Kuvempu University
Department of Chemistry
M.Sc. Chemistry Syllabus - 2015 (CBCS Scheme)
M.Sc. Course Pattern and Scheme of Examination under CBCS approved by PG-BOS in Chemistry held on 02-01-2015.

Course Pattern:

Semester	Theory code	Hrs/Week	Credits	Practicals code	Hrs/Week	Credits	Total Credits per Semester
	Hard core						
	ChHC-1.1	4	4	ChHCL-1.1	4	2	
I	ChHC-1.2	4	4	ChHCL-1.2	4	2	
	ChHC-1.3	4	4	ChHCL-1.3	4	2	
	ChHC-1.4	4	4				**22**
	Hard core						
	ChHC-2.1	4	4	ChHCL-2.1	4	2	
	ChHC-2.2	4	4	ChHCL-2.2	4	2	
II	ChHC-2.3	4	4	ChHCL-2.3	4	2	
	ChHC-2.4	4	4				
	Elective						
	ChEL-2.1	2	2				**24**
	Soft core						
	ChSC-3.1	3	3	ChSCL-3.1	4	2	
	ChSC-3.2	3	3	ChSCL-3.2	4	2	
III	ChSC-3.3	3	3	ChSCL-3.3	4	2	
	ChSC-3.4	3	3				
	Elective						
	ChEL-3.1	2	2				**20**
	Soft core						
	ChSC-4.1	3	3	ChSCL-4.1	4	2	
	ChSC-4.2	3	3	ChSCL-4.2	4	2	
	ChSC-4.3	3	3	ChSCL-4.3	4	2	
IV	ChSC-4.4	3	3				
	Project Work						
	ChPR-4.1	4	4				**22**
Total Credits : I - IV SEMESTER (88) + Soft Skills (03) = 91							

Theory and Practicals (M.Sc. in Chemistry - CBCS):

ChHC-1.1: Analytical Chemistry-I
ChHC-1.2: Inorganic Chemistry-I
ChHC-1.3: Organic Chemistry-I
ChHC-1.4: Physical Chemistry-I

ChHCL-1.1: Inorganic Chemistry Practicals-I
ChHCL-1.2: Organic Chemistry Practicals-I
ChHCL-1.3: Physical Chemistry Practicals-I

ChHC-2.1: Analytical Chemistry-II
ChHC-2.2: Inorganic Chemistry-II
ChHC-2.3: Organic Chemistry-II
ChHC-2.4: Physical Chemistry-II
ChEL-2.1: Chemistry Elective-I

ChHCL-2.1: Inorganic Chemistry Practicals-II
ChHCL-2.2: Organic Chemistry Practicals-II
ChHCL-2.3: Physical Chemistry Practicals-II

ChSC-3.1: Analytical Chemistry-III
ChSC-3.2: Inorganic Chemistry-III
ChSC-3.3: Organic Chemistry-III
ChSC-3.4: Physical Chemistry-III
ChEL-3.1: Chemistry Elective-II

ChSCL-3.1: Inorganic Chemistry Practicals-III
ChSCL-3.2: Organic Chemistry Practicals-III
ChSCL-3.3: Physical Chemistry Practicals-III

ChSC-4.1: Analytical Chemistry-IV
ChSC-4.2: Inorganic Chemistry-IV
ChSC-4.3: Organic Chemistry-IV
ChSC-4.4: Physical Chemistry-IV
ChPR-4.1: Project Work

ChSCL-4.1: Inorganic Chemistry Practicals-IV
ChSCL-4.2: Organic Chemistry Practicals-IV
ChSCL-4.3: Physical Chemistry Practicals-IV

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Examination Pattern:

Theory						Practical				
Semester	**Paper**	**Duration (hrs)**	**Max. Marks**	**IA**	**Total**	**Paper**	**Duration (hrs)**	**Max. Marks**	**IA**	**Total**
I	ChHC-1.1	3	75	25	100	ChHCL-1.1	4	50	-	50
	ChHC-1.2	3	75	25	100	ChHCL-1.2	4	50	-	50
	ChHC-1.3	3	75	25	100	ChHCL-1.3	4	50	-	50
	ChHC-1.4	3	75	25	100					
Total					**400**					**150**
II	ChHC-2.1	3	75	25	100	ChHCL-2.1	4	50	-	50
	ChHC-2.2	3	75	25	100	ChHCL-2.2	4	50	-	50
	ChHC-2.3	3	75	25	100	ChHCL-2.3	4	50	-	50
	ChHC-2.4	3	75	25	100					
	ChEL-2.1	1.5	40	10	50					
Total					**450**					**150**
III	ChSC-3.1	3	75	25	100	ChSCL-3.1	4	50	-	50
	ChSC-3.2	3	75	25	100	ChSCL-3.2	4	50	-	50
	ChSC-3.3	3	75	25	100	ChSCL-3.3	4	50	-	50
	ChSC-3.4	3	75	25	100					
	ChEL-3.1	1.5	40	10	50					
Total					**450**					**150**
IV	ChSC-4.1	3	75	25	100	ChSCL-4.1	4	50	-	50
	ChSC-4.2	3	75	25	100	ChSCL-4.2	4	50	-	50
	ChSC-4.3	3	75	25	100	ChSCL-4.3	4	50	-	50
	ChSC-4.4	3	75	25	100					
	ChPR-4.1	Project Report	75	-						
		Project Viva	25	-	100					
Total					**500**					**150**

Total Marks: I - IV SEM	**Theory + Project**	**Practical**	**Total credits**
2400	**1800**	**600**	**88**

Question Paper Pattern – 2015
First and Second Semesters M.Sc. Examination
(CBCS Scheme)
CHEMISTRY

Paper Title and Code:

Time: 3hrs] [Max. Marks: 75

Note: 1) Answer Part-I and any FIVE questions from Part-II by selecting at least ONE question from each UNIT.
2) Figures to the right indicate marks.

PART - I

1. Answer the following: (At least 02 Questions should be selected from each Unit)
   a), b), c), d), e), f), g), h), i) and j)

10 x 2 = 20

PART – II

(Answer any FIVE questions from Part-B by selecting at least ONE question from each UNIT)

5 x 11 = 55

UNIT – A

(Questions should be selected from UNIT - I)

2. a) 3 Marks
   b) 4 Marks
   c) 4 Marks

   a) 5 Marks
   b) 6 Marks

   a) 4 Marks
   b) 7 Marks

OR

3. a) 3 Marks
   b) 4 Marks
   c) 4 Marks

   a) 5 Marks
   b) 6 Marks

   a) 4 Marks
   b) 7 Marks

UNIT – B

(Questions should be selected from UNIT - II)

4. a) 3 Marks
   b) 4 Marks
   c) 4 Marks

   a) 5 Marks
   b) 6 Marks

   a) 4 Marks
   b) 7 Marks

OR

5. a) 3 Marks
   b) 4 Marks
   c) 4 Marks

   a) 5 Marks
   b) 6 Marks

   a) 4 Marks
   b) 7 Marks

UNIT – C

(Questions should be selected from UNIT - III)

6.	a) 3 Marks	a) 5 Marks	a) 4 Marks
	b) 4 Marks	b) 6 Marks	b) 7 Marks
	c) 4 Marks		

OR

7.	a) 3 Marks	a) 5 Marks	a) 4 Marks
	b) 4 Marks	b) 6 Marks	b) 7 Marks
	c) 4 Marks		

UNIT – D

(Questions should be selected from UNIT - IV)

8.	a) 3 Marks	a) 5 Marks	a) 4 Marks
	b) 4 Marks	b) 6 Marks	b) 7 Marks
	c) 4 Marks		

OR

9.	a) 3 Marks	a) 5 Marks	a) 4 Marks
	b) 4 Marks	b) 6 Marks	b) 7 Marks

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Question Paper Pattern - 2015
Third and Fourth Semesters M.Sc. Examination
(CBCS Scheme)
CHEMISTRY

Paper Title and Code:

Time: 3hrs] [Max. Marks: 75

Note: 1) Answer Part-I and any FIVE questions from Part-II by selecting at least ONE question from each UNIT.
2) Figures to the right indicate marks.

PART - I

1. Answer the following: (At least 03 Questions should be selected from each Unit)
   a), b), c), d), e), f), g), h), i) and j)

10 x 2 = 20

PART – II

(Answer any FIVE questions from Part-B by selecting at least ONE question from each UNIT)

5 x 11 = 55

UNIT – A

(Questions should be selected from UNIT - I)

2. a) 3 Marks a) 5 Marks a) 4 Marks
   b) 4 Marks b) 6 Marks b) 7 Marks
   c) 4 Marks

OR

3. a) 3 Marks a) 5 Marks a) 4 Marks
   b) 4 Marks b) 6 Marks b) 7 Marks
   c) 4 Marks

UNIT – B

(Questions should be selected from UNIT - II)

4. a) 3 Marks a) 5 Marks a) 4 Marks
   b) 4 Marks b) 6 Marks b) 7 Marks
   c) 4 Marks

OR

5. a) 3 Marks a) 5 Marks a) 4 Marks
   b) 4 Marks b) 6 Marks b) 7 Marks
   c) 4 Marks

UNIT – C

(Questions should be selected from UNIT - III)

6.	a) 3 Marks	a) 5 Marks	a) 4 Marks
	b) 4 Marks	b) 6 Marks	b) 7 Marks
	c) 4 Marks		

OR

7.	a) 3 Marks	a) 5 Marks	a) 4 Marks
	b) 4 Marks	b) 6 Marks	b) 7 Marks
	c) 4 Marks		

UNIT – D

(Questions should be selected from UNIT - I, UNIT - II and UNIT - III)

8.	a) 3 Marks	a) 5 Marks	a) 4 Marks
	b) 4 Marks	b) 6 Marks	b) 7 Marks
	c) 4 Marks		

OR

9.	a) 3 Marks	a) 5 Marks	a) 4 Marks
	b) 4 Marks	b) 6 Marks	b) 7 Marks

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Question Paper Pattern - 2015
Second and Third Semesters M.Sc. Examination
(CBCS Scheme)
CHEMISTRY (Elective Paper)

Paper Title and Code:

Time: 1 ½ hrs] [Max. Marks: 40

Note: 1) Answer Part-I and any THREE questions from Part - II
2) Figures to the right indicate marks.

PART - I

1. Answer the following: (At least 03 Questions should be selected from each Unit)
   a), b), c), d), e) 5 x 2 = 10

PART – II

(Answer any THREE questions)

3 x 10 = 20

2.	a) 5 Marks	a) 4 Marks	a) 3 Marks
	b) 5 Marks	b) 6 Marks	b) 7 Marks
3.	a) 5 Marks	a) 4 Marks	a) 3 Marks
	b) 5 Marks	b) 6 Marks	b) 7 Marks
4.	a) 5 Marks	a) 4 Marks	a) 3 Marks
	b) 5 Marks	b) 6 Marks	b) 7 Marks
5.	a) 5 Marks	a) 4 Marks	a) 3 Marks
	b) 5 Marks	b) 6 Marks	b) 7 Marks
6.	a) 5 Marks	a) 4 Marks	a) 3 Marks
	b) 5 Marks	b) 6 Marks	b) 7 Marks

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M.Sc. Chemistry Syllabus - 2015 (CBCS Scheme)
Revised Regulations -2010

I - SEMESTER

ChHC-1.1: ANALYTICAL CHEMISTRY - I

Total: 64 hrs

UNIT-I: EVALUTION OF ANALITYCAL DATA 16 hrs

Importance of analytical chemistry, classification of analytical methods – qualitative, quantitative, instrumental, non-instrumental methods. Limitations of analytical methods, classification of errors – systematic (determinate) errors (operational, personal, instrumental, reagent errors), random (indeterminate) errors, distribution of random errors- frequency distributions, normal error curve. Accuracy (absolute and comparative method), precision, methods to reduce systematic errors, significant figures, mean and standard deviation, distribution of random errors, reliability of results, confidential interval, comparison of results (student's t-test, F-test), comparing the mean of two samples, paired t-test, number of replicable determinations, correlations and regression, linear regression, errors in the slope and intercept, error in the estimation of concentration, standard additions, non-linear regression, comparison of more than two means, experimental design, two-way analysis of variance, chemometrics and experimental design, factorial design, Yates' method, interaction effect – alternative calculation, factorial design – critical appraisal, optimization methods, sequential simplex optimization, critical appraisal, treatment of multivariate data, factor analysis, quick statistics.

Sampling: Sampling techniques, sampling statistics, variability in the sample, sample stability, regulation and legislation, terminology of sampling, methods of sampling for gases (vapours), liquids and solids, effects of sampling uncertainties, sampling hazardous. Need for quality assurance; ISO 9000 series of quality system. Significance and importance of six sigma concepts in maintaining the quality.

UNIT-II: TITRIMETRIC AND GRAVIMETRIC METHOD OF ANALYSIS 16 hrs

Titrimetry: Theoretical considerations, titrimetry, theory of indicators, indicator action, preparation of indicator solutions, metal ion indicators, mixed indicators, primary and secondary standard solutions and their preparations. Classification of reactions in titrimetric analysis, neutralization titrations (strong acid-strong base, weak acid-strong base, weak base-strong acid,

weak acid-weak base, polyprotic acid-strong base), choice of indicators in neutralization reactions, titrations in non-aqueous solvents, indicators for non-aqueous titrations, complexation titrations – EDTA titrations (direct and back titrations, titration of mixture of ions), precipitation titrations, detection of end point in precipitation titrations, oxidation-reduction titrations, detection of end point in redox titrations.

Gravimetry: General principles, requirement for quantitative separations, the process of precipitation, saturated and supersaturated solutions, nucleation, crystal growth, conditions of precipitation, completeness of precipitation, factors influencing solubility of precipitate, purity of precipitate, effect of digestion, adsorption of ions on precipitates, co-precipitation, occlusion and post-precipitation, precipitation from homogeneous solutions (PFHS), effect of - pH, ion releasing reagents, change in oxidation states, use of mixed solvents on the nature of precipitation. Gravimetric estimations of – chloride as silver chloride, calcium as calcium oxalate, iron as ferric oxide, nickel as nickel-DMG.

UNIT-III: ELECTROANALYTICAL TECHNIQUES **16 hrs**

Introduction, electrochemical cells, electrical double layer, faradic and non-faradic current, mass transfer in cells, schematic representation of cells, galvanic and electrolytic cells, anodes and cathodes, potentials in electroanalytical cells, thermodynamics of cell potentials, liquid junction potential, electrode potentials, nature of electrode potentials, standard electrode potentials, standard hydrogen electrode (SHE), standard calomel electrode (SCE). Classification of electroanalytical techniques.

Polarography: Theory, principle and applications classical polarography, dropping mercury electrode, polarogram, polarographic measurements, polarographic current, Ilkovic equation, current and concentration relationship, half wave potential, oxygen interference- advantages and limitations. Qualitative and quantitative analysis. Derivative polarography.

Amperometry, amperomtric titrations, Coulometry at controlled potential and at constant current. Cyclic voltammetry-basic principles, cyclic voltammogram of $K_4[Fe(CN)_6]$ system , irreversible and quasi-reversible curves, instrumentation and applications.

Electrogravimetry: Theory, electrode reactions, over-voltage, characteristics of a good deposit, completeness of deposition, separation of metals at controlled cathode potential. Estimation of copper and nickel in Cu-Ni alloy.

UNIT-IV: CHROMATOGRAPHIC TECHNIQUES - I **16 hrs**

General description of chromatography- classification, chromatograms, migration rates of solutes, distribution constants, retention time, relation between retention time and distribution constant, retention factor, capacity factor, selectivity factor, shapes of chromatographic peaks, band broadening and column efficiency, methods for describing column efficiency - plate theory. Theory of band broadening, van Deemter equation, column resolution, variables affecting column resolution.

Paper Chromatography (PC): Principle, types and theory of paper chromatography, stationary and mobile phases, R_f, R_x and R_G values, techniques of paper chromatography, two-dimensional paper chromatography, visualization and evaluation of chromatograms, quantitative estimations, sources of errors, precautions, applications, experimental paper chromatography.

Thin-layer Chromatography (TLC): Superiority of TLC, theory of TLC, stationary and mobile phases, techniques of TLC, types of TLC, two-dimensional TLC, visualization and evaluation of chromatograms, applications.

Gas Chromatography: Introduction, an overview of GSC and GLC, instrumentation, sample injection systems, columns, detectors (TCD, FID, β-ray ionization detectors), temperature programmed gas chromatography (PTGC), applications - quantitative and qualitative analysis, hyphenated techniques (GC-MS), derivative gas chromatography, pyrolysis gas chromatography – advantages and applications.

HPLC: Introduction, superiority of HPLC, instrumentation, column packing, pump systems, detectors and applications.

Super critical fluid chromatography (SFC): Instrumentation of SFC, comparison of SFC with HPLC and GLC.

