(4)

ದಾವಣಗೆರೆ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

ರಸಾಯನಶಾಸ್ತ್ರ ಅಧ್ಯಯನ ವಿಭಾಗ,
ಶಿವಗಂಗೋತ್ರಿ. ದಾವಣಗೆರೆ–577 007

ಡಾ. ನಾಗಸ್ವರೂಪ ಹೆಚ್ ಪಿ,
ಪ್ರಾಧ್ಯಾಪಕರು ಮತ್ತು ಅಧ್ಯಕ್ಷರು
Mobile No: 9945406900

ಸಂಖ್ಯೆ:ದಾವಿವಿ:ರಸಾ:2024-25/411 ದಿನಾಂಕ:24-09-2024

ಗೆ,
ಕುಲಸಚಿವರು
ಆಡಳಿತ ವಿಭಾಗ,
ದಾವಣಗೆರೆ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ
ಶಿವಗಂಗೋತ್ರಿ
ದಾವಣಗೆರೆ – 577 007.

ಮಾನ್ಯರೆ,

ವಿಷಯಃ ರಸಾಯನಶಾಸ್ತ್ರ ಅಧ್ಯಯನ ವಿಭಾಗದ ಪಠ್ಯಕ್ರಮ ಮತ್ತು ಅಧ್ಯಯನ ಮಂಡಳಿಯ(BoS) ನಡಾವಳಿಯನ್ನು ಕಳುಹಿಸಿಕೊಡುವ ಕುರಿತು.

ಮೇಲ್ಕಂಡ ವಿಷಯಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ, ರಸಾಯನಶಾಸ್ತ್ರ ಅಧ್ಯಯನ ವಿಭಾಗದಲ್ಲಿ ದಿನಾಂಕ:24/09/2024 ರಂದು ನಡೆದ ಅಧ್ಯಯನ ಮಂಡಳಿಯ ಪಠ್ಯಕ್ರಮ ಮತ್ತು ಅಧ್ಯಯನ ಮಂಡಳಿಯ(BoS) ನಡಾವಳಿಯನ್ನು ಈ ಮೂಲಕ ಮುಂದಿನ ಸೂಕ್ತ ಕ್ರಮಕ್ಕಾಗಿ ತಮಗೆ ಸಲ್ಲಿಸುತ್ತಿದ್ದೇನೆ.

ವಂದನೆಗಳೊಂದಿಗೆ,

ತಮ್ಮ ವಿಶ್ವಾಸಿ,
24/09/2024

CHAIRMAN
DOS in Chemistry
Davangere University
Shivagangotri, Davangere-577007

25/09/2024

DAVANGERE UNIVERSITY
Department of Studies in Chemistry

Proceedings of PG BoS Meeting in Chemistry

The Board of Studies Meeting in Chemistry (PG) held in the Department of Chemistry, Davangere University, Shivangangothri, Davangere at 11. 00AM on 24 September 2024.

MEMBERS:

1. Prof. H P Nagaswarupa — -- Chairman BoS
   Department of Studies in Chemistry,
   Davangere University Davangere.
2. Prof. M.Y. Kariduraganavar. — -- External Member
   Karnatak University Bengaluru
3. Prof. Basavaraja Padmashali — -- External Member
   Rani Channamma University, Belagavi
4. Prof. Mamatha G P — -- Internal Member
   Seniour Professor, Davangere University
5. Dr. Nandeshwarappa B P — -- Internal Member
   Professor,Davangere University
6. Dr. Rajendraprasad S — -- Internal Member
   Asistant Professor, Davangere University

The chairman welcomed the board members of the committee and take up the following agenda.

Meeting Agenda : 1) Preparation and Approval of M.Sc. **Chemistry** (CBCS 2024-25 Onwards), Syllabus.

2) Any other academic matters.

Approval:

Approval of the Syllabus of M.Sc. Chemistry (CBCS 2024-25 Onwards), for I to IV semester of Post Graduate Programme, prepared by the Department of Studies in chemistry was submitted to BoS for approval through the above mentioned circular.

The Chairman of BOS (PG) Send all the details about the Syllabus of M.Sc. Chemistry (CBCS 2024-25 Onwards), Programme through the mail to the members of the BOS and requested for the approval of the same.

