl benzoate
(2) Benzoic acid from benzyl alcohol
(3) Ethyl-3-nitrobenzoate from 3-nitrobenzoic acid
(4) 2-hydroxychalcone from salicylaldehyde
(5) Anthracene-maleic anhydride adduct

PART V

Prediction of FTIR, UV-Visible, ^{1}H and ^{13}C NMR spectra of the substrates and products at each stage of the products synthesized by the above methods.

References

1. A.I. Vogel, A Textbook of Practical Organic Chemistry, Longman, 1974.
2. A.I. Vogel, Elementary Practical Organic Chemistry, Longman, 1958.
3. F.G. Mann and B.C Saunders, Practical Organic Chemistry, 4thEdn., Pearson Education

India, 2009.
4. J.R. Adams, J.R. Johnson, J.F. Wilcox, Laboratory Experiments in Organic Chemistry, Macmillan, 1979.
5. V.K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Ane Books, 2009.
6. Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, DST, 2009

Course	Details				
Code	ICHXPR01				
Title	Project (Major)				
Degree	Integrated M.Sc. Programme in Basic Sciences-Chemistry				
Branch(s)	Pure Chemistry				
Year/Semester	V/X				
Type	Core-Project				
Credits	16	Hrs/Week	25	Total Hours	450

Description
The major project is for students to get hands on experience in a research atmosphere or at the industry as an internship. The students must be assigned a guide who is an inhouse faculty and a mentor who is the faculty / expert at the centre where the students will be doing the project. Evaluation of the project is external.

Course	Details				
Code	ICHXVV02				
Title	Comprehensive Viva Voce				
Degree	Integrated M.Sc. in Basic Sciences-Chemistry				
Branch(s)	Pure Chemistry				
Year/Semester	V/X				
Type	Core-Viva Voce				
Credits	4	Hrs/Week	-	Total Hours	-

Description
The objective of viva voce is to assess the overall knowledge of the student acquired through the previous semesters over the five years of study. The main objective is to prepare the students to face interviews especially pertaining to their subject matter.