REFERENCES:

1. ***Vogel's Textbook of Quantitative Chemical Analysis***, J. Mendham, R.C. Denney, J.D. Barnes, M. Thomas, B. Sivasankar, 6th Edition, Pearson Education, New Delhi, India, 2012.
2. ***Principles of Instrumental Analysis***, D.A. Skoog, E.J. Holler, T.A. Nieman, 5th Edition, Thomson Aisa Pvt. Ltd., Singapore, 2004.
3. ***Instrumental methods of Chemical Analysis (covering UGC Syllabus),*** H. Kaur, Pragathi Prakashan, New Delhi, India

4. ***Quantitative Chemical Analysis,*** Daniel C. Harris, 6th Edition, W.H. Freeman and Company, New York, USA, 2003.

5. ***Fundamentals of Analytical Chemistry***, D.A. Skoog, D.M. West, E.J. Holler, S.R. Crouch, 8th Edition, Thomson Aisa Pvt. Ltd., Singapore, 2004.

6. ***Introduction to Spectroscopy,*** D.L. Pavia, G.M. Lampman, G.S. Kriz, 3rd Edition, Cengage Learning India Pvt. Ltd., New Delhi, 2008.

7. ***Spectrometric Identification of Organic Compounds,*** R.M. Silverstein, F.X. Webster, 6th Edition, Wiley Student Edition, New Delhi, India, 2007.

8. ***Applications of Absorption Spectroscopy of Organic Compounds***, John R. Dyer, Prentice-Hall of India Pvt. Ltd., New Delhi, India, 2007.

9. ***Instrumental Analysis***, D.A. Skoog, E.J. Holler, S.R. Crouch, 11th Indian Reprint, Cengage Learning India Pvt. Ltd., New Delhi, 2012.

10. ***Molecular Structure and Spectroscopy***, G. Aruldhas, 2nd Edition, Prentice-Hall of India Pvt. Ltd., New Delhi, India, 2007.

11. ***Symmetry and Spectroscopy of Molecules,*** K. Veera Reddy, New Age International Pvt. Ltd., New Delhi, India, 1998.

12. ***Analytical Chemistry – Theory and Practice,***, R.M. Verma, 3rd Edition, CBS Publishers and Distributors, New Delhi, India, 2007.

13. ***Vibrational Spectroscopy – Theory and Applications***, D.N. Sathyanarayana, New Age International Publishers, New Delhi, India, 2004.

14. ***Organic Spectroscopy***, William Kemp, 3rd Edition, Palgrave, New York, USA, 2004.

15. ***Basic Atomic and Molecular Spectroscopy***, J. Michael Hollas, Royal Society of Chemistry, Cambridge, UK, 2002.

16. ***Quantitative Analysis,*** Day and Underwood, Prentice/Hall Pvt. Ltd. 6th Edition (1993).

17. ***Vogel's text Book of Quantitative Chemical Analysis,*** Revised by G.H. Jaffery, J. Bassett, J. Mendhrn and R.C. Denny, ELBS 5th Edition (1998).

18. ***Analytical Chemistry,*** Gray D. Christian, 5th Edition, John Wiley and Sons, Inc

19. ***Introduction to Chromatography- Theory and Practice,*** V.K. Srivatsan and K.K. Srivatsan, S. Chand Company Ltd. 4th Edition (1991).

ChHC-1.2: INORGANIC CHEMISTRY-I

Total: 64 hrs

UNIT-I: CHEMICAL BONDING **16hrs**

a) Ionic bond- properties of ionic compounds, factors favouring ionic bond formation, close packing in ionic compounds, radius ratio rules, structure of simple ionic compounds (NaCl, CsCl, CaF_2, TiO_2, perovskites and spinels); Lattice energy- Born-Lande equation, Kapustinskii equation, Born-Haber cycle- application; solvation process and solvation energy, hydration energy and solubility of ionic compounds; polarisation of ions, Fajan's rules, effect of polarization on properties of ionic compounds.

b) Covalent bond- Molecular orbital theory- LCAO method- sigma, Pi and delta M.Os, characteristics of bonding and anti-bonding MOs, comparison between - i) bonding and anti-bonding molecular orbitals, ii) sigma and pi molecular orbitals, iii) atomic and molecular orbitals; MO diagrams, bond order, molecular orbital configurations; MOT of homonuclear diatomic molecules (1^{st} & 2^{nd} row elements & molecular ions) and heteronuclear diatomic molecules (CO, NO, HCl); MOT of delocalized pi bonding systems- CO_3^{2-}, NO_3^- ;

H-bond- types and importance; synergic and agostic bonding.

c) Shapes of covalent molecules

VSPER theory and geometry of covalent molecules: postulates of VSEPR theory, bonding and shapes of molecules with bonding electron pairs (bps)only, bonding and shapes of molecules with lone electron pairs (lps) – AB_3L , AB_2L_2, AB_4L, AB_2L_3, AB_4L_2, AB_5L, AB_6L types (H_2S,ClF_3, ICl_4^-,TeF_5^-, I_3^-, $TeCl_6^{2-}$, XeF_6, $SbCl_6^{3-}$, IF_7 ; shapes of CO_3^{2-}, ClO_3^- ions; Bent's rule and applicatons.

UNIT-II: Chemistry of main group elements. **16hrs**

Inter halogen compounds- Main types, preparation, chemistry, structure and bonding (one representative compound from each type).

Noble gas compounds: Reactivity trends, compounds of xenon (XeF_2, XeF_4, XeF_6, $XeOF_2$, $XeOF_4$) -preparation, reactions, bonding and structure.

Boranes, carboranes and metallo- carboranes: preparation, chemistry, structure and bonding; Wade's rules and structure predictions.

Borazine - preparation, properties, structure and bonding; comparison with benzene. Phossphazenes: chlorophosphazenes- trimer and tetramer: - preparation, structure and bonding; linear polymeric chlorophosphazenes $(PNCl_2)n$- preparation, properties and applications. S-N compounds: $(SN)_4$, $(SN)_n$ species-preparation, properties, structure and bonding; Silicone polymers- preparation, properties, and importance of silicone polymers.

Silicates - main types, structure and properties.

Zeolites: natural and synthetic- structural features, preparation of ZSM-5 zeolite, properties and applications. Isopoly and heteropoly molybdates and tungstens – preparation, properties and structures.

UNIT-III: ACIDS AND BASES **16 hrs**

Bronsted theory, conjugate acid-base pairs, Solvent system(or autoionisation) concept; strengths of acids and bases- role of solvents, leveling effects of solvents, leveling and differentiating solvents; factors affecting relative strengths of acids and bases (including organic acids & bases); Lux – flood and Usanovich concept; Lewis concept- Lewis acids and bases, relative strengths of Lewis acids and bases - factors affecting Lewis acidity and basicity; HSAB concept- Pearson's principle, classification of acids and bases as hard and soft; acid- base strength and hardness and softness; symbiosis, theoretical basis of HSAB concept, application of HSAB concept.

Reactions in Non-aqueous solvents: Types of solvents, physical properties of solvents. Reactions in non aqueous solvents: reactions in liquid NH_3, anhydrous H_2SO_4, CH_3COOH, liquid N_2O_4, and liquid SO_2.

Metal-NH_3 solutions: properties and applications. Molten salts as solvents- reactions in molten salts.

UNIT-IV: ENVIRONMENTAL CHEMISTRY **16 hrs**

Atmosphere- segments and temperature distribution. Air pollution: types of pollutants- particular matter, SO_X, NO_X, CO_X, H_2S, CFCs, HCs, PCBs (polychlorinated biphenyls); sources and effects on vegetation, material and health: photochemical smog, fog, green house effect (global warming), acid rain; ozone layer formation and importance, and depletion of ozone layer.

Air quality standards; sampling, monitoring and analysis of SO_2, NOx, COx, H_2S and HCs, particulate emission and control. Earth's carbon cycle- carbon emitters, carbon sequestration, carbon foot print and carbon trading.

Water pollution: Water pollutants- heavy metal ions(Hg^{2+}, Cd^{2+}, Pb^{2+}, As^{3+}), Cl^-, SO_4^{2-}, PO_4^{3}, NO_3^-, NO_2^-, pesticides, insecticides, PCBs, detergents, oil spills, domestic sewage, microorganisms- sources and their environmental impact, biochemical effects of As, Cd, Pb, Hg, NO_2^-, algal boom, eutrophication.

Water quality parameters- D.O, BOD, solids, metal ions, contents of Cl^-, SO_4^{2-}, PO_4^{3-}, NO_3^-, NO_2^-, micro organism; water quality standards.

Determination of BOD, COD, DO, Hg^{2+}, Cd^{2+}, Pb^{2+}, As^{3+}, residual chlorine, chlorine demand, total organic carbon(TOC), total hardness.

Domestic sewage and treatment- primary, secondary and tertiary processes. Some case studies of air and water pollution – Bhopal Gas Tragedy, Chernobyl, Three Mile Island and Minamata Bay disasters.

REFERENCES:

1. ***Inorganic Chemistry – Principles of Structure and Reactivity***, James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, 4th Edition, Pearson Education, Indian Edition, New Delhi, India, 2013.
2. ***Inorganic Chemistry,*** Peter Atkins,Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong, 5th Edition, Oxford University Press, UK, 2013.

3. ***Inorganic Chemistry – Principles of Structure and Reactivity***, James E. Huheey, Ellen A. Keiter, Richard L. Keiter, 4th Edition, Pearson, Indian Edition, New Delhi, India, 2004.

4. ***Inorganic Chemistry,*** Gary L. Miessler, Donald A. Tarr, 3rd Edition, Pearson Education, New Delhi, India, 2004.

5. ***Inorganic Chemistry,*** Keith F. Purcell, John C. Kotz, First Indian Reprint, Cengage Learning India Pvt. Ltd., New Delhi, India 2010.

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7. ***Advanced Inorganic Chemistry, Volume-I,*** Satya Prakash, G.D. Tuli, S,K, Basu, R.D. Madan, S. Chand and Company, New Delhi, India, 2008.

8. ***Principles of Inroganic Chemistry (UGC Syllabus)***, B.R. Puri, L.R. Sharma, K.C. Kalia, Milestone Publishers, New Delhi, India, 2008.

9. ***Inorganic Chemistry,*** James E. House, First Indian Reprint, Academic Press, USA, 2010.

10. ***Basic Concepts of Inorganic Chemistry,*** D.N. Singh, Pearson Education, New Delhi, 2010.

11. ***Advance Inorganic Chemistry,*** F. Albert Cotton, Geoffrey, Wilkinson, Carlos A. Murillo, Manfred Bochmann, 6th Edition, Wiley Student Edition, John Wiley and Sons, INC, New York, 2004.

14. ***Environmental Chemistry,*** A.K. De, 6th Edition, New Age International Publishers, New Delhi, India, 2008.

15. ***Environmental Pollution Analysis,*** S.M. Khopkar, Wiley International Publishers.

ChHC-1.3: ORGANIC CHEMISTRY - I

Total: 64 hrs

UNIT-I: BASIC ASPECTS OF ORGANIC MOLECULES AND INTERMEDIATES

16 hrs

Concept of hybridization: sp, sp^2, sp^3 hybridization with examples, modified hybrid orbitals.

Electron delocalization and Resonance: Delocalized electron in conjugated systems, resonance hybrid, resonance energy, stability of allylic and benzylic cations and radicals, effect of delocalized electrons on pK_a.

Aromaticity: Concept of aromaticity, Huckel's rule, aromaticity of benzene, dienes, cyclopentadienylanion, tropyliumcation, cyclopropenylcation, annulenes, azulene, heterocyclic compounds. Aromatic dications and dianions. Aromaticity due to polar structure. Concept of homoaromaticity, nonaromatic and antiaromatic compounds.

Electronic effects: Inductive, electronic, electromeric, mesomerism, hyperconjugation, field effect and hydrogen bonding.

Reactive intermediates: Formation, structure and stability of carbocations, carbanions, free radicals, carbenes, nitrenes, arynes, ylides (phosphorous and sulphur ylides) and enamines. Thermodynamic and kinetic requirements of a chemical reaction.

Methods of determining reaction mechanisms: Kinetic method, identification of products, detection of intermediates, study of catalysts, isotopic labeling, cross-over experiments and stereochemical evidences.

Organic acids and bases: Scale of acidity, scale of basicity, Lewis acids and bases, some acid base reactions, origin of acidity, factors affecting acidity and basicity, acid and base catalyzed reactions (Elementary approach).

UNIT-II: SUBSTITUTION REACTIONS

16 hrs

Nucleophilic substitution reactions: Introduction to nucleophiles, hard and soft nucleophiles. Nucleophilic substitution at saturated carbon - S_N1, S_N2 and S_Ni reactions and mechanisms. Factors affecting substitution reaction – substrate (neighbouring group participation and conjugation), nucleophile, leaving group, solvent, steric and strain effect on substitution and ionization rates.

Reactivity of benzylic, allylic, vinylic and aryl halides. Mitsunobu reaction. Nucleophilic substitution on epoxides, esters and ethers. Introduction to nitrogen and sulphur nucleophiles in S_N2 reactions.

Nucleophilic substitution at aromatic compounds: Addition-elimination mechanism, nucleophilic substitution via aryne intermediate, nucleophilic substitution by unimolecular mechanism, preparation of aryl halides through radical mechanism. Nucleophilic substitution by rearrangements.

Electrophilic substitution reactions: General mechanism in aromatic electrophilic substitution reaction, nitration, halogenations, sulphonation, Friedal Craft alkylation and acylation. Orientation effect of substituents, theory of reactivity and orientation, ortho-para ratio, competition between substituents for third group. Side chain reactions of benzene derivatives.

UNIT-III: ADDITION AND ELIMINATION REACTIONS 16 hrs

Addition Reactions: Addition to carbon-carbon and carbon-hetero atom multiple bonds. Addition involving electopliles, nucleophiles and free radicles, concerted addition. Mechanism, orientation and stereochemistry of addition reactions. Addition of hydrogen halides alkenes. Addition of HCN, bisulphate, Grignard reagent, hydride, amino compounds, alcohols and thioalcohols to C=O. Acid catalyzed hydration and related addition reactions. Addition of halogens, sulphenylation and selenenylation. Addition reactions involving epoxides – epoxide from alkenes and peroxidic reagents, subsequent transformation of epoxides.

Electrophilic additions involving metal ions – solvomercuration, argentation – formation of siver complexes. Synthesis and reactions of alkyl boranes – hydroboration, reaction of organoboranes, enantioselective hydroboration. Comparison of electrophilic addition reactions. Addition to allenes, isolated dienes and conjugated dienes. Addition of dienophile to a conjugated diene.

Elimination Reactions: E_1, E_2 and E_{1CB} reactions, regioselectivity in β-elimination reactions (orientation of π-bonds), Saytzeff and Hoffmann rules, elimination vs substitution, E_1, E_2 and E_{1CB} comparative study, 1,1-elimination (α-elimination) - dehalogenation of vicinal dihalides, elimination reactions without involving hydrogen, dehalogenation and related reactions, decarboxylative elimination, elimination with fragmentation, elimination by phosphine, β-elimination in forming carbon-hetero atom multiple bonds. Pyrolytic eliminations. Chugave and Cope eliminations, Hoffmann degradation. Competition between substitution and elimination.

UNIT-IV: STEREOCHEMISTRY **16 hrs**

Optical isomerism: Introduction, molecular structure – projection formulas (Fischer, Newmann, Sawhorse and Flying wedge), interconversion of projection formulas. Molecular symmetry and symmetry elements (Inversion centre, axis of symmetry, plane of symmetry, improper axis of symmetry). Chirality and steroisomerism. Homomers, enatiomers, diastereomers, epimers, anomers (definition and examples). Racemic mixture, Racemisation involving - carbonanion, carbocation as intermediates, Walden inversion, rotation about carbon-carbon single bond. Resolution (racemic modification) – mechanical separation, preferential crystallization, biochemical, chemical and chromatographic method. Optical rotation, optical purity, D,L-configuration threo, erythro – configuration, R,S-nomenclature for isomers with more than one chirality centre, optical isomerism in compounds not containing chiral carbon atoms – allene, spiranes, biphenyl, alkylidine and cycloalkanes.

Geometrical isomerism: Introduction, cis-trans, sym-anti, E,Z nomenclature. Geometrical isomerism in alkenes, dienes, oximes, monocyclic, fused and bridge ring systems. Determination of configuration of geometrical isomers – physical and chemical methods.

Conformational isomerism: Conformational analysis of butane, 1,2-dichloroethane, 1,2-difluoroethane, cyclohexane and substituted cyclohexanes (boat, chair and twist boat conformations).

New methods of asymmetric synthesis – emulsin, penicillin, glaucum, aspirin, catalytic LAH, NaH, sterically hindered Grignard reagent. Enantio selective and diastereo selective synthesis, Cram's rule and Felkin-Anh model.