The members of BOS have meticulously gone through the details during the meeting held on 24-09-2024 (External Members were present through the online) and approved the syllabus of the M.Sc. Chemistry (CBCS 2024-25 Onwards), for the I to IV semester of Post graduate Programme After the consolidation and approval the same was forwarded to the Registrar Office for the needful action

Signature of the Committee Members:

1. Prof. H P Nagaswarupa , Chairman BoS — 24/09/24
2. Prof. M.Y. Kariduraganavar, External Member
3. Prof. Basavaraja Padmashali., External Member
4. Prof. Mamatha G P Internal Member — 24/9/24
5. Dr. B P Nandeshwarappa., Internal Member — 24/09/2024
6. Dr. Nagaswarupa H P, Internal Member — 24/09/24
7. Dr. Rajendraprasad S, Internal Member — 24/9/2

Prof. H P Nagaswarupa 24/09/24
Chairman BoS
Department of Chemistry,
Davangere University.Davangere.

DAVANGERE UNIVERSITY
Department of Studies in Chemistry

Proceedings of PG BoS Meeting in Chemistry

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24/9/24.

Prof. H P Nagaswarupa
Chairman BoS
Department of Chemistry,
Davangere University.Davangere.
24/09/24

DAVANGERE UNIVERSITY
Shivagangothri, Davangere – 577 007

POST-GRADUATE PROGRAMME
Master of Science (M. Sc.) in Chemistry

Choice Based Credit Scheme (CBCS) Syllabus
2024-25 onwards

DOS in Chemistry, Davangere University,
Shivagangothri, Davangere – 577 007

Dr. U.S. MAHABALESHWAR
M.Sc., M.Phil., Ph.D.
Professor & Dean, Science & Technology
Davangere University, Shivagangotri,
Davangere-577 007, Karnataka, India.

Registrar
Davangere University
Shivagangotri, Davangere

CHAIRMAN
DOS in Chemistry
Davangere University
Shivagangotri, Davangere-577007

DAVANGER UNIVERSITY

M.Sc., Chemistry (CBCS) Course Structure (2024-25 onwards)

Semester	Subject/Course /paper/Code	Title of the Paper//Course	Instruction Hrs./w	Marks			Credits	Examination duration (Hrs.)
				Examination	Internal Assessm	Total Marks		
SEMESTER-I		**THEORY PAPERS**						
	Ch 1.1	Inorganic Chemistry-I	4	70	30	100	4	3
	Ch 1.2	Organic Chemistry-I	4	70	30	100	4	3
	Ch 1.3	Physical Chemistry-I	4	70	30	100	4	3
	Ch 1.4	Analytical Chemistry-I	4	70	30	100	4	3
		PRACTICAL PAPERS						
	ChL1.1	Inorganic Chemistry-I	4	40	10	50	2	3
	ChL 1.2	Organic Chemistry-I	4	40	10	50	2	3
	ChL 1.3	Physical Chemistry-I	4	40	10	50	2	3
	ChL 1.4	Applied Analysis-I	4	40	10	50	2	3
	Mandatory Credits: English Language, Communication Skill		2	---	---	---	2	---
SEMESTER-II		**THEORY PAPERS**						
	Ch 2.1	Inorganic Chemistry-II	4	70	30	100	4	3
	Ch 2.2	Organic Chemistry-II	4	70	30	100	4	3
	Ch 2.3	Physical Chemistry-II	4	70	30	100	4	3
	Ch 2.4	Chromatography & Spectroscopy	4	70	30	100	4	3
		PRACTICAL PAPERS						
	ChL 2.1	Inorganic Chemistry-II	4	40	10	50	2	3
	ChL 2.2	Organic Chemistry-II	4	40	10	50	2	3
	ChL 2.3	Physical Chemistry-II	4	40	10	50	2	3
	ChL 2.4	Applied Analysis-II	4	40	10	50	2	3
	Mandatory Credits: Computer Skill		2	---	---	---	2	---
SEMESTER-III		**THEORY PAPERS**						
	Ch 3.1	Organometallic Chemistry	4	70	30	100	4	3
	Ch 3.2	Reaction Mechanisms &Natural Products	4	70	30	100	4	3
	Ch 3.3	Physical Chemistry – III	4	70	30	100	4	3
	Ch 3.4	Advanced Analytical Techniques	4	70	30	100	4	3
	Ch.EL 3.5	Ch.EL 3.5-1A -Environmental Chemistry / Ch.EL 3.5-1B- Nanochemistry/ Ch.EL 3.5-1C -Dyes And Pigments Ch.EL 3.5-1D – Fundamentals of herbal medicinal chemistry and applications Ch.EL 3.5-1E - Polymer Chemistry (Interdisciplinary-Elective paper)	2	40	10	50	2	2
		PRACTICAL PAPERS						
	ChL 3.1	Inorganic Chemistry-III	4	40	10	50	2	3
	ChL 3.2	Organic Chemistry-III	4	40	10	50	2	3
	ChL 3.3	Physical Chemistry-III	4	40	10	50	2	3
	ChL 3.4	Analytical Chemistry–I	4	40	10	50	2	3
SEMESTER-IV		**THEORY PAPERS & PROJECT WORK/DISSERTATION**						
	Ch 4.1	Coordination &Bioinorganic Chemistry	4	70	30	100	4	3
	Ch 4.2	Modern Interfaces of Organic Chemistry	4	70	30	100	4	3
	Ch 4.3	Advanced Physical Chemistry	4	70	30	100	4	3
	Ch 4.4	Project Work/Dissertation	6	70	30	100	6	3
		PRACTICAL PAPERS & STUDY TOUR/FIELD VISIT						
	ChL 4.1	Inorganic Chemistry-IV	4	40	10	50	2	3
	ChL 4.2	Organic Chemistry-IV	4	40	10	50	2	3
	ChL 4.3	Physical Chemistry-IV	4	40	10	50	2	3
	ChL-4.4	Analytical Chemistry–II	4	40	10	50	2	3
		Study Tour/Field Visit	---	---	---	---	---	---
		Value Added Course	2	--	---	---	---	---
	Mandatory Credits: Personality Development		2	---	---	---	2	---
	Total Credits for the Course		136	---	---	2400	104	---