REFERENCES:

1. ***Organic Chemistry***, J. Clayden, S. Warren, N. Greeves, P. Wothers, 1st Edition, Oxford University Press, UK, 2001.
2. ***Organic Chemistry – Solution Mannual***, S. Warren, Oxford University Press, UK, 2009.
3. ***Advanced Organic Chemistry, Part-A:Structure and Mechanisms,*** 5th Edition, Francis A. Carey, Richard J. Sundberg, Springer, New York, 2007.
4. ***Principles of Organic Synthesis***, R.O.C. Norman, J.M. Coxon, 3rd Edition (First Indian Reprint), Nelson Thrones, UK, 2003.
5. ***Advance Organic Chemistry – Reactions, mechanisms and structure***, Jerry March, 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2008.

6. ***Organic Reaction Mechanisms,*** V.K. Ahluwalia, R.K. Parashar, 3rd Edition, Narosa Publishing House, New Delhi, 2009.

7. ***Pathway to Organic Chemistry – Structure and Mechanism***, P. Bhattacharjee, Arunabha Sen Books and Allied Pvt. Ltd., Kolkta, India, 2012.

8. ***Organic Chemistry,*** Paula Yurkanis Bruice, 3rd Edition, Pearson Education, Sai Printo Pack Pvt. Ltd., New Delhi, India, 2007.

9. ***Organic Chemistry (As per UGC Syllabus),*** S.M. Mukherji, S.P Singh, R.P. Kapoor, R. Dass, Vol. I, New Age International Pvt. Ltd., New Delhi, 2010.

10. **Stereochemistry of Organic Compounds – Principles and applications**, D. Nasipuri, Revised 2nd Edition, New Age International Pvt. Ltd., New Delhi, 2009.

11. ***Organic Reactions and their Mechanisms,*** P.S. Kalsi, 2nd Edition, New Age International Pvt. Ltd., New Delhi, 2007.

12. ***Organic Chemistry,*** Solomons, Fryhle, 8th Edition (Wiley Student Edition), Brijbasi Art Press Ltd., Noida, India 2004.

13. ***Organic Chemistry***, G. Marc Loudon, 4th Edition, Oxford University Press, UK, 2000.

14. ***Organic Chemistry,*** R.T. Morrison, R.N. Boyd, 6th Edition, Pearson Education (Singapore Pvt. Ltd.), Delhi, Indian, 2005.

15. ***Organic Chemistry***, L.G. Wade, JR., 5th Edition, Pearson Education (Singapore Pvt. Ltd.), Delhi, Indian, 2004.

16. ***Organic Chemistry***, M.A. Fox, J.K. Whitesell, 2nd Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts, London, 1997.

17. ***Organic Chemistry***, M. Jones, Jr., 2nd Edition, W.W. Norton and Company, New York, 2000.

18. ***Organic Chemistry,*** Francis A. Carey, 5th Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

19. ***Modern Methods of Organic Synthesis,*** W. Carruthers, 3rd Edition, Cambridge University Press, UK, 2004.

ChHC-1.4: PHYSICAL CHEMISTRY - I

Total: 64 hrs

UNIT-1: THERMODYNAMICS **16 hrs**

The laws of thermodynamics (Statements and significances), concepts of free energy, enthalpy and entropy, thermodynamic criteria for equilibrium and spontaneity, variation of free energy with temperature and pressure. Maxwell's relations (Derivations), thermodynamic equations of state (Derivations), principle of equipartition energy. Entropy of vapourisation and Trauton's rule, limitations of Van't Hoff's equation, Nernst heat theorem, determination of free energy change. Third law of thermodynamics, determination of third law entropies, concepts of residual entropy.

Thermodynamics of systems of variable compositions, partial molar properties, partial molar volume and its determination (Intercept method), partial molar free energy – chemical potential and its significance, Gibbs-Duhem equation, thermodynamics of ideal and real gases and gas mixtures. Fugacity - its variation and determination, activity and activity coefficient. Gibbs-Duhem-Margules equation and its application. Thermodynamics of ideal and non-ideal dilute solutions.

UNIT-I: STATISTICAL THERMODYNAMICS **16 hrs**

Maxwell-boltzmann distribution law (sterling's approximations), Types of statistics - Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac statistics. Evaluation of Lagrange's undetermined multipliers, Molecular partition function for an ideal gas, evolution of translational, rotational, vibration, electronic and nuclear partition functions. Thermodynamic properties in terms of the partition function. Thermodynamic properties of an ideal monoatomic gas and diatomic gas. Molar partition function of a system. Partition function of a real gas. Calculation of thermodynamic functions and equilibrium constant in terms of partition functions. Entropy of mono atomic gas, Sackur-Tetrode equation. Comparison of third law and statistical entropies.

Statistical thermodynamic properties of solids, thermal characteristics of crystalline solid, heat capacities of monoatomic crystals, Einstein theory of heat capacity, Debye theory of heat capacity, Debye-T^3 law. Limitation and modification of Debye theory - Complex solids, Electronic heat capacity of solids.

UNIT-III: CHEMICAL DYNAMICS **16 hrs**

The rate of reactions, the rate law and the rate constant, order of a reaction, integration of rate expressions [first, second, third and zero order reactions], half-life of a reaction, methods of determining order of a reaction [differential, integral, half-life and isolation methods], order and molecularity of a reaction, mechanism of complex reactions, collisions and encounters, effect of temperature and catalyst on reaction rates, the Arrhenius equation. Theories of reaction rates [collision theory and activated complex theory of bimolecular gaseous reactions], the Erying equation, the Lindemann theory of unimolecular gaseous reactions. Kinetics of complex reactions [reversible, consecutive, and chain reactions].

Kinetics of reactions in solution [diffusion controlled reactions-the Debye-Smoluchowski equation]. Influence of ionic strength and solvent on reaction rates. Kinetic isotopic effects. Kinetics of fast reactions: flow methods, pulse method, flash photolysis method, pulse radiolysis method, relaxation method (Temperature-Jump Method). Molecular reaction dynamics and potential energy surfaces. Femtochemistry – Introduction, experimental set-up, few examples.

UNIT-IV: ELECTROCHEMISTRY **16 hrs**

Electrolytic solutions, strong electrolytes, ionic-atmosphere, relaxation and electrophoretic effects, quantitative treatment of Debye –Huckle theory and its extension by Onsagar. Activity and activity coefficients, mean ionic activity coefficient, dependence of activity coefficients on ionic strength (Debye - Huckel limiting law), Debye - Huckel equation for appreciable concentration [Debye - Huckel - Bronsted equation].

Thermodynamics of electrolytic cells, polarization and over voltage, decomposition potential. Half cell reactions, reversible electrodes, single electrode potential, standard electrode potentials, electrochemical series, Nernst equation. Electrochemical energy systems - introduction, fundamentals of batteries, dry cell, alkaline MnO_2 batteries and other secondary batteries, Lead acid and alkaline storage batteries. Battery charging-theory and practice. Energy economics, Fuel cells – types, electrochemistry of fuel cells.

REFFERENCES:

1. ***Quantum Chemistry***, R.K. Prasad, 4th Edition, New Age International Publishers, New Delhi, 2010.

2. ***Quantum Mechanics for Chemists***, David O. Hayward, The Royal Society of Chemistry, UK, 2002.

3. ***Principles of Physical Chemistry (Comprehensive UGC Syllabus)***, B.R. Puri, L.R. Sharma, M.S. Pathania, 46th Edition, Vishal Publishing House, Jalandhar, India, 2012.

4. ***Physical Chemistry – A Molecular Approach***, Donald A. McQuarrie, John D. Simon, 3rd Edition (Viva Student Edition), Viva Books Pvt. Ltd., New Delhi, 2011.

5. ***Elements of Physical Chemistry***, B.R. Puri, L.R. Sharma, M.S. Pathania, 1st Edition, Vishal Publishing House, Jalandhar, India, 2013.

6. ***Quantum Chemistry***, John P. Lowe, Kirk A. Peterson, 3rd Edition, Academic Press, London, UK, 2009.

7. ***Quantum Chemistry***, Donald A. McQuarrie, 1st Indian Edition, Viva Books Pvt. Ltd., New Delhi, 2003.

8. ***Physical Chemistry***, N.B. Singh, S.S. Das, R.J. Singh, 2nd Edition, New Age International Publishers, New Delhi, 2007.

9. ***Atkins' Physical Chemistry***, Peter Atkins, 8th Edition, Jolio De Paula, International Student Edition, Osford University Press, New York, 2010.

10. ***Physical Chemistry***, Ira N Levine, 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.

11. ***Physical Chemistry,*** R. Stephen Berry, Stuart A. Rice, John Ross, 2nd Edition, Oxford University Press, New York, 2007.

12. ***Quantum Chemistry***, Ira N. Levine, 5th Edition, Pearson Education Pvt. Ltd., New Delhi, 2004.

13. ***Chemical Kinetics***, K.J. Laidler, 3rd Edition, Pearson Education Pvt. Ltd., New Delhi, 2004.

14. ***Electrochemistry – Principles and Applications,*** Porter

15. ***Electrochemistry,*** B.K. Sharma , Krishna Prakashan Media (p) Ltd, 1998.

16. ***Fundamentals of Molecular Spectroscopy***, Colin N. Banwell, Elaine M. McCash, 4th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.

17. ***Thermodynamics, Kinetic Theory, and Statistical Thermodynamics***, Francis W. Sears Gerhard L. Salinger, 3rd Edition, Narosa Publishing House, New Delhi, 1998.

18. ***An Introduction to Electrochemistry***, Samuel Glasstone, Litton Educational Publishing, Inc., New York, 2008.

19. ***Industrial Electrochemistry***, D. Pletcher and F.C. Walsh, Chapman and Hall, 2nd Edition, 1984.

20. ***Industrial Electrochemistry***, F. C. Walsh D. Pletcher, Kluwer Academic Pub, 2nd Edition, 1990.

M.Sc. Chemistry Practicals

I – SEMESTER

ChHCL-1.1: Inorganic Chemistry Practicals – I

COMPLEXOMETRIC TITRATIONS

1. Estimation of the amount of Calcium and Magnesium ions present in the given solution complexometrically by using EDTA solution.
2. Estimation of copper ions complexometrically using EDTA solution.
3. Estimation of Lead ions complexometrically using EDTA solution.
4. Estimation of Nickel ions complexometrically using EDTA solution.
5. Estimation of Zinc ions complexometrically using EDTA solution.
6. Estimation of mixtures of metal ions complexometrically using EDTA solution.

REDOX TITRATIONS

7. Estimation of the amount of Fe (II) and Fe (III) present in the given solution using $K_2Cr_2O_7$.
8. Estimation of the amount of Fe (II) and Fe (III) present in the given solution by using ceric ammonium sulphate solution.
9. Estimation of the amount of Fe (II) and Fe (III) present in the given solution by using Vanadium solution.

GRAVIMETRIC ESTIMATIONS

10. Estimation of copper as copper thiocyanate gravimetrically.
11. Estimation of Sulphate as Barium sulphate gravimetrically.
12. Estimation of Nickel as Nickel Dimethyl glyoximate gravimetrically.
13. Estimation of calcium as calcium phosphate gravimetrically.

REFERENCES:

1. Vogel's Textbook of Quantitative analysis, J Mendham, R.C. Denney, J.D. Barnes M.J.K. Thomas, 3rd, 4th , 5th and 6th edition.
2. College practical Chemistry, Ahulwalia
3. Analytical Chemistry,G.D. Christian.
4. Practical Inorganic Chemistry, K. Somashekara Rao.
5. Principles of Inorganic Chemistry, Puri, Sharma, Khalia.

ChHCL-1.2: Organic Chemistry Practicals – I

QUALITATIVE ANALYSIS

Systematic separation of organic binary mixtures using chemical and physical methods. At least eight experiments from the following combinations,

Acid + Phenol Phenol + Base Base + Neutral

Acid + Base Phenol + Neutral

Acid + neutral

REFERENCES:

1. **Advanced Practical Organic Chemistry**
   N K Vishnoi , Second edition, Vikas Publishing House Pvt. Ltd, 1996
2. **Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis**
   Renu Aggarwal, V. K. Ahluwalia, Universities press (India), 2001
3. **Systematic Laboratory Experiments in Organic Chemistry**
   Arun Sethi, New Age International, 2003.
4. **Comprehensive Practical Organic Chemistry: Qualitative Analysis**
   Ahluwalia V.K. Sunitha Dhingra, First edition, Orient Longman, 2004
5. **Practical Organic Chemistry: Qualitative Analysis**
   Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
6. **Vogel's Textbook of Practical Organic Chemistry**
   Brian S. Furniss, 5th Edition, Pearson India, 2005.
7. **Practical Organic Chemistry**
   F.G. Mann, B.C Saunders, Fourth edition , Pearson India,2009.

ChHCL-1.3: Physical Chemistry Practicals – I

1. Study on the effect of catalyst on the rate of reaction of acid catalyzed hydrolysis of an ester.
2. Conductometric titration of a strong acid v/s strong base.
3. Conductometric titration of a weak acid v/s strong base.
4. Conductometric titration of mixture of a strong acid + weak acid and strong base.
5. Potentiometric redox titration ($K_2Cr_2O_7$ v/s FAS).
6. Potentiometric redox titration ($KMnO_4$ v/s FAS).
7. Determination of pK_a value of weak electrolyte (acetic acid) by condctometric titration.
8. Determination of pK_a value of weak electrolyte (formic acid) by conductometric titration.
9. Determination of pKa value of weak electrolyte (acetic acid) by potentiometric titration.
10. Determination of pKa value of weak electrolyte (formic acid) by potentiometric titration.

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M.Sc. Chemistry Syllabus - 2015 (CBCS Scheme)
Revised Regulations -2010
II - SEMESTER
ChHC-2.1: ANALYTICAL CHEMISTRY - II

Total: 64 hrs

UNIT-1: MOLECULAR SYMMETRY AND GROUP THEORY 16 hrs

Introduction to symmetry: symmetry operations, symmetry elements – rotational axis of symmetry, plane of symmetry, rotation-reflection axis (improper rotational axis), center of symmetry (inversion centre), identity element, Cartesian coordinate system and symmetry elements, mathematical requirement for a point group.

Group theory: Concept of group, properties of group, Abelian and non-Abelian groups, definition of point groups, procedure for classification of molecules in to point groups, group multiplication tables (C_{2V} and C_{3V} point groups).

Matrix methods in symmetry: Definition and types of matrices, block-factorization of matrix, matrix representation of symmetry elements, matrix mathematics (addition, subtraction, multiplication, determinants, inverse and diagonalization of matrices), representation of symmetry operations as matrices, product of symmetry operations (in terms matrices), matrix representation of point groups (C_{2V} and C_{3V} point groups),

Character Tables: Reducible and irreducible representations, character of a representation, properties of irreducible representations, structure of character tables, construction of character tables (C_{2V}, C_{3V} and C_{4V} point groups), Mulliken symbols for irreducible representations, determination of symmetry species for translations and rotations (C_{2V} and C_{2h}), the standard reduction formula (C_{2V} and C_{3V}).

Symmetry of normal modes of molecules: Cartesian coordinate method and internal coordinate method (molecules belong to C_{2V} and C_{3V} point groups), Infrared and Raman activity of molecules belong to C_{2V} (H_2O, ClF_3, *cis*-N_2F_2) and C_{3V} (NH_3) point groups.

UNIT-II: ELECTRONIC SPECTROSCOPY 16 hrs

Introduction: Electromagnetic radiation, electromagnetic spectrum, nature and interaction of electromagnetic radiation with matter, types of molecular spectra, selection rules, characteristic features for absorption or emission of electromagnetic radiation, band width, factors contributing

to the band width, Doppler broadening, intensity of spectral lines and transition probability, factors influencing positions and intensity of spectral lines, energy dissipation from excited states.

Electronic Spectroscopy: Energy levels, molecular orbitals, theory of electronic spectroscopy, Frank-Condon principle, transition probability, types of transitions, types of absorption bands, solvent effect on electronic transitions, electronic spectra of polyatomic molecules, chromophore and auxochrome, Woodward-Fischer rules for calculating absorption maximum, calculation of absorption maximum in conjugated dienes, trienes, polyenes, poly-ynes, eneynes, α,β-unsaturated carbonyl compounds, benzene and substituted benzenes, other aromatic hydrocarbons, heterocyclic systems. Stereochemical factors in electronic spectroscopy – biphenyls and binaphthyls, *cis*- and *trans*-isomers. Angular distortion and cross-conjugation, steric inhibition of resonance. Instrumentation for electronic spectroscopy.

UNIT-III: INFRARED SPECTROSCOPY AND RAMAN SPECTROSCOPY 16 hrs

Vibrational motion of a diatomic molecule, force constant and bond strengths, vibration-rotation spectroscopy, characteristic features.