CHAIRMAN
BOS in Chemistry

Dr. U.S. MAHABALESHWAR
M.Sc., M.Phil., Ph.D.
Professor & Dean, Science & Technology
Davangere University, Shivagangotri,

Registrar
Davangere University
Shivagangotri, Davangere

Ch. 1.1 INORGANIC CHEMISTRY-I 64 hrs

Course Objectives:

- To learn the properties of ionic substances and type of ionic crystals, Born-Haber cycle, Uses of Born-Haber type of calculations. To know the concept of Covalent bond – octet rule, maximum covalence rule and its applications, failure of octet rule.
- To learn the different theories of acids and bases, reactions in non-aqueous media like To know the concept effect of substituents on acid base strength.
- To learn the shape and hybridization of interhalogens, psuedohalogens, polyhalide ions, oxyhalogen species, xenon oxides and fluorides.
- To know the concept of Oxy- and peroxy acids of N, P and S. carbides, pure silicon, silica and silicates, zeolites.

Course Outcome:

- To be able to understand the coordination number of an ion, structure and type of ionic crystals. Extraction and separation of Spectra and magnetic properties lanthanides.
- To be able to understand the VBT, VSEPR theory and MOT, structure and geometry of different types of covalent molecules.
- To be able to understand Theories of acids and bases.
- To be able to understand the interhalogens, psuedohalogens, polyhalide ions and their type of hybridization, structures and bonding. The applications of alkali metal species like Alkali and alkaline earth metal complexes of crown ethers, cryptands and calixarenes and their biological significance.

UNIT I **16 hrs**

Ionic Bonds: Properties of ionic substances, coordination number of an ion, structure and type of ionic crystals – AB type (NaCl, ZnS, CsCl). Lattice energy- Born Lande equation, Born-Haber cycle, Uses of Born-Haber type of calculations. Ionic radii, methods of determining ionic radii, factors affecting ionic radii, radius ratio rule, covalent character in ionic bonds, hydration energy and solubility of ionic solids.

Covalent Bond: octet rule, ionic bond, electrovalence, inert pair effect, covalent bond, maximum covalence rule and its applications, failure of octet rule.

UNIT II **16 hrs**

Theories, Hybridizations and Shapes of Covalent Molecules: valence bond theory, resonance, hybridization, Bent's rules and energetics of hybridization, Deduction of molecular shapes – VSEPR theory, Molecular orbital theory (MOT) in covalent bonds

Postulate of VSEPR theory, hybridization, structure and geometry of – AB_2 type species ($BeCl_2$, CO_2), AB_3 type species (BCl_3, SO_3), AB_4 type species (CH_4, NH_4^+, SO^{2-}_4), AB_5 type species (PF_5), AB_2 (lp) type species ($SnCl_2$, $PbCl_2$, SO_2), AB_3 (lp) type species (NH_3, PH_3, PCl_3, ClO_3^-), AB_2 (lp)2 type species (H_2O, SCl_2, $SeCl_2$, NH_2^-, ICl_2^+), AB_4 (lp) type species (SF_4, $TeCl_4$, $SeCl_4$), AB_3 $(lp)_2$ type species (ClF_3, BrF_3, ICl_3, IF_3), AB_2 $(lp)_3$ type species (XeF_2, ICl_2^-), AB_5 (lp) type species (IF_5, BrF_5, ClF_5, $[SbF_4]^{2-}$), AB_4 $(lp)_2$ type species (XeF_4, ICl_4^-).

Salient features of MOT, variation of electron-charge density with inter-nuclear distance in H_2 molecule, characteristics of bonding and anti-bonding molecular orbitals, comparison between - i) bonding and anti-bonding molecular orbitals, ii)sigma and pi molecular orbitals, iii) atomic and molecular orbitals, bond order, molecular orbital configuration of H_2, H_2^+, H_2^-, He_2, Determination of molecular orbital configuration of A_2 type species (Li_2, Be_2, B_2, C_2, N_2, N_2^+, O_2, O_2^+, O_2^-, O_2^{2-}, F_2, Ne_2), molecular orbital configuration of CO, CN, CN^-, NO, NO^+, N_2O NO^-, HF species, molecular orbital configuration of CO and NO^+, comparison between VBT and MOT.

UNIT III **16 hrs**

Theories of Acids and Bases: Theories of acids and bases – Bronsted and Lewis acids and bases, Lux-Flood theory, gas phase vs. solution acidity, solvent leveling effects, hardness and softness, HSAB concept. Super acids. Reactions in non-aqueous media: Liquid ammonia, anhydrous sulphuric acid, glacial acetic acid, anhydrous HF, bromine trifluoride, liquid sulphur dioxide and dinitrogen tetroxide. Ionic liquid: Molten salts solvent system, ionic liquids at ambient temperature reactions and application of molten salts/ionic liquid media. Arrhenius concept, Proto transfer theory, solvent system, effect of polarity and dielectric constant and effect of substituents on acid base strength. Measurement of acid base strength in gas phase. Enthalpies of acid base reactions from empirical parameters.

UNIT IV **16 hrs**

Halogens and noble gas chemistry- Interhalogens (ICl, ClF_3, IF_5, IF_7), psuedohalogens, polyhalide ions-structure and geometry (I_3^+,I_3^-, I_4^-, ICl_2^+, IF_4^+, IF_6^-, IF_6^+, ICl2-, $IBrCl^-$), oxyhalogen species. Structure and geometry of Xenon compounds - oxides of xenon (XeO_2, XeO_3, XeO_4), fluorides of xenon (XeF_2, XeF_4, XeF_6), oxy-fluorides of xenon ($XeOF_4$, $XeOF_2$, XeO_2F_2, XeO_3F_2, XeO_2F_4, $XeOF_4$). Structure and geometry of - PCl_6^-, P_2O_5, P_2O_{10}, SOCl, SO_2Cl, $SnCl_4$2-SnF_6^{2-}, AlF_6^-, SbF_5^{2-}, SbF_6^{3-}, SeO_2, SeO_3, TeO_2, TeO_3, PoO_3.Oxyacids of nitrogen, phosphorous, sulphur and halogens. Preparation, properties and applications of - Carbides, silicon, silica. Silicates-classification, structure and applications, zeolites.

References:

1. Shriver, Atkins and Langford: Inorganic Chemistry (3rd edn.) OUP, 1999.
2. J.D.Lee: Concise Inorganic Chemistry, (5th edn.) Blackwell Science, 2000.
3. B.E.Douglas, D.McDaniel & A Alexander: Concepts & Models of Inorganic Chemistry, Wiley 2001
4. W.W. Porterfield: Inorganic chemistry – A Unified Approach, Elsevier, 2005.
5. James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, 4th Edition, Pearson Education, Indian Edition, New Delhi, India, 2013- Inorganic Chemistry – Principles of Structure and Reactivity
6. Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong, 5th Edition, Oxford University Press, UK, 2013- *Inorganic Chemistry*
7. Gary L. Miessler, Donald A. Tarr, 3rd Edition, Pearson Education, New Delhi, India, 2004.- Inorganic Chemistry.
8. Keith F. Purcell, John C. Kotz, First Indian Reprint, Cengage Learning

ChL 1.1 Inorganic Chemistry-I

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 Zinc ions complexometrically using EDTA solution.
4. Estimation of Nickel ions complexometrically using EDTA solution.
5. Estimation of the amount of Fe (II) and Fe (III) present in the given solution using $K_2Cr_2O_7$.
6. Estimation of the amount of Fe (II) and Fe (III) present in the given solution by using ceric ammonium sulphate solution.
7. Estimation of the amount of Fe (II) and Fe (III) present in the given solution by using Vanadium solution.
8. Estimation of copper as copper thiocyanate gravimetrically.
9. Estimation of Sulphate as Barium sulphate gravimetrically.
10. Estimation of Nickel as Nickel Dimethyl glyoximate gravimetrically.