Infrared (IR) spectroscopy: Origin of IR spectrum, IR regions (finger print and group frequency regions), normal modes of molecular vibrations, factors influencing vibrational frequencies (physical states of the sample, vibrational coupling, electrical effect, inductive effects, hydrogen bonding and ring structure), metal-ligand vibrations, instrumentation – FTIR, sampling handling techniques, interpretation and examination of IR spectrum, group frequencies of - alkanes, alkenes, alkynes, aromatic hydrocarbons, alcohols, phenols, aldehydes, ketones, carboxylic acids, acid halides, acid anhydrides, acid amides, amino acids, amines, isocyanates, thiocyanites, esters, lactones, ethers, epoxides, peroxides, nitro and nitroso groups, heteroarmatic compounds, sulphur and silicone compounds, applications of IR spectroscopy.
Raman spectroscopy: Introduction, quantum mechanical theory of Raman effect (Rayleigh scattering, Raman scattering - Stokes and Anti-Stokes lines), classical theory of Raman effect, rotational and vibrational Raman spectra, rule of mutual exclusion, instrumentation, Raman effect in solids, liquids and gases, applications of Raman spectroscopy (Inorganic, Organic, Physical and Polymer chemistry), Resonance Raman Spectroscopy (RRS) and its applications,

Resonance Raman Effect (RRE), non-linear Raman effects, Coherent Anti-Stokes Raman Scattering (CARS) and its applications. Comparison between IR and Raman spectroscopy.

UNIT-IV: NMR SPECTROSCOPY AND MASS SPECTROMETRY 16 hrs

^{1}H NMR spectroscopy: Introduction, nuclear spin states, nuclear magnetic moments, absorption of energy, mechanism of absorption, population densities of nuclear spin states, the chemical shift and shielding. Chemical equivalence, integrals and integration, chemical environment and chemical shift, local diamagnetic shielding (effects of electronegativity, hybridization, acidic and exchangeable protons, hydrogen bonding), magnetic anisotropy, spin-spin splitting, (n+1) rule, Pascal's triangle, the coupling constant, mechanism of coupling (one-bond, two-bond, three-bond and log-range coupling), comparison of NMR spectra at low and high field strengths, Instrumentation for NMR Spectroscopy. Typical ^{1}H NMR absorption of - alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, amines, nitriles, aldehydes, ketones, esters, carboxylic acid and amide compounds.

Exchange in H_2O and D_2O (acid/water and alcohol/water mixtures, deuterium exchange, peak broadening due to exchange), tautomerism, protons on nitrogen – quadrupole broadening and decoupling, effect of solvent on chemical shift, chemical shift reagents (High-field spectra), chiral resolving agents, spin decoupling methods (double resonance), NOE difference spectra.

Advanced NMR spectroscopy: Pulse sequences, pulse widths, spins, magnetization vectors, DEPT experiment, determining number of attached hydrogens (methine, methylene, methyl, quaternary carbons), introduction to 2D-NMR, an overview of the COSY technique and how to read COSY spectra, an overview of the HETCOR technique and how to read HETCOR spectra, an overview of Magnetic Resonance Imaging (MRI), some sample ^{1}H NMR spectra.

Carbon-13 NMR:

The Caron-13 nucleus, ^{13}C chemical shifts – correlation charts, calculation of chemical shifts, proton-coupled ^{13}C spectra, spin-spin splitting of Carbon-13 signals, proton-decoupled ^{13}C spectra, Nuclear Overhauser Enhancement (NOE), cross polarization – origin of Nuclear Overhauser effect, problems with integration in ^{13}C spectra, molecular relaxation processes, off-resonance decoupling, Carbon-13 NMR solvents, heteronuclear coupling of carbon to Deuterium, ^{19}F and ^{31}P, some sample Carbon-13 NMR spectra.

Mass spectrometry: Basic theory, instrumentation-Mass spectrometer, methods of generation of positively charged ions, mass analyzers, resolving power, molecular ion peak, base peak, meta-stable peak, modes of fragmentations, McLafferty rearrangement, Retro Diels-Alder reaction, ortho effect, determination of molecular formulas (precise-mass determination, isotope ratio data), nitrogen rule, some fragmentation patterns of – alkanes, cycloalkanes, alkenes, alkynes, aromatic hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, nitrogen and sulphur compounds and alkyl halides, some sample mass spectra. An overview of MALDI technique.

REFERENCES:

1. ***Vogel's Textbook of Quantitative Chemical Analysis***, J. Mendham, R.C. Denney, J.D. Barnes, M. Thomas, B. Sivasankar, 6th Edition, Pearson Education, New Delhi, India, 2012.
2. ***Principles of Instrumental Analysis***, D.A. Skoog, E.J. Holler, T.A. Nieman, 5th Edition, Thomson Aisa Pvt. Ltd., Singapore, 2004.
3. ***Instrumental methods of Chemical Analysis (covering UGC Syllabus),*** H. Kaur, Pragathi Prakashan, New Delhi, India
4. ***Quantitative Chemical Analysis,*** Daniel C. Harris, 6th Edition, W.H. Freeman and Company, New York, USA, 2003.
5. ***Fundamentals of Analytical Chemistry***, D.A. Skoog, D.M. West, E.J. Holler, S.R. Crouch, 8th Edition, Thomson Aisa Pvt. Ltd., Singapore, 2004.
6. ***Introduction to Spectroscopy,*** D.L. Pavia, G.M. Lampman, G.S. Kriz, 3rd Edition, Cengage Learning India Pvt. Ltd., New Delhi, 2008.
7. ***Spectrometric Identification of Organic Compounds,*** R.M. Silverstein, F.X. Webster, 6th Edition, Wiley Student Edition, New Delhi, India, 2007.
8. ***Applications of Absorption Spectroscopy of Organic Compounds***, John R. Dyer, Prentice-Hall of India Pvt. Ltd., New Delhi, India, 2007.
9. ***Instrumental Analysis***, D.A. Skoog, E.J. Holler, S.R. Crouch, 11th Indian Reprint, Cengage Learning India Pvt. Ltd., New Delhi, 2012.
10. ***Molecular Structure and Spectroscopy***, G. Aruldhas, 2nd Edition, Prentice-Hall of India Pvt. Ltd., New Delhi, India, 2007.
11. ***Symmetry and Spectroscopy of Molecules,*** K. Veera Reddy, New Age International Pvt. Ltd., New Delhi, India, 1998.
12. ***Analytical Chemistry – Theory and Practice,***, R.M. Verma, 3rd Edition, CBS Publishers and Distributors, New Delhi, India, 2007.
13. ***Vibrational Spectroscopy – Theory and Applications***, D.N. Sathyanarayana, New Age International Publishers, New Delhi, India, 2004.

14. ***Organic Spectroscopy***, William Kemp, 3rd Edition, Palgrave, New York, USA, 2004.

15. ***Basic Atomic and Molecular Spectroscopy***, J. Michael Hollas, Royal Society of Chemistry, Cambridge, UK, 2002.

16. ***Quantitative Analysis,*** Day and Underwood, Prentice/Hall Pvt. Ltd. 6th Edition (1993).

17. ***Vogel's text Book of Quantitative Chemical Analysis,*** Revised by G.H. Jaffery, J. Bassett, J. Mendhrn and R.C. Denny, ELBS 5th Edition (1998).

18. ***Analytical Chemistry,*** Gray D. Christian, 5th Edition, John Wiley and Sons, Inc

19. ***Introduction to Chromatography- Theory and Practice,*** V.K. Srivatsan and K.K. Srivatsan, S. Chand Company Ltd. 4th Edition (1991).

20. ***Instrumental Methods of Analysis***-Willard, Merrit and Dean, 7th Edition, (1998).

21. Instrumental Methods of Chemical Analysis-B.K. Sharma, Goel Publishing House. Meerut, (2000).

ChHC-2.2: INORGANIC CHEMISTRY - II

Total: 64 hrs

UNIT-I: 16hrs

d-Block elements: Electronic configuration, general characteristics and correlation with electronic configuration; comparative study of 3d, 4d and 5d elements by taking titanium sub-group as example.

f-Block elements: Position in the periodic table, f-orbitals and their symmetry aspects. Lanthanides-electronic configuration, oxidation states, lanthanide contraction; extraction of a mixture of lanthanides from monazite sand, difficulties in separation; separation of lanthanides-ion-exchange chromatographic methods: complex formation-coordination number and stereochemistry, colour, spectra and magnetic properties; comparison with d-block elements: Lanthanum compounds – lanthanum oxide, chloride, bromide, iodide, sulphate, nitrate and carbonate; anthanides as shift reagents.

Actinides-electronic configuration, oxidation states, extraction and separation of actinides; spectral and magnetic properties, complexes; comparison with lanthanides and d-block elements. Trans-uranium elements, further extension of P.T.: super heavy elements (SHE).

UNIT-II: COORDINATION CHEMISTRY-I 16 hrs

Introduction, types of ligands- monodentate, chelating, bridging and macrocyclic ligands, nomenclature of Coordination chemistry.

Preparation of coordination compounds: direct reactions, ligand substitution, oxidation, reduction, photochemical, thermal decomposition, template synthesis and trans effect methods.

Detection of complexation- colour change, conduction, pH, solubility change, precipitate formation, IR Spectra and magnetic methods.

Isomerism in metal complexes: Structural Isomers – ionization, coordination, linkage, solvate (hydrate) and ligand isomers. Stereoisomers- geometrical (cis-trans) and optical isomers of complexes with C.N. 4 and 6. Identification of isomeric metal complexes: conductance method, cryoscopy, IR spectroscopy, X-ray diffraction, Dipole moment, NMR spectroscopy, chemical methods.

UNIT-III **16hrs**

Stability of coordination complexes : thermodynamic and kinetic stability; stability constants (formation constants) -stepwise (K_n) and overall stability (β_n)constants, trends in stepwise stability constants(K_n), relation between K_n and β_n. Factors affecting stability of complexes- metal ion, ligand, chelate effect, macrocyclic effect, geometry, role of hardness and softness; Irving – William Series.

Determination of composition: Jobs method, mole ratio method, slope ratio method. Determination of stability constants: spectrophotometric method, pHmetric (Bjerrums) method and polarographic method.

Bonding in metal complexes: Valence bond theory -basic concepts; explanation of geometry and magnetic properties; limitations.

UNIT- IV: **16hrs**

Bonding in metal complexes:

Crystal Field Theory (CFT): Salient features of CFT, d-orbital splitting in octahedral, tetrahedral and square planar complexes, crystal field splitting, Δ; factors affecting Δ- nature of ligand, nature of metal ion, size of d-orbitals, geometry of complexes; high spin and low spin complexes; crystal field stabilization energy (CFSE); explanation of colour and magnetic properties of complexes.

Crystal field effects on ionic radii, lattice energy, heat of ligation (hydration), site preference- octahedral vs tetrahedral; structure of spinels; Jahn-Teller distortion and its effects.

Limitations of CFT.

MOT of metal complexes:

Evidences for covalency in metal-ligand bond: Lande's splitting factor, ESR, NMR and NQR spectral evidences, Nephelauxetic effect.

MOT of octahedral and tetrahedral metal complexes with σ- and π-ligands, MO diagrams for σ- and π-complexes,

REFERENCES:

1. ***Inorganic Chemistry – Principles of Structure and Reactivity***, James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, 4th Edition, Pearson Education, Indian Edition, New Delhi, India, 2013.
2. ***Inorganic Chemistry,*** Peter Atkins,Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong, 5th Edition, Oxford University Press, UK, 2013.
3. ***Inorganic Chemistry – Principles of Structure and Reactivity***, James E. Huheey, Ellen A. Keiter, Richard L. Keiter, 4th Edition, Pearson, Indian Edition, New Delhi, India, 2004.
4. ***Inorganic Chemistry,*** Gary L. Miessler, Donald A. Tarr, 3rd Edition, Pearson Education, New Delhi, India, 2004.
5. ***Inorganic Chemistry,*** Keith F. Purcell, John C. Kotz, First Indian Reprint, Cengage Learning India Pvt. Ltd., New Delhi, India 2010.
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8. ***Principles of Inroganic Chemistry (UGC Syllabus)***, B.R. Puri, L.R. Sharma, K.C. Kalia, Milestone Publishers, New Delhi, India, 2008.
9. ***Inorganic Chemistry,*** James E. House, First Indian Reprint, Academic Press, USA, 2010.
10. ***Basic Concepts of Inorganic Chemistry,*** D.N. Singh, Pearson Education, New Delhi, 2010.
11. ***Advance Inorganic Chemistry,*** F. Albert Cotton, Geoffrey, Wilkinson, Carlos A. Murillo, Manfred Bochmann, 6th Edition, Wiley Student Edition, John Wiley and Sons, INC, New York, 2004.
12. ***Vogel's Qualitative Inorganic Analysis,*** 7th Edition, G. Svehla, Pearson Education, New Delhi, 1996.

ChHC-2.3: ORGANIC CHEMISTRY - II

Total: 64 hrs

UNIT-I: MOLECULAR REARRANGEMENTS 16 hrs

General mechanistic treatment of nucleophilic, electrophilic and free-radical rearrangements.

Rearrangements reactions involving migration to electron deficient Carbon: Wagner-Meerwein rearrangement, hydride shift (1,2-hydride shift, long range hydride shift), pinacol-pinacolone rearrangement, dienone-phenol rearrangement, acid catalyzed isomerization of aromatic hydrocarbons, benzil-benzilic rearrangement, rearrangements involving diazomethane and alkanes, Wolf rearrangement, migration of hetero atoms, rearrangement of aryl hydroxylamines (Bamberger reaaarngement).

Rearrangements reactions involving migration to electron rich Carbon: Favorskii, Sommlet-Hauser, Neber, Stevens and Wittig rearrangements.

Rearrangements reactions involving migration to electron deficient Nitrogen: Hoffmann, Curtius, Schmidt, Lossen and Beckmann rearrangement.

Rearrangements reactions involving migration to electron deficient Oxygen: Bayer-Villiger oxidation, hydroperoxide rearrangement and Dakin rearrangement.

AROMATIC REARRANGEMENTS: Migration around the aromatic nucleus – migration of alkyl groups and halogens. Migration of group from the side chain to the nucleus – rearrangement of aniline derivatives (N-haloacetanilides, Hofmann-Martius rearrangement, phenylhydroxylamine, diazoamino compounds, N-nitroanilines, N-nitosoanilines). Rearrangements involving migration from oxygen to aromatic ring – phenolic ethers, Fries, Claisen rearrangements.

UNIT-II: PHOTOCHEMISTRY AND PERICYCLIC REACTIONS 16 hrs

Photochemistry: Bonding and antibonding orbitals, singlet and triple states, modes of energy transfers from the excited states- Jablonski diagram. Photoaddition: alkenes to carbonyl compounds (Paterno-Buchi reaction), alkenes and alkynes to aromatic compounds, photodimerization of alkenes, conjugated dienes and aromatic compounds.

Photorearrangements: cis-trans isomerization (stilbenes), intramolecular photocyclization (conjugated dienes, 1,4-dienes, cage compounds), photoisomerization of benzenoid compounds, cyclohexadienones, photoreductions of ketones.

Photooxidation: Formation of peroxy compounds, oxidative coupling of aromatic compounds.

Photochemical fragmentation: Photolysis of carbonyl compounds (Norrish type-I and Norrish type-II reactions), photolysis of diazoalkanes and alkyl azides, di-pi-methane rearrangement, photochemistry of arenes.

Pericyclic reactions: Introduction, frontier molecular orbitals, formation and properties of molecular orbitals, molecular orbitals of ethene, 1,3-butadiene, 1,3,5-hexatriene, allyl and pentadienyl system. Electrocyclic reactions – FMO approach for electrocyclic reactions, cyclization of 4n system, ring opening of $[\sigma^2 + \pi^2]$ system. Cyclization of [4n+2] system, ring opening of $[\pi^4 + \sigma^2]$ system. Woodward-Hofmann rule for electrocyclic reactions. [4+2] cycloaddition reaction (Diels-Alder reaction), FMO approach for [4 + 2] cycloaddition reaction, intramolecular Diels-Alder reaction. [2 + 2] cycloadditions – thermal and photochemical cycloadditions. Chelotropic reactions (exclusion reactions). Sigmatropic rearrangements – nomenclature, suprafacial and antrafacial processes, FMO approach for sigmatropic shift of hydrogen or carbon group, Ene reaction.

UNIT-III: HETEROCYCLIC COMPOUNDS **16 hrs**

Heterocyclic compounds: Nomenclature, synthesis and reactivity (towards electrophilic and nucleophilic reactions) – Pyrroles, Furans, Thiophenes, Pyridines, Azepines, Oxepins, Thiepins, Indoles, Benzofuran, Benzothiphene, Quinolines, Isoquinolines, Pyrazoles, Imidazoles, Isoxazoles, Oxazoles, Thiazoles, Pyridazines, Pyrimidines, Purine, Xanthine, Caffeine and Uric acid. Crown ethers and cryptands.

Mesoinonic compounds: Nomenclature, synthesis and applications of Sydnones, Oxadiazolium and Thiadiazolium compounds.

UNIT-IV: CHEMISTRY OF NATURAL PRODUCTS -I **16 hrs**

Carbohydrates: Classification of carbohydrates, D,L-notations, configuration of aldoses and ketoses, redox reactions of monosaccharides, osazone formation, chain elongation (Kiliani-

Fischer synthesis), chain shortening (Ruff degradation), cyclic structure of monosaccharides (hemiacetal formartion), stability of glucose, acylation and alkylation of monosaccharides, formation of glycosides, anomeric effect, reducing and non-reducing sugars. Disaccharides – cellobiose, maltose and lactose, structural elucidation of cellulose, starch (amylose and amylopectin) and glycogen, chitin – structure and applications.

Amino acids: Classification and nomenclature of amino acids, general properties of amino acids, configuration of amino acids, separation of amino acids – electrophoresis, paper, thin layer, ion-exchange chromatography. Resolution of racemic mixtures of amino acids. General methods of synthesis of amino acids – Amination of α-haloacids, Gabriel's phthalimide synthesis, Strecker synthesis, Malonic ester synthesis, Darapsky synthesis, Azlactone synthesis.

Peptides and proteins: Structure and nomenclature of peptides and proteins, automated solid phase peptide synthesis (Bruce-Merrifield synthesis), cleavage of disulphide linkages, determination of amino acid composition, sequencing the peptide from N-terminus (Edman degradation) and C-terminus, determination of structure of proteins (primary, secondary and tertiary structures), some biologically important proteins (Oxytocin, Insulin, Thyrotropin Releasing Hormone and Antamanide).

Nucleic acids: Classification of nucleic acids, structure of nucleosides, nucleotides and nucleic acids, nucleosides containing pyrimidine and purine bases, sequence of nucleic acids, Crick-Watson model of DNA, structure of RNA (m-RNA, t-RNA and r-RNA), genetic code – salient feautures.

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2. ***Organic Chemistry – Solution Mannual***, S. Warren, Oxford University Press, UK, 2009.
3. ***Advanced Organic Chemistry, Part-A:Structure and Mechanisms,*** 5th Edition, Francis A. Carey, Richard J. Sundberg, Springer, New York, 2007.
4. ***Principles of Organic Synthesis***, R.O.C. Norman, J.M. Coxon, 3rd Edition (First Indian Reprint), Nelson Thrones, UK, 2003.
5. ***Advance Organic Chemistry – Reactions, mechanisms and structure***, Jerry March, 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2008.
6. ***Organic Reaction Mechanisms,*** V.K. Ahluwalia, R.K. Parashar, 3rd Edition, Narosa Publishing House, New Delhi, 2009.

7. ***Pathway to Organic Chemistry – Structure and Mechanism***, P. Bhattacharjee, Arunabha Sen Books and Allied Pvt. Ltd., Kolkta, India, 2012.

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9. ***Organic Chemistry (As per UGC Syllabus),*** S.M. Mukherji, S.P Singh, R.P. Kapoor, R. Dass, Vol. I, New Age International Pvt. Ltd., New Delhi, 2010.

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11. ***Organic Reactions and their Mechanisms,*** P.S. Kalsi, 2nd Edition, New Age International Pvt. Ltd., New Delhi, 2007.

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24. ***Organic Chemistry,*** I.L. Finar, 5th Edition (Volume-2), Pearson Education, New Delhi, India, 2009.

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26. O***rganic Chemistry of Natural products***, Gurudeep R. Chatwal, (Edited by M. Arora), Vol. 2, Himalaya Publishing House, Mumbai, India, 2008.

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28. ***Organic Chemistry – Natural Products***, O.P. Agarwal, Vol. II, GOEL Publishing House, Meerut, India, 2004.

29. ***Organic Name Reactions***, Goutam Brahmachari, 5th Revised Edition, NarosaPublishing House, New Delhi, India, 2012.

30. ***Name Reactions***, Jie Jack Li, 4th Edition, Sringer (India) Pvt. Ltd. New Delhi, India, 2012.

ChHC-2.4: PHYSICAL CHEMISTRY - II

Total: 64 hrs

UNIT-I: QUANTUM MECHANICS - I **16 hrs**

A brief resume of black body radiation, Classical and Max Plank quantum theories, Photoelectric effect, Compton effects, vibration of atoms in crystals, hydrogen atomic spectrum, Rydberg formula. Bohr-hydrogen atom model, wave particle duality and de-Broglie's hypothesis, uncertainty principle – uncertainty of energy and time, theory of wave motion – classical waves and wave equation, stationary waves and nodes. Particle wave – the Schrödinger equation (one-dimensional time-dependant), the wave function and its physical meaning, condition for acceptable wave function, conditions of normalization and orthogonality.

Operators - Algebraba of operators, commumutative property, linear operator, commutative operator. Eigen values and Eigen functions - Hamiltonian property of operators, Postulates of quantum mechanics, some typical theorems relating to basic postulates. Free particle system – position, momentum and uncertainty relations, energy of the particle, motion in three dimensions, formulation of Schrödinger's equation (application to particle in one- and three-dimensional boxes). Particle in a box – infinite potential barriers, one dimensional box, three dimensional box, particle with finite potential barrier of definite thickness, the quantum mechanical tunneling.

UNIT-II: MOLECULAR SPECTROSCOPY **16 hrs**

The electromagnetic spectrum, interaction of electromagnetic radiation with matter. Quantization of different forms of energy (transnational, rotational, vibrational and electronic), conditions of resonance and energy of absorption for various types of spectra, width and intensity of spectral lines (Doppler broadening and selection rules). The theoretical treatment of rotation, (rigid and non-rigid rotator models), linear poly-atomic molecules. Determination of bond lengths. Isotopic effect on rotation spectra. Vibrational spectra of diatomic molecules, linear harmonic oscillator model. The anharmonic vibrations, Morse potential and potential energy surfaces, fundamental vibration-frequencies, overtones and hot bands, degree of freedom of polyatomic molecules. Vibration-rotation spectra of diatomic and linear polyatomic molecules, PQR branches.

UNIT-III: RADIATION AND PHOTOCHEMISTRY **16 hrs**

Photochemistry: Photophysical processes, A review of laws of photochemistry (Beer-Lambert law, Grotthus-Draper law, Bunsen and Roscoe law, Stark-Einstein law and Platnikow law). Quantum yield and its determination. Actinometers (Bunsen and Roscoe's actinometer, Eder's actinometer, Uranyl Oxalate actinometer, Malachite Green Leucocyanide actinometer, Ferrioxalate actinometer and Reinecke's salt actinometer), photo properties, fluorescence, phosphorescence, chemiluminescence and electrochemilumiscence. Stem-Volmer equation, Lasers in photochemical studies, photo-electrochemistry, solar energy conversion and storage.

Radiation chemistry: Interaction of radiation with matter, method of losing energy and common units, dosimetry (terms and units, chemical dosimeters - Fricke and Ceric sulphate dosimeters). Radiation chemistry of gases, water, aqueous solution and solids. Biological effects of radiation. Safety measures against radiation hazards.

UNIT-IV: POLYMER CHEMISTRY **16 hrs**

Types of polymer (linear, branched, cross linked and copolymer with example - a qualitative account). Molecular weight distributions: number average and weight-average molecular weight. Thermoplastics and thermosets, fibers and plastics (only qualitative account). Determination of average molecular weight – end group analysis, viscosity method, ultra-centrifugation method, osmotic pressure method [derivation of equations not necessary], sedimentation velocity method, turbidity method and light scattering method [Zimm plot]. Kinetics of polymerization-condensation and step-growth polymerization, kinetics of free radical polymerization, chain transfer reactions, anionic polymerization, co-polymerization. Polydispersivity.

Analysis and testing of polymers, chemical analysis of polymers, spectroscopy method, X-ray diffraction study, microscopy and thermal analysis. Physical testing: tensile strength, fatigue, impact tear resistance hardness and abrasion resistance. Properties of commercial polymers-fire retarding polymers-electrically conducting polymers, biomedical polymers, polymer blends, alloys and composites. Polymer additives (Fillers, Plasticizers, Antioxidants, Colourants, Flame Retardants, Stabilizers) and compounding.

REFFERENCES:

1. ***Quantum Chemistry***, R.K. Prasad, 4th Edition, New Age International Publishers, New Delhi, 2010.
2. ***Polymer Chemistry,*** Malcolm P. Stevans, First Indian Edition, Oxford University Press, New York, 2008.

3. ***Quantum Mechanics for Chemists***, David O. Hayward, The Royal Society of Chemistry, UK, 2002.

4. ***Principles of Physical Chemistry***, B.R. Puri, L.R. Sharma, M.S. Pathania, 45th Edition, Vishal Publishing House, Jalandhar, India, 2012.

5. ***Physical Chemistry – A Molecular Approach***, Donald A. McQuarrie, John D. Simon, 3rd Edition (Viva Student Edition), Viva Books Pvt. Ltd., New Delhi, 2011.

6. ***Elements of Physical Chemistry***, B.R. Puri, L.R. Sharma, M.S. Pathania, 1st Edition, Vishal Publishing House, Jalandhar, India, 2013.

7. ***Quantum Chemistry***, John P. Lowe, Kirk A. Peterson, 3rd Edition, Academic Press, London, UK, 2009.

8. ***Quantum Chemistry***, Donald A. McQuarrie, 1st Indian Edition, Viva Books Pvt. Ltd., New Delhi, 2003.

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17. ***Polymer Science – A Textbook***, V.K. Ahluwalia, Anuradha Mishra, Ane Books India, Noida, 2008.

18. ***Thermodynamics, Kinetic Theory, and Statistical Thermodynamics***, Francis W. Sears Gerhard L. Salinger, 3rd Edition, Narosa Publishing House, New Delhi, 1998.

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M.Sc. Chemistry Practicals

II – SEMESTER

ChHCL-2.1: Inorganic Chemistry Practicals – II

ORE ANALYSIS

1. Estimation of calcium carbonate in limestone by oxalate method.
2. Estimation of amount of iron present in hematite ore.
3. Estimation of Mno_2 present in the given pyrolusite ore.
4. Estimation of amount of nitrite present in sodium nitrite ore solution.
5. Estimation of amount of copper present in gypsum ore.
6. Estimation of amount of chromium present in chromite ore.

ESTMATIONS

7. Estimation of amount of available chlorine in bleaching powder.
8. Estimation of amount of copper present in $CuSo_4$ solution.
9. Separation and estimation of Copper and Iron in a solution mixture.
10. Separation and estimation of Nickel and Iron in a solution mixture.
11. Estimation of Ascorbic acid.
12. Estimation of Chlorate in potassium chlorate solution.

REFERENCES:

1. Vogel's Textbook of Quantitative analysis, J Mendham, R.C. Denney, J.D. Barnes M.J.K. Thomas, 3rd, 4th , 5th and 6th edition.
2. College practical Chemistry, Ahulwalia
3. Analytical Chemistry,G.D. Christian.
4. Practical Inorganic Chemistry, K. Somashekara Rao.
5. Principles of Inorganic Chemistry, Puri, Sharma, Khalia.

ChHCL-2.2: Organic Chemistry Practicals – II

I. ONE STEP PREPARATIONS:

At least six preparations have to be carried out involving following types of reactions.

1. Substitution reactions
2. Oxidation reactions
3. Named reactions

II. ESTIMATIONS:

1. Estimation of glucose by titration
2. Estimation of ascorbic acid by titration
3. Estimation of hydroxyl group by titration
4. Estimation of amino group by titration
5. Saponification value of oils by titration

   Estimation of ester group by titration

REFERENCES:

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   N K Vishnoi , Second edition, Vikas Publishing House Pvt. Ltd, 1996
2. **Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis**
   Renu Aggarwal, V. K. Ahluwalia, Universities press (India), 2001
3. **Systematic Laboratory Experiments in Organic Chemistry**
   Arun Sethi, New Age International, 2003.
4. **Comprehensive Practical Organic Chemistry: Qualitative Analysis**
   Ahluwalia V.K. Sunitha Dhingra, First edition, Orient Longman, 2004
5. **Practical Organic Chemistry: Qualitative Analysis**
   Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
6. **Vogel's Textbook of Practical Organic Chemistry**
   Brian S. Furniss, 5th Edition, Pearson India, 2005.
7. **Practical Organic Chemistry**
   F.G. Mann, B.C Saunders, Fourth edition , Pearson India,2009.

ChHCL-2.3: Physical Chemistry Practicals – II

1. Determination of mean ionic activity co-efficient of weak acid (formic acid).
2. Determination of mean ionic activity co-efficient of weak acid (acetic acid).
3. Determination of pK_a value of polybasic acid by potentiometric titration.
4. pH titration of HCl v/s NaOH.
5. pH titration of CH_3COOH v/s NaOH.
6. pH titration $CuSO_4$ v/s NaOH.
7. Determination of equivalent conductance at infinite dilution for strong electrolyte (KCl).
8. Determination of equivalent conductance at infinite dilution for strong electrolyte (NaCl).
9. Determination of strength of $ZnSO_4$ solution using $BaCl_2$ solution conductometrically.
10. Determination of strength of $NiSO_4$ solution using $BaCl_2$ solution conductometrically.
11. Partial molar volume of ethanol-water system.
12. Colorimetric estimation ($K_2Cr_2O_7$).
13. Colorimetric estimation ($KMnO_4$).
14. Colorimetric estimation ($CuSO_4$).

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M.Sc. Chemistry Syllabus - 2015 (CBCS Scheme)
Revised Regulations -2010
III - SEMESTER
ChSC-3.1: ANALYTICAL CHEMISTRY – III

Total: 48hrs

UNIT-I: FES, AAS, AES, MOLECULAR LUMINESCENCE SPECTROSCOPY 16 hrs

Flame emission spectroscopy (FES): Basic principles, flames and flame temperatures, excitation profiles and chemical reactions in flame, spectra of metals in flame, instrumentation (single beam and double beam), evaluation methods in flame photometry, factors affecting intensity of emitted radiation, interferences, background correction methods, applications, flame emission experiments, limitations of FES.

Atomic absorption spectroscopy (AAS): Basic principles, absorption of radiation energy by atoms, instrumentation (single beam and double beam), detection limits, interferences, advantages of AAS over FES, some typical AAS determinations.

Atomic emission spectroscopy (AES): Basic principles, advantages and disadvantages of AES, origin of spectra, instrumentation, measurement of light intensity, applications.

Molecular luminescence spectroscopy: Basic principles of fluorescence and phosphorescence, excitation and deactivation processes (energy level diagram), factors affecting fluorescence and phosphorescence, quenching of fluorescence, fluorescence (or phosphorescence) intensity, fluorescence and chemical structure, instrumentation for fluorimetry and phosphorimetry, application of fluorimetry and phosphorimetry, fluorescent indicators, comparison between fluorimetry and phosphorimetry, chemiluminescence.

UNIT-II: ESR, MOSSBAUER, NQR SPECTROSCOPY 16 hrs

Electron spin resonance (ESR) spectroscopy: Basic principles, instrumentation, experimental technique, FTESRS, double resonance spectrometers, ENDOR and ELDOR, interpretation of derivative curve in an ESR spectrum, ESR spectra of DPPH, intensity of ESR lines, g-value, factors affecting ESR lines, hyperfine interaction, Fermi (or contact or isotopic) hyperfine interaction, hyperfine splitting constant, anisotropic hyperfine interaction, Zero-field splitting and Kramer's degeneracy, Spin-Hamiltonian, spin densities and McConnell relationship,

applications of ESR, ESR spectra of free-radical containing a single set of equivalent protons (methyl, p-benzoquine anion, cyclopentadienyl, benzene, cycloheptatrienyl anions), study of transition metal complexes, biological applications of ESR, spin labeling ESR spectroscopy.

Mossbauer spectroscopy: Basic principles, Mossbauer nuclides, spectral parameters required for evaluating Mossbauer spectra, isomer shift, quadrupole interactions, magnetic interactions (time and temperature dependent effect), instrumentation, Lamb Mossbauer factor, application – bonding in Fe-complexes, study of Sn compounds, structure determination, biological applications.

Nuclear quadrupole resonance (NQR) spectroscopy: Quadrupole nuclei, quadrupole moment, electric field gradient and coupling constant, theory of NQR, splitting in NQR spectra, Zeeman effect, instrumentation, applications, interpretation of eQq data, effect of crystal lattice on the magnitude of eQq, structural information from NQR spectra.

UNIT-III: STRUCTURAL ELUCIDATION OF ORGANIC COMPOUNDS 16 hrs

Introduction, basic steps involved in the structure elucidation of organic compounds (molecular formula, molecular weight, elements present, H-index, DBE, presence of nitrogens, presence of chromophore and auxochrome, functional groups, chemical shift values, coupling constants, fragmentation patterns – base peak, molecular ion peak).

Structure elucidation of – hydrocarbons (normal, branched-chain and cyclo alkanes, alkenes, alkynes), aromatic hydrocarbons, polynuclear aromatic hydrocarbons, alcohols, phenols, esters, epoxides, peroxides, ketones, aldehydes, carboxylic acids, lactones, acid halides, acid anhydrides, amides, lactams, amines, nitriles, isonitriles, azo compounds, nitro compounds, sulphur compounds, halogen compounds, silicon compounds, phosphorous compounds, heteroaromatic compounds (at least one compound has to be studied under each category).

REFERENCES:

1. ***Vogel's Textbook of Quantitative Chemical Analysis***, J. Mendham, R.C. Denney, J.D. Barnes, M. Thomas, B. Sivasankar, 6th Edition, Pearson Education, New Delhi, India, 2012.
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3. ***Instrumental methods of Chemical Analysis (covering UGC Syllabus),*** H. Kaur, Pragathi Prakashan, New Delhi, India

4. ***Quantitative Chemical Analysis,*** Daniel C. Harris, 6th Edition, W.H. Freeman and Company, New York, USA, 2003.

5. ***Fundamentals of Analytical Chemistry***, D.A. Skoog, D.M. West, E.J. Holler, S.R. Crouch, 8th Edition, Thomson Aisa Pvt. Ltd., Singapore, 2004.

6. ***Introduction to Spectroscopy,*** D.L. Pavia, G.M. Lampman, G.S. Kriz, 3rd Edition, Cengage Learning India Pvt. Ltd., New Delhi, 2008.

7. ***Spectrometric Identification of Organic Compounds,*** R.M. Silverstein, F.X. Webster, 6th Edition, Wiley Student Edition, New Delhi, India, 2007.

8. ***Applications of Absorption Spectroscopy of Organic Compounds***, John R. Dyer, Prentice-Hall of India Pvt. Ltd., New Delhi, India, 2007.

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10. ***Molecular Structure and Spectroscopy***, G. Aruldhas, 2nd Edition, Prentice-Hall of India Pvt. Ltd., New Delhi, India, 2007.

11. ***Symmetry and Spectroscopy of Molecules,*** K. Veera Reddy, New Age International Pvt. Ltd., New Delhi, India, 1998.

12. ***Analytical Chemistry – Theory and Practice,***, R.M. Verma, 3rd Edition, CBS Publishers and Distributors, New Delhi, India, 2007.

13. ***Vibrational Spectroscopy – Theory and Applications***, D.N. Sathyanarayana, New Age International Publishers, New Delhi, India, 2004.

14. ***Organic Spectroscopy***, William Kemp, 3rd Edition, Palgrave, New York, USA, 2004.

15. ***Basic Atomic and Molecular Spectroscopy***, J. Michael Hollas, Royal Society of Chemistry, Cambridge, UK, 2002.

16. ***Quantitative Analysis,*** Day and Underwood, Prentice/Hall Pvt. Ltd. 6th Edition (1993).

17. ***Vogel's text Book of Quantitative Chemical Analysis,*** Revised by G.H. Jaffery, J. Bassett, J. Mendhrn and R.C. Denny, ELBS 5th Edition (1998).

18. ***Analytical Chemistry,*** Gray D. Christian, 5th Edition, John Wiley and Sons, Inc

19. ***Introduction to Chromatography- Theory and Practice,*** V.K. Srivatsan and K.K. Srivatsan, S. Chand Company Ltd. 4th Edition (1991).

20. ***Instrumental Methods of Analysis***-Willard, Merrit and Dean, 7th Edition, (1998).

21. ***Instrumental Methods of Chemical Analysis***-B.K. Sharma, Goel Publishing House. Meerut, (2000).

22. ***Group theory and its applications to Chemistry*** – K.V. Raman, Tata McGraw Hill 1997.

23. ***Fundamentals of Molecular Spectroscopy***, 3rd edition – C.N. Banwall, McGraw Hill, Book co, (UK) Ltd 1983.

ChSC-3.2: INORGANIC CHEMISTRY-III

48 hrs

UNIT- I **16 hrs**

Electronic spectra and magnetic properties of complexes:

Spectra of transition metal complexes- Spectroscopic terms and microstates for free ions, spin-orbit coupling (L-S)scheme, obtaining terms for p^2 and d^2 configurations. Ground state terms, hole formalism, ground state terms for d^1 to d^9 configurations; splitting of terms in weak crystal fields.

Ligand field (d-d) spectra: selection rules for d-d transitions - spin and Laporte selection rules and their relaxation, band intensities, band widths; Racah parameters.

Orgel diagrams and Tanabe-Sugano (T-S) diagrams for octahedral and tetrahedral complexes-interpretation of electronic spectra, calculation of Dq , B, and β parameters for aqua complexes of V(III), Cr(III), Co(II) and Ni(II) ions; spectra of $[CoCl_4]^{2-}$ Spectrochemical series and Nephilauxetic series. Charge transfer spectra- characteristics, types-LMCT & MLCT.

Magnetic properties of transition metal complexes:

Types and origin of magnetic behavior-dia, para and ferro and antiferro magnetism, magnetic susceptibility(χ) and magnetic moment(μ); Pascal constants; Determination of mag. susceptibility by Gouy method and Faraday method.

μ_J, μ_{L+S} and μ_S expressions for free ions and complexes; factors affecting μ of complexes-strength and symmetry of ligand field, spectroscopic ground state and multiplet separations, orbital contribution, spin -orbit coupling. Quenching of orbital mag. moment; anomalous magnetic moment, magnetic exchange coupling (binuclear system); applications of magnetic data for the study of complexes.

UNIT- II: **16 hrs**

Reactions, Kinetics and Mechanism.

Reactivity of metal complexes, inert and labile complexes, interpretation of lability and inertness on the basis of VBT and CFT, crystal field activation energy.

Mechanism of ligand substitution – associative and dissociative mechanisms, main features of reaction intermediates. Ligand substitution in octahedral complexe, Acid catalysed aquation-dissociative mechanism, kinetics, factors influencing rate, evidences supporting mechanism.

Base catalysed hydrolysis: conjugate base mechanism, direct and indirect evidences of conjugate mechanism, kinetics. Cis effect in octahedral substitution reactions. Anation reactions, isomerisation and recimisation of tris chelate complexes. Substitution in square planer complexes: Dissociative mechanism, kinetics, factors affecting rate, evidences for dissociative mechanism. Trans affect, theories of trans effect, trans series and its applications.

Redox reactions: electron transfer reactions, self exchange and cross reactions, mechanism of one electron transfer reactions- outer sphere and inner sphere mechanisms: characteristics, factors affecting rates; role of bridging group in inner sphere mechanism.

Photochemical reactions of metal complexes: substitution and redox reactions of Cr(III), Ru(II) and Ru(III) complexes, applications in synthesis, catalysis, chemical actinometry and photochromism.

UNIT- III: 16 hrs

Organometallic Chemistry:

Organometallic complexes of transition metal ions: classification of ligands σ and π ligands, hapticity of ligands, nomenclature of organometallic complexes, 18 and 16 electron rules, electron counting schemes.

Transition metal carbonyl complexes-preparation , properties, structure and bonding, linear and bridging bonding modes of CO ligand, IR spectral evidences; nitrosyl and dinitrogen complexes- synthesis, bonding and structure; carbine (Fischer and Schrock type) complexes-synthesis, structure and bonding. Alkene and alkyne complexes- synthesis, structure and bonding.

Cyclopentadiene complexes: ferrocene and ruthenocene- synthesis, reactions, structure and bonding. Arene complexes: dibenzene chromium- synthesis, structure and bonding.

Reactions of organometallic complexes: Substitution reactions in carbonyl complexes- oxidative addition and reductive elimination, insertion and elimination; carbonylate anions- formation,

stability and synthetic applications as nucleophile. Transition metal cluster compounds: Types, factors favouring cluster formation.

Carbonyl clusters: Low Nuclear Carbon y Clusters(LNCC) and High Nuclear Carbonyl Clusters(HNCC)- electron counting and structure; Halide clusters-[Re2Cl8]2-: preparation, structure and bonding. Fluxional behavior of organometallic complexes.

Catalysis by Organometallic complexes:

Importance and mechanism of the following: Olefin hydrogenation-Wilkinson's catalyst, polymer supported catalyst, Waker's process, Hydroformylation (oxo process), Fisher-Tropsch reaction and olefin polymerization(Zigler-Natta process)

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1. ***Advanced Inorganic Chemistry***, 5th edition, F.A. Cotton and G. Wilkinson, John-Willey and sons 1988.
2. ***Inorganic Chemistry, principles of structure and reactivity***, 3rd ed. James E. Huheey, Ellen E Keithr and Richard L Keither, Harper Collins college pub, 1993.3
3. ***Inorganic Chemistry***, 3rd ed. D.P.Shriver and P.W.Atkins, Oxford University press, 1999
4. ***Comprehensive coordination Chemistry*.** Eds: G.Wilkinson, R.D.Gillers and J.A.McCleurry, Pergomon Press
5. ***Synthesis and Characterization of Inorganic Compounds***, W. L. Jolly, Prentice Hall
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7. ***Inorganic Photochemistry: Introduction to Photochemical and Photophysical Aspects of Metal Complexes,*** Kala Publications, Thiruchirapally, India, 2002.
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ChSC-3.3: ORGANIC CHEMISTRY - III

Total: 48 hrs

UNIT-I: REAGENTS IN ORGANIC SYNTHESIS 16 hrs

DDQ – Preparation of 2,3-dichloro-5,6-dicyano-1,4-benzoquinone (DDQ), mechanism of dehydrogenation, aromatization, oxidative cyclization, oxidation of benzylic and allylic alkyl groups.

DCC – Preparation of N,N-dicyclohexylcarbodiimide (DCC), synthesis of peptides, esters, peroxides. Heterocylisation reactions, synthesis of amides from carboxylic acids and amines. Synthesis of α,β-unsaturated ketones and esters.

LDA – Preparation, synthetic applications of lithium diisopropyl amide (LDA) [alkylation and acylation of ketones, aldol condensation, alkylation of acids, esters, amides, imides and nitriles].

DIBAL – Preparation, synthetic applications [reduction of alkynes, carboxylic acids, amides, ketones, esters, lactones and nitriles].

Aluminium isopropoxide – Reduction of carbonyl compounds, oxidation of alcohols, hydrolysis of oximes, preparation of ethers, reaction with epoxides.

Diazomethane – Preparation of diazomethane, methylation, homologation, addition reactions, miscellaneous reactions.

Organosilicon compounds – Preparation, reactions involving chlorotrialkylsilanes, trimethylsilyl iodide, arylsilanes, vinylsilanes and allylsilanes.

Organic reactions involving – Grignard reagent, Gilmans reagent, organozinc, organocadmium, organomercury, organolead, organochromium, organoiron, organopalladium, organorhodium, organoruthenium and organotellurium. Reactions involving phase transfer catalysts.

UNIT-II: NAMED REACTIONS 16 hrs

C–C Bond forming reactions: Alder – Ene reaction, Aldol condensation, Bischler – Napieralski reaction, Claisen condensation, Dieckmann condensation, Evans aldol reaction, Gattermann – Koch reaction, Heck reaction, Horner – Wadswrts – Emmons reaction, Knoevenagel condensation, Mannich reaction, Michael reaction, Mukaiyama aldol reaction, Mukaiyama – Michael addition, Nazarov cyclisation, Perkin reaction, Peterson olefination, Prins reaction, Reformatsky reaction, Robinson annulations, Simmons – Smith reaction, Sonogashira reaction,

Stobbe condensation, Vilsmeier – Haack reaction, Wittig reaction, Arndt – Eisterd synthesis, acyloin synthesis.

Coupling reactions: Hiyama cross-coupling reaction, Kumada cross-coupling reaction, McMurry coupling reaction, Negishi cross-coupling reaction, Stille coupling, Suzuki – Miyaura coupling, Ullmann coupling.

C–N Bond forming reactions: Buchirer reaction, Buchwald – Hartwig amination, Stork enamine reaction, Doebner – von Miller reaction, Hofmann – Loffler – Freytag reaction, Chichibabin reaction, Petasis reaction, Sharpless asymmetric amino hydroxylation, Barton reaction.

C–O Bond forming reactions: Corey – Nicolaou macrolactonization, Dakin reaction, Darzens condensation, Mislow – Evans rearrangement, Mukaiyama reagent, Pechmann coumarin synthesis, Preost trans-dihydroxylation, Sharpless asymmetric epoxidation, Woodward cis-dihydroxylation, Bayer – Villager reaction.

C–X Bond forming reactions: Chan – Lam coupling reaction, Hell – Volhard – Zelinsky reaction, Hunsdiecker – Borodin reaction, Takai reaction.

UNIT-III: OXIDATION AND REDUCTION REACTIONS 16 hrs

Oxidation reactions: Introduction, oxidation by potassium permanganate - alcohols, alkenes, alkynes, aldehydes, ketones, amines, nitro compounds, aromatic side chains, aromatic rings. Oxidation by manganese dioxide: allylic and benzylic alcohols. Oxidation of alcohols and phenols by chromic acid and potassium dichromate, Jones reagent, chromium trioxide-pyridine complex, pyridinium chlorochromate (PCC), pyridinium dichromate (PDC), oxidation of alkanes, alkenes, aromatic side chains and aromatic rings. Oxidation with peracids – oxidation of alkenes, ketones, N-hetercycles. Oxidation with miscellaneous oxidants: Ozones, hydrogen peroxide, t-Butyl hydroperoxide, aluminium tri-isopropaxide, aluminium tri-t-butoxide, lead tetra-acetate, selenium dioxide, osmium tetroxide, periodic acid, dimethyl sulphoxide, N-Bromosuccinimide, mercuric oxide, potassium bromate, iondine-silver carboxylate.

Reduction reactions: Homogeneous hydrogenation - reduction with metal hydrides ($LiAlH_4$, $NaBH_4$, $NaBH_3CN$, B_2H_6), reduction by dissolving metals (Na-alcohol, Na-liq.ammonia, Mg-Hg, Zn-HCl), reduction by miscellaneous reducing agents (di-imide, hydrazine, silanes, $SnCl_2$,

tin-hydrochloric acid, Zn-acetic acid, Zn-NaOH, sodium metabisulphite, sodium dithionite, Mg-alcohol, sodium hydrogen sulphide, formic acid).

Heterogeneous hydrogenation – introduction to Pt, Pd, Ni, Copper chromite catalysts, reduction of alkenes, alkynes, aldehydes, ketones, aromatic compounds, nitriles, oximes and nitro compounds. Hydrogenolysis.

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5. ***Advance Organic Chemistry – Reactions, mechanisms and structure***, Jerry March, 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2008.
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11. ***Organic Reactions and their Mechanisms,*** P.S. Kalsi, 2nd Edition, New Age International Pvt. Ltd., New Delhi, 2007.
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ChSC-3.4: PHYSICAL CHEMISTRY- III

Total: 48 hrs

UNIT-I: QUANTUM MECHANICS-II 16 hrs

Application of Schrödinger's wave-equation to harmonic oscillator, rigid-rotor and H-atom (separation of r, θ, ϕ equation and their solutions). Approximate methods – Necessity of approximate methods, perturbation method, the theory of perturbation method – first and second order correction, application to He-atom (first order correction only) – calculation of first ionization potential and binding energy. Variation theorem – statement and proof. Application of variation theorem to a particle in one dimensional box, linear oscillator, H and He-atoms, SCF method for many electron systems. Slater orbitals – Effective Nuclear Charge (ENC), expressions for Slater's orbitals for 1s, 2s, 3s, 2p and 3d electrons (no derivation), Slater's rules for calculation of ENC – Slater's orbitals for helium, carbon and nitrogen atoms. Chemical bonding in diatomics, elementary concept of MO and VB theories; Huckel molecular orbital (HMO) theory for conjugated π-electron systems and its applications to 1,3-butadiene and benzene.

UNIT-II: SURFACE CHEMISTRY AND CATALYSIS 16 hrs

Surface Chemistry: Adsorption by solids, types of adsorption isotherms, chemisorption, adsorption of gasses by solids, factors influencing adsorption, Freundlich and Langmuir adsorption theories, BET theory of multilayer adsorption (Derivation of BET equation), surface area measurement, types of adsorption isotherms, adsorption from solution, Gibbs adsorption isotherm, insoluble surface films on liquids, modern techniques for investigating surfaces: LEED, PES, STM, EXAFS and SEXAFS techniques.

Catalysis: Introduction, characteristics of catalytic reactions, acid-base catalysis, mechanism and kinetics of enzyme-catalyzed reactions, Michaelis-Menten equation, effect of temperature, pH and concentration on enzyme catalysis. Heterogeneous catalysis: surface reactions, kinetics of surface reactions, unimolecular and bimolecular surface reactions, pH-dependence of rate constants of catalyzed reactions, oscillatory reactions and their applications.

UNIT-III: PHASE EQUILIBRIA AND COLLOIDS 16 hrs

Phase equilibria: Introduction, derivation of phase rule, applications of phase rule to one-component systems (water and sulphur systems). Two-component systems (potassium iodide-

water system and ferric chloride-water system), three-component systems (two solids + one liquid system, and three liquid systems).

Colloids: Colloidal systems, classification of colloids, lyophobic and lyophilic sols, preparation of lyophobic colloidal solutions (dispersion and condensation methods), purification of colloidal solutions, Properties of colloidal systems: Electrical properties – charge on colloidal particles, electrical double layer, zeta potential, DLVO theory of the stability of lyophobic colloids, flocculation values, coagulation of colloidal solutions. Electrokinetic properties – electrophoresis and electro-osmosis streaming and sedimentation potential. Determination of size of colloidal particles, surfactants, hydrophile-lypophile balance (HLB). Emulsions, gels, elastic and non-elastic gels. Micelle formation – mass action model and phase separation model, shape and structure of micelles, micellar aggregation numbers, critical micelle concentration (CMC), factors affecting CMC in aqueous media, thermodynamic approach to CMC, thermodynamics of micellization, micelle temperature range (MTR) or Krafft point. Solubilization – location of solubilizates in micelles, the phase rule of solubilization. Micellar catalysis, importance and applications of colloids.

REFFERENCES:

1. ***Quantum Chemistry***, R.K. Prasad, 4th Edition, New Age International Publishers, New Delhi, 2010.
2. ***Polymer Chemistry,*** Malcolm P. Stevans, First Indian Edition, Oxford University Press, New York, 2008.
3. ***Quantum Mechanics for Chemists***, David O. Hayward, The Royal Society of Chemistry, UK, 2002.
4. ***Principles of Physical Chemistry***, B.R. Puri, L.R. Sharma, M.S. Pathania, 45th Edition, Vishal Publishing House, Jalandhar, India, 2012.
5. ***Physical Chemistry – A Molecular Approach***, Donald A. McQuarrie, John D. Simon, 3rd Edition (Viva Student Edition), Viva Books Pvt. Ltd., New Delhi, 2011.
6. ***Elements of Physical Chemistry***, B.R. Puri, L.R. Sharma, M.S. Pathania, 1st Edition, Vishal Publishing House, Jalandhar, India, 2013.
7. ***Quantum Chemistry***, John P. Lowe, Kirk A. Peterson, 3rd Edition, Academic Press, London, UK, 2009.
8. ***Quantum Chemistry***, Donald A. McQuarrie, 1st Indian Edition, Viva Books Pvt. Ltd., New Delhi, 2003.

9. ***Physical Chemistry***, N.B. Singh, S.S. Das, R.J. Singh, 2nd Edition, New Age International Publishers, New Delhi, 2007.

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21. ***Industrial Electrochemistry***, D. Pletcher and F.C. Walsh, Chapman and Hall, 2nd Edition, 1984.

M.Sc. Chemistry Practicals
III – SEMESTER

ChHCL-3.1: Inorganic Chemistry Practicals – III

COMPLEX PREPARATIONS

1. Preparation of Mercurytetrathiocyanatocobaltate(II)complex.
2. Preparation of Chloropentamminecobalt(III)chloride complex.
3. Preparation of Bisoxalatocuprate(II)di hydrate complex.
4. Preparation of Tris-oxalatoferrate(III) complex.
5. Preparation of Sulphatotristhioureazinc(II) complex.
6. Preparation of Tristhioureacopper(I)sulphate complex
7. Cis and trans Diaquadioxalatochromate(III)complex.
8. Preparation of Hexaminenickle(II)chloride complex.

COMPLEX ANALYSIS

9. Estimation of cobalt present in Chloropentamminecobalt(III)chloride complex.
10. Estimation of Copper and Oxalate present ingiven Bisoxalatocuprate(II)-di hydrate complex.
11. Estimation of Iron and Oxalate present in given Trisoxalatoferrate(III) complex.
12. Estimation of nickel present in Hexaminenickle(II)chloride complex.

REFERENCES:

1. Vogel's Textbook of Quantitative analysis, J Mendham, R.C. Denney, J.D. Barnes M.J.K. Thomas, 3rd, 4th , 5th and 6th edition.
2. College practical Chemistry, Ahulwalia
3. Analytical Chemistry,G.D. Christian.
4. Practical Inorganic Chemistry, K. Somashekara Rao.
5. Principles of Inorganic Chemistry, Puri, Sharma, Khalia.

ChHCL-3.2: Organic Chemistry Practicals – III

I.TWO STEP PREPARATIONS:

At least six preparations have to be carried out involving following types of reactions.

1. Nitration reactions
2. Acetylation reactions
3. Bromination reactions
4. Halogenation reactions
5. Rearrangement reactions (Beckmann rearrangement , Hofmann rearrangement)

II. ESTIMATIONS

1. Estimation of Cholesterol by Colorimetry.
2. Estimation of Amino acids by Colorimetry.
3. Estimation of Proteins by Colorimetry.
4. Estimation of Carbohydrates by Colorimetry.
5. Iodine value of fat or oils
6. Estimation of Aspirin by titration

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   N K Vishnoi , Second edition, Vikas Publishing House Pvt. Ltd, 1996
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   Renu Aggarwal, V. K. Ahluwalia, Universities press (India), 2001
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   Arun Sethi, New Age International, 2003.
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   Ahluwalia V.K. Sunitha Dhingra, First edition, Orient Longman, 2004
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   Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
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   Brian S. Furniss, 5th Edition, Pearson India, 2005.
7. **Practical Organic Chemistry**
   F.G. Mann, B.C Saunders, Fourth edition , Pearson India,2009.

ChHCL-3.3: Physical Chemistry Practicals – III

1. Determination of hardness of water.
2. Estimation of Fe^{+2} and Fe^{+3} ions present in a given method.
3. Determination of chemical oxygen demand.
4. Analysis of dolomite.
5. Estimation of sulphate using EDTA solution.
6. Phase diagram.
7. Estimation of iodine in common salt.
8. Adsorption characteristics of acetic acid on charcoal.
9. Reaction kinetics.
10. Estimation of nitrite.
11. Electrogravimetry.
12. To determine the half wave potential of Cd^{2+}, Cu^{2+} and Zn^{2+} in 0.1M solution.

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M.Sc. Chemistry Syllabus - 2015 (CBCS Scheme)
Revised Regulations -2010
IV - SEMESTER
ChSC-4.1: ANALYTICAL CHEMISTRY – IV

Total: 48 hrs

UNIT-I: SEPARATION TECHNIQUES **16 hrs**

Ion-Exchange chromatography (IEC): Ion-exchangers, cation-exchange resins, anion-exchange resins, ion-exchange mechanism, factors affecting ion-exchange equilibrium, ion-exchange capacity, affinity scale, instrumentation, techniques for ion-exchange, liquid ion-exchanger, applications of IEC, experimental IEC, ion-chromatography (IC) – instrumentation and applications (removal of interfering ions, separation of lanthanides, concentration and recovery of tracer ions).

Size exclusion (Gel) chromatography: Introduction, theory and principles of size exclusion process, materials for size exclusion process, application in polymer chemistry (weight average and number average concept).

Affinity chromatography: Introduction, classification, Selection of matrix, role of spacers, affinity ligands, applications of affinity chromatography in the separation of biomolecules.

Solvent extraction: Theory of extraction, mechanism of solvent extraction, aqueous phase, organic phase, factors favouring solvent extraction of inorganic species, extraction involving ion association complexes, synergic extraction, solvent extraction by crown ethers, cryptands, calixarenes, applications of solvent extraction (determination of copper as diethyldithiocarbamate complex, determination of iron as 8-hydroxyquinolate). **Solid-phase extraction:** solid-phase micro extraction (SPME), advantages of SPME.

Electrophoresis: Free solution, paper and capillary electrophoresis, theory, instrumentation for capillary electrophoresis, separation of amino acids by capillary zone electrophoresis, applications of capillary electrophoresis, experimental paper electrophoresis.

UNIT-II: X-RAY, ELECTRON AND NEUTRON DIFFRACTION STUDIES **16 hrs**

X-Ray diffraction studies: Theory, Mosley's law, interaction of X-ray with matter, Auger and Coster Kronig processes, instrumentation, X-ray absorption and emission methods, X-ray

diffraction, automated X-ray diffractometry, Miller indices, Bragg's condition for diffraction, X-ray detection and measurement, structural analysis of crystals, Laue method, Bragg's method, Rotating crystal method, Debye and Scherrer powder method, simple lattices and X-ray intensities, scattering factors, structure factor and its relation to electron density, identification of unit cells from systematic absences in diffraction patterns, predicting diffraction pattern of lattices, phase problem, procedure for X-ray structure analysis, Ramachandran diagram.

Electron diffraction: Basic principle, scattering intensity and scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules, electron diffraction studies of some compounds, low-energy electron diffraction (LEED) and structure of surfaces.

Neutron diffraction: Introduction, theory, scattering of neutrons by solids and liquids, magnetic scattering, measurement technique, elucidation of structure of magnetically ordered unit cell, applications of neutron diffraction studies.

UNIT-III: SURFACE CHARACTEIRIZATION TECHNIQUES, AUTOMATIC METHODS AND THERMAL METHODS OF ANALYSIS. 16 hrs

Surface characterization techniques: Introduction, definition of solid surface, types of surface measurements, spectroscopic surface methods – general technique in surface spectroscopy. Electron spectroscopy: Basic principles, instrumentation and applications of X-ray photoelectron spectroscopy (XPS) and Auger electron spectroscopy (AES). Secondary-ion mass spectrometry, laser microprobe mass spectrometry, Electron microprobe spectrometry: Basic principles, instrumentation and applications of scanning electron microscopy (SEM), scanning probe microscopes, scanning tunneling microscope (STM) – principles, instrumentation and applications, atomic force microscope (AFM) - principles, instrumentation and applications.

Automatic methods of analysis: specifications and performance of automated methods, automation strategy, advantages and disadvantages of automated techniques, infrared process analyzers, selection of on-line analyzers, on-line potentiometric analyzers, chemical sensors (optodes and microsensors), automatic chemical analyzers, discrete analyzers, continuous analyzers (single channel and multi channel), continuous flow methods, flow-injection analysis, centrifugal analyzers, automatic elemental analyzers, laboratory robots.

Thermal methods of analysis: Introduction, thermogravimetric methods, thermogram, factors affecting thermogram, thermogravimetric analysis (TGA) – instrumentation and applications (TGA analysis of polymers and inorganic compounds), static and dynamic thermogravimetry. Differential thermal analysis (DTA) – theory, instrumentation and applications (DTA analysis of polymers and inorganic compounds). Differential scanning calorimetry (DSC): theory, instrumentation and applications, factors affecting DTA and DSC.

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4. ***Quantitative Chemical Analysis,*** Daniel C. Harris, 6th Edition, W.H. Freeman and Company, New York, USA, 2003.
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7. ***Spectrometric Identification of Organic Compounds,*** R.M. Silverstein, F.X. Webster, 6th Edition, Wiley Student Edition, New Delhi, India, 2007.
8. ***Applications of Absorption Spectroscopy of Organic Compounds***, John R. Dyer, Prentice-Hall of India Pvt. Ltd., New Delhi, India, 2007.
9. ***Instrumental Analysis***, D.A. Skoog, E.J. Holler, S.R. Crouch, 11th Indian Reprint, Cengage Learning India Pvt. Ltd., New Delhi, 2012.
10. ***Molecular Structure and Spectroscopy***, G. Aruldhas, 2nd Edition, Prentice-Hall of India Pvt. Ltd., New Delhi, India, 2007.
11. ***Symmetry and Spectroscopy of Molecules,*** K. Veera Reddy, New Age International Pvt. Ltd., New Delhi, India, 1998.
12. ***Analytical Chemistry – Theory and Practice,***, R.M. Verma, 3rd Edition, CBS Publishers and Distributors, New Delhi, India, 2007.
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19. ***Introduction to Chromatography- Theory and Practice,*** V.K. Srivatsan and K.K. Srivatsan, S. Chand Company Ltd. 4th Edition (1991).

20. ***Instrumental Methods of Analysis***-Willard, Merrit and Dean, 7th Edition, (1998).

21. ***Instrumental Methods of Chemical Analysis,*** B.K. Sharma, Goel Publishing House. Meerut, (2000).

22. ***Group theory and its applications to Chemistry,*** K.V. Raman, Tata McGraw Hill 1997.

23. ***Fundamentals of Molecular Spectroscopy***, 3rd edition – C.N. Banwall, McGraw Hill, Book co, (UK) Ltd 1983.

CH.SC.4.2-INORGANIC CHEMISTRY-IV

Total: 48 hrs

Unit-I **16 hrs**

a) Chemistry of new materials: Conducting polymers: Polyaniline (PAN), poly p-phenylene (PPP),), poly-pyrrole (PPP) , poly-phenylacetelene (PPA) - mechanism of conduction, doping, properties, engineering and biological applications.

Super conductors- introduction, type I and type II super conductors, preparation of high Tc super conductor-$Y_1Ba_2Cu_3O_8$, BCS theory, Meisner effect, magnetic levitation, applications of high Tc super conductors.

Supra molecular chemistry: Definition, nature of supra molecular interactions; supra molecular host-guest compounds, common host molecules- crown ethers, porphyrins, zeolites, pillarenes, clixarenes, Molecular recognition and molecular receptors; Supra molecular catalysis, molecular switches, molecular wires.

UNIT II **16 hrs**

Bioinorganic Chemistry-I:

Essential and trace metal ions in biological process, , bioligands- amino acids, proteins, nucleic acids, nucleotides and their potential metal binding sites; special ligands- porphyrins, chlorin and corrin. Metalloproteins- role of protein and metal ions in metalloproteins; metalloenzymes and metal activated enzymes.

Ion transport across cell membrane:

Structure and function of biological membranes, concentration of metal ions outside and inside cells, ion transport across cell membrane; crown ethers, ionophores-channel forming and carrier ionophores; active and passive transport; transport Na^+& K+ions: Na^+/K^+ pump- importance and mechanism of action; Ca^{2+} storage and transport, Ca^{2+} pump- importance and mechanism of action, role of Ca^{2+} in muscle contraction and blood clotting.

Transport and storage of Fe: Structure and roles of ferritin, transferrin and siderophores; Transport of Cu: - Structure and role of ceruloplasmin.

Biological oxygen carriers: Heme proteins -O_2 uptake, transport and storage. Thermodynamic and kinetic aspects of dioxygen as oxidant, activation of O_2 through transition metal complexation; basic requirements for effective O_2 carriers, Structure and functioning of hemoglobin(Hb) and myoglobin(Mb) proteins, O_2 binding- cooperativity effect, Perutz trigger mechanism, Bohr effect, role of distal and proximal histidine; role of protein chains; CO and CN^- poisoning and treatment. Model compounds for O_2 binding and synthetic O_2 carriers; non-porphyrin systems- hemerythrin and hemocyanin. Photosynthesis: Chlorophyll: structural features, role of Mg^{2+}; light and dark reactions, PS-I and PS-II, Z-scheme of photosynthesis, oxygen evolving complex(OEC).

UNIT III **16 hrs**

Bioinorganic Chemistry-II: Nitogen fixation - Chemical inertness of N_2- thermodynamic and kinetic aspects, activation of N_2 through metal interaction. Biological nitrogen fixation: Nitrogenase enzyme, structure, N_2 binding sites and mechanism of action.

Electron transfer proteins: organic cofactors-FAD, NAD, FMN, ubiquinone; Structure and functions of:- blue copper protein (plastocyanin); Fe-S protein- rubredoxin, ferridoxin and HIPIP; heme proteins: cytochromes- cytochrome c and cytochrome c-oxidase. Electron transport chain (ETC) in respiration.

Metalloenzymes: Zinc enzymes- nature's choice of Zn(II) for non-redox enzymes ; structure of active site and function of carboxypeptidase, carbonic anhydrase and alcohol dehydrogenase. Copper enzyme-super oxide dismutase. Molybdenum enzyme- xanthineoxidase. Iron enzyme-catalase, peroxidase and cytochrome p-450. Vitamin B_{12} and coenzymes: structure of corrin ring, cobalamin unit, reduction of aquacobalamin $B_{12a}(Co^{III})$ to $B_{12r}(Co^{II})$, $B_{12s}(Co^{I})$ and their importance; biomethylation and mutase activity of cobalamins.

Applied bioinorganic chemistry: Metal ion deficiency and treatment- Fe, Cu, Mn, Zn deficiency and treatment. Metal ion excess toxicity-Fe excess toxicity- African siderosis, hemosiderosis, hemochromatosis (bronze diabetes) and detoxification. Cu excess toxicity: Wilson's disease and treatment.

Heavy metal ion toxicity: Hg, Pb, Cd, As toxic effects – mechanism of toxic effects. Heavy metal toxicity treatment- chelation therapy: chelating agents for Hg, Pb, Cd, As toxicity. Metal

complexes as drugs: cis-plain as anticancer agent: mechanism of action and side effects; gold complexes as antiarthritic drugs- chrysotherapy. Metal complexes in diagnosis - Gd complexes in magnetic resonance imaging (MRI).

References:

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2. ***Inorganic Chemistry***, 3rd ed. D.P.Shriver and P.W.Atkins, Oxford University press, 1999.
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5. ***Bioinorganic Chemistry,*** Bertini , Gray, Lippard and Valentine**,** Viva Books, Pvt., Ltd. 2004.
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8. ***Introduction to nanoscience,*** Gabor L. Hornyak, Joydeep Dutta, HarryF.Tibbals, Anil K. Rao, CRC Press, 2008.
9. ***Nanotechnology: Importance and applications,*** M.H. Fulekar, IK Internation al, 2010.
10. ***Supramolecular chemistry- Concepts and Perspectives***, J.M. Lehn, Wiley-VCH, 1995.
11. ***Supramolecular Chemistr'.*** P. D. Beer, P. A. Gale, D. K. Smith, Oxford University Press, 1999.
12. ***Supramolecular Chemistry ,*** J.W.Steed, J.L. Atwood, Wiley, 2000.

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ChSC-4.3: ORGANIC CHEMISTRY - IV

Total: 48 hrs

UNIT-I: CHEMISTRY OF NATURAL PRODUCTS - II 16 hrs

Alkaloids: Introduction, occurrence, nomenclature, classification, isolation, properties determination of molecular structure. Synthesis and structural elucidation of Papaverine and Reserpine. Biosynthesis of ephedrine, hygrine, nicotine and nicotinic acid.

Terpenoids: Introduction, occurrence, classification, isolation, general characteristics, isoprene rule. Synthesis and structural elucidation of Citral and α-Pinene. Biosynthesis of terpenes.

Steroids: Introduction, Diel's hydrocarbon, Sterols – Cholesterol, Lanosterol, Ergosterol, Stigmasterol (elementary account). Structural analysis of Cholesterol (structure of nucleus, position of double bond and hydroxyl group, nature and position of side chain, position of angular methyl group).

Lipids: Introduction, simple lipids (fats, oils, waxes), compound lipids, phospholipids (Lecithins, Cephalins, Plasmalogens, Sphingomyelins), glycolipids, galactolipids.

Prostaglandins: Introduction, occurrence, importance, isolation, nomenclature, classification, biosynthesis of PGE_2, $PGF_{2\alpha}$ and PGD_2. Structural elucidation of PGE.

Vitamins: Classification, nomenclature, biological functions, isolation, structure, biological importance and co-enzymes of Vitamin-B_1, B_2, B_3, B_6, B_{12}, Folic acid (Folate), Vitamin-A., A_1, A_2, Vitamin-E, Vitamin-C, Nicotinic acid and Nicotinamide.

Enzymes: Structure and reactivity of Cocarboxylase (Thiamine pyrophosphate), Nicotinamide adenine dinucleotide (NAD^+), Nicotinamide adenine dinucleotide phosphate ($NADP^+$), Coenzyme-A, Pyridoxal phosphate, Uridine diphosphate glucose (UDPG), Flavin adenine dinucleotide (FAD), Adenosine diphosphate (ADP), Adenosine triphosphate (ATP).

UNIT-II: SYNTHETIC APPROACHES IN ORGANIC REACTIONS 16 hrs

Retrosynthesis analysis by disconnection approach – Development of organic synthesis, retrosynthesis. Mono-functional disconnection - disconnection of carboxylic acids and their derivatives, alkanes and amines. Bi-functional disconnection.

Protection and de-protection in organic synthesis – Protection of hydroxyl, carboxyl, carbonyl, amino, thiol groups their de-protection.

Microwave assisted organic synthesis – Introduction, advantages and limitations, few examples.

Solid support synthesis and combinatorial synthesis – Introduction, advantages and limitations, few examples.

Green chemistry: Introduction, price of achievements of chemistry, definition of green chemistry, pillars of green chemistry – catalyzed reactions, replacement of organic solvents, starting materials from renewable resources, atom economy, biodegradable household and bulk chemicals. Plausible routes - to increase the atom economy, to reduce toxicity of reactions and to lower the production cost. Future status of green chemistry.

UNIT-III: MEDICINAL CHEMISTRY AND CHEMOTHERAPY 16 hrs

Drug design: Introduction, analogous and pro-drugs, concept of lead molecule, factors governing drug design – quantum mechanical approach, molecular orbital approach, molecular connectivity approach, linear free energy approach. Method of variation – drug design through disjunction and conjunction.

Factors governing ability of drugs to reach active sites – absorption, distribution, metabolism (biotransformation), excretion, intramolecular distances and biological activity.

Molecular modeling and drug design: Introduction, methodologies, molecular mechanics, quantum mechanics, known receptor sites – 3D structure of macromolecular targets, major steps in structure-based-drug-design, Ligand Receptor Recognition, active site for a target molecule, characterization of sites – hydrogen bonding and other group binding sites, electrostatic and hydrophobic fields, design of ligands, calculation of affinity, unknown receptor sites – pharmacophore vs binding-site models, searching for similarity, molecular comparisons, predictive ADME, reverse designing, CADD – methods.

Sulphonamides: Introduction, classification, synthesis and SAR studies of – Sulfanilamide, Sulfacetamide, Sulfaguanidine, Mafenide, Dapsone.

Antimalarials: Introduction, classification, synthesis and SAR studies of – Chloroquine, Pamaquine, Mepacrine, Pyrimethamine.

Antibiotics: Introduction, classification, synthesis and SAR studies of – Penicillins, Chloramphenicol.

Antivirals: Introduction, classification and synthesis of – Amantidine hydrochloride, Idoxuridine, Methisazone.

Antipsychotics (Tranquilizers): Introduction, classification and synthesis of – Pipradrol, Captodiame, Chlorpromazine.

REFERENCES:

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2. ***Organic Chemistry – Solution Mannual***, S. Warren, Oxford University Press, UK, 2009.
3. ***Advanced Organic Chemistry, Part-A:Structure and Mechanisms,*** 5th Edition, Francis A. Carey, Richard J. Sundberg, Springer, New York, 2007.
4. ***Principles of Organic Synthesis***, R.O.C. Norman, J.M. Coxon, 3rd Edition (First Indian Reprint), Nelson Thrones, UK, 2003.
5. ***Advance Organic Chemistry – Reactions, mechanisms and structure***, Jerry March, 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2008.
6. ***Organic Reaction Mechanisms,*** V.K. Ahluwalia, R.K. Parashar, 3rd Edition, Narosa Publishing House, New Delhi, 2009.
7. ***Pathway to Organic Chemistry – Structure and Mechanism***, P. Bhattacharjee, Arunabha Sen Books and Allied Pvt. Ltd., Kolkta, India, 2012.
8. ***Organic Chemistry,*** Paula Yurkanis Bruice, 3rd Edition, Pearson Education, Sai Printo Pack Pvt. Ltd., New Delhi, India, 2007.
9. ***Organic Chemistry (As per UGC Syllabus),*** S.M. Mukherji, S.P Singh, R.P. Kapoor, R. Dass, Vol. I, New Age International Pvt. Ltd., New Delhi, 2010.
10. **Stereochemistry of Organic Compounds – Principles and applications**, D. Nasipuri, Revised 2nd Edition, New Age International Pvt. Ltd., New Delhi, 2009.
11. ***Organic Reactions and their Mechanisms,*** P.S. Kalsi, 2nd Edition, New Age International Pvt. Ltd., New Delhi, 2007.
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13. ***Organic Chemistry***, G. Marc Loudon, 4th Edition, Oxford University Press, UK, 2000.
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16. ***Organic Chemistry***, M.A. Fox, J.K. Whitesell, 2nd Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts, London, 1997.
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19. ***Modern Methods of Organic Synthesis,*** W. Carruthers, 3rd Edition, Cambridge University Press, UK, 2004.

20. ***Heterocyclic Chemistry,*** J.A. Joule, K. Mills, 4th Edition, Blackwell Publishing, Wiley India Pvt. Ltd., New Delhi, 2009.

21. ***Stereochemistry – Conformation and Mechanism,*** P.S. Kalsi, 7th Edition, New Age International Publishers, New Delhi, India, 2008.

22. ***Heterocyclic Chemistry,*** Thomas L. Gilchrist, 3rd Edition, Pearson Education, New Delhi, India, 2007.

23. ***Heterocyclic Chemistry,*** Raj K, Bansal, 4th Edition, New Age International Publishers, New Delhi, India, 2009.

24. ***Organic Chemistry,*** I.L. Finar, 5th Edition (Volume-2), Pearson Education, New Delhi, India, 2009.

25. ***Organic Chemistry,*** I.L. Finar, 6th Edition (Volume-1), Pearson Education, New Delhi, India, 2007.

26. O***rganic Chemistry of Natural products***, Gurudeep R. Chatwal, (Edited by M. Arora), Vol. 2, Himalaya Publishing House, Mumbai, India, 2008.

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28. ***Organic Chemistry – Natural Products***, O.P. Agarwal, Vol. II, GOEL Publishing House, Meerut, India, 2004.

29. ***Organic Name Reactions***, Goutam Brahmachari, 5th Revised Edition, Narosa Publishing House, New Delhi, India, 2012.

30. ***Name Reactions***, Jie Jack Li, 4th Edition, Sringer (India) Pvt. Ltd. New Delhi, India, 2012.

31. ***Medicinal Chemistry,*** Ashutosh Kar, 4th Edition, New Age International Pvt. Ltd., New Delhi, India, 2007.

32. ***Medicinal Chemistry,*** Ashutosh Kar, 5th Revised Edition, New Age International Pvt. Ltd., New Delhi, India, 2010.

33. ***An Introduction to Medicinal Chemistry***, Graham L. Patrick, 4th Edition, Oxford University Press, New York, 2009.

34. ***The Organic Chemistry of Drug Design and Drug Action***, Richard B. Silverman, 2nd Edition, Academic Press, UK, 2008.

35. ***Organic Synthesis –The Disconnection Approach,*** Stuart Warren, Wiley Student Edition, New Delhi, India, 2007.

36. ***Modern Synthetic Reaction***, Herbet O. House, 2nd Edition, Mentopark, California, 1972.

37. ***Organic Synthesis – Design, Reagents, Reactions and Rearrangements***, J. Singh, L.D.S. Yadav, 1st Edition, Pragathi Prakashan, Meerut, India, 2009.

ChSC-4.4: PHYSICAL CHEMISTRY - IV

Total: 48 hrs

UNIT- I: CHEMISTRY OF NANOMATERIALS 16 hrs

Introduction: Fundamentals and importance, Metal nanoclusters, magic numbers, theoretical modeling of nano particles, Geometric structure, electronic structure, reactivity, fluctuations, magnetic clusters, Bulk to nano transitions. Semi conducting nanoparticles- optical properties, photofragmentation, coulombic explosion.

Carbon nano particles: Introduction, Carbon molecules, Nature of the carbon bond, New carbon structures. Carbon clusters: small carbon clusters, C_{60}; Discovery, structure, crystal, alkali doping, super conductivity, Fullerens, other Bulkyballs. Carbon nano-tubes: Fabrication, structure, electrical properties, vibrational properties, mechanical properties, application of nano materials.

Methods of preparation: Plasma arcing, chemical vapour deposition, sol-gel, silica-gel, hydrolysis, Condensation and polymerization of monomers to form particles, Electrodeposition, ball milling, Chemical methods, Thermolysis, Pulsed laser methods.

UNIT – II: METAL FINISHING AND CORROSION 16 hrs

Metal finishing: Electrode potential-standard potential, EMF series and its applications, Deposition potential-deposition from simple salt solution and solution mixtures, polarization and over voltage, effect of polarization on electrodeposition, limiting current density, hydrogen over voltage. Principles of electroplating. Role of anodes in electroplating. Pre-plating process and surface preparation. Hull cell experiment, covering power and throwing power. Electroplating practice for metals and alloys (Cu, Ni, Zn, brass, bronze).

Specifications and testing of electroplates - Introduction, thickness-destructive and non destructive testing methods, Adhesion-bend test, burnishing test, file test, grinding test, heat test, peel test, corrosion resistance-salt spray test, acetic acid salt spray test, copper accelerated acetic acid salt spray test, corrodekote test, Sulphur dioxide test, porosity-Ferroxyl test, electrographic test, hot water test, hardness test. Immersion (Galvanic) plating, electroless plating.

Corrosion and its control: Types of corrosion (atmospheric, environmental and microbial). Galvanic series – merits and demerits, thermodynamics and kinetics of corrosion, corrosion rate

measurement, corrosion failure and passivity. Methods of prevention of corrosion, corrosion problems in practice.

UNIT-III: ELECTROSYNTHESIS **16 hrs**

Fundamentals, generalized electrochemical reaction, reaction variables in electro synthesis, setting up the electrolysis cell – Basic laboratory apparatus, two-electrode cells, three-electrode cells. Laboratory cell designs, Selection of electrode material and cell Geometry – Electrode material, cell geometry. Selection of electrode potential, divided and undivided cells, preparation of solution for electrolysis – solvent and supporting electrolyte, temperature effects. Generalized electrochemical reaction from a physical perspective, preliminary investigations into the feasibility of an electro synthesis.

Electro-organic reactions: Electrooxidation and reductions of hydrocarbons, nitro compounds, sulphur compounds, nitrogen heterocyclic compounds, halogen compounds and carboxylic acids (Kolbe's synthesis). Some preparative examples - Reductive intermolecular Carbon-Nitrogen bond formation, Carboxylic acids from primary alcohols, cyanation of N,N-Propylpyrrolidine, preparation of 3,6-Dichloropicolinic acid from 3,4,5,6-Tetrachloropicolinic acid.

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1. ***Introduction to Nanotechnology,*** Charles P. Poole, Jr., and Frank J. Owens, Wiley -Interscience, A. John Wiley and Sons, Inc., 2006.
2. ***Nanotechnology (Basic Science and Emerging Technologies)***, Mick Wilson, Kamali Kannangara Geoff Smith, Michelle Simmons, and Burkhard Raguse, First Indian Edition, Overseas Press India Private Limited, 2005.
3. ***Chemical and Electrochemical Energy Systems,*** R. Narayan and B. Vishwanathan (University Press).
4. ***Industrial Electrochemistry***, D. Pletcher and F.C. Walsh, Chapman and Hall , II Edition, 1984.
5. ***A Text Book Of Physical Chemistry,*** A.S. Negi and S.C. Anand , New Age international Pvt. Ltd.
6. ***Physical Chemistry,*** Moore, Orient Longman, 1972.
7. ***An introduction to Electrochemistry***, Glastone, East west Ltd.
8. ***Basics of Electroorganic Synthesis***, Demetrios K. Kyriacou, A Wikley-Interscience Publications, New York, 1981.

M.Sc. Chemistry Practicals

IV – SEMESTER

ChHCL-4.1: Inorganic Chemistry Practicals – IV

1. Analysis of Cement- Estimation of combined oxide, estimation of silica, estimation of Ca and Mg.
2. Estimation of Copper in Brass.
3. Estimation of Silver as Volhord's method.
4. Estimation of Chromium and manganese in steel sample.
5. Estimation of Ascorbic acid by acid-base titration.
6. Estimation of Ascorbic acid by Iodimetry.
7. Estimation of Iron in pharmaceutical samples.
8. Estimation of available O_2 in Hydrogen peroxide.
9. Estimation of Iron present in mustard seed solution sample by spectrophotometer.
10. TLC – Reaction progress Monitoring.
11. Paper chromatography – Demo and Practice for separation of Fe and Ni.
12. Determination of Magnetic susceptibility by Gouy's Magnetic Balance Method.

REFERENCES:

1. Vogel's Textbook of Quantitative analysis, J Mendham, R.C. Denney, J.D. Barnes M.J.K. Thomas, 3rd, 4th , 5th and 6th edition.
2. College practical Chemistry, Ahulwalia
3. Analytical Chemistry,G.D. Christian.
4. Practical Inorganic Chemistry, K. Somashekara Rao.
5. Principles of Inorganic Chemistry, Puri, Sharma, Khalia.

ChHCL-4.2: Organic Chemistry Practicals – IV

I. PREPARATIONS

A.DYES (Minimum three)

B.DRUGS (Minimum three)

II. ISOLATION AND SEPARATION OF NATURAL PRODUCTS

1. Piperine from pepper
2. Caffeine from tea leaves
3. Casein from milk
4. Nicotine from tobacco leaves
5. Hesperidin from peal of orange
6. Cineole from Eucalyptus leaves

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1. **Advanced Practical Organic Chemistry**
   N K Vishnoi , Second edition, Vikas Publishing House Pvt. Ltd, 1996
2. **Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis**
   Renu Aggarwal, V. K. Ahluwalia, Universities press (India), 2001
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   Arun Sethi, New Age International, 2003.
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   Ahluwalia V.K. Sunitha Dhingra, First edition, Orient Longman, 2004
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   Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
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   Brian S. Furniss, 5th Edition, Pearson India, 2005.
7. **Practical Organic Chemistry**
   F.G. Mann, B.C Saunders, Fourth edition , Pearson India, 2009.

ChHCL-4.3: Physical Chemistry Practicals – IV

1. Reaction kinetics.
2. Reaction kinetics.
3. Isoelectric point of glycine.
4. Potentiometric titration (CAS v/s FAS).
5. Heat of solution of benzoic acid.
6. Heat of solution of salicylic acid.
7. Reaction kinetics by conductometry.
8. Polymer viscosity.
9. Corrosion rate measurement.
10. Determination unknown concentration of $ZnSO_4$ by polarography
11. Determination of unknown concentration of mixture by spectrophotometric method.
12. To determine the CMC of SLS from the measurement of conductivity at different concentration.

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