References:

1. Vogel's Textbook of quantitative chemical analysis- Revised by G.H.jaffery, J. Bassett, J. Mendhmand R.C. Denney ELBS 5thedition (1998).
2. Concise coordination Chemistry - R Gopalan, V Ramalingam, vikas Publicatin 2nd Edition,2008
3. College Practical Chemistry, - V k Ahluwalia Sunita Dhingra, Adarsh Gulati, Universities Press (India) Limited, 2rd Edition, 2005
4. Analytical Chemistry, - G.D. Christian, BrwkslCole Publishing Co, 4th Edition, Vol. 1,2003
5. Text Book of Practical Inorganic Chemistry, Kaza Somasekhara Rao, Kalyani Publishers, 1st Edition 2004.
6. Principles of Inorganic Chemistry, - Puri, Sharma, Khalia, Vallabh Publications, 29th Edition,2004.

Ch 1.2 ORGANIC CHEMISTRY-I 64 hrs

Course objectives:

- To learn and recall the fundamental of chemical bonding, nature of the bonding in organic molecules, and different types of compounds.
- To understand the basic principles of reaction intermediates and types of intermediates and different methods of reaction mechanism.
- To study Free radical reaction mechanism, elimination reaction, effect of substrate on reaction.
- To learn about optical activity of molecules., Basic idea about chirality, stereochemistry of compounds, and the concept of isomerism and E,Z notation.

Course outcome:

- Students will be able to understand the type of the chemical bonding in organic compounds and the different types of molecules.
- Students will try to recognize the types of intermediates and the reaction mechanism methods.
- Understand the concept of free radical types of reaction, eliminate reactions, Effect of solvent and substrate in the reaction mechanism.
- Students will be able to understand the concept of stereochemistry, its application, and identify the stereochemical notation.

UNIT I **16 hrs**

Bonding in Organic Molecules: Localized and delocalized bonding**:** Conjugation, Cross conjugation, resonance, hyper-conjugation and tautomerism.

Aromaticity: Huckel rule, **B**enzenoid and non-benzenoid molecules, alternant and non- alternant hydrocarbons, Homo-aromatic, anti-aromatic, non aromatic & psedoaromatic systems . Annulenes and hetero- annulenes.

Addition compounds, crown ether complexes, cryptands, inclusion compounds, catenanes, valence isomers, fluxional molecules.

Acids and Bases: Introduction to acids and bases, Bronsted-Lowry concept, organic acids and bases, pKa and pH, effect of solvent on acid and base strength, effect of structure of organic compound on acid and base strength, Lewis acids and bases, acid-base reactions.

UNIT II **16 hrs**

Reaction Intermediates: Generation, structure, stability, reactivity and detection of classical and non-classical carbocations, carbanions, free radicals, carbenes, nitrenes and arynes. Singlet oxygen-generation and reactions with organic molecules.

Methods of Determining Reaction Mechanism: Kinetic and non-kinetic methods, Identification of products, detection of intermediates, isotopic labeling, stereochemical evidences, cross-over experiments, kinetic evidences and kinetic isotopic effects.

UNIT III **16 hrs**

Free Radical Reactions: Types, mechanisms of free radical substitution reactions & neighbouring group assistance. Reactivity for the aliphatic and aromatic substances at a bridgehead.Reactivity of attacking radical. Effect of solvent on reactivity.Auto-oxidation, coupling of alkynes. Arylation of aromatic compounds by diazonium salts. Sandmeyer, Ullmann & Hunsidiecker reactions. Allylic halogenation (NBS).

Elimination Reactions: Discussions of E_1, E_2, E_1cB and E_2cB mechanisms. Orientation during elimination reactions. Saytzeff and Hofmann rules. Reactivity-effects of substrate structures, attacking base, leaving group and solvent medium.

Pyrolytic Eliminations: Mechanisms of pyrolysis of esters of carboxylic acids. Chugaev reactions, Hofmann degradation, Cope elimination.

UNIT IV **16 hrs**

Stereochemistry

Optical Isomerism: Conformation and configuration of molecules, projection formulae, Fischer, Saw-horse, Newman and Flying wedge representations. Absolute configuration (D, L) and (R, S) systems. Elements of symmetry, chirality, molecules with more than one chiral centre, threo and erythro isomers, methods of resolution, stereospecific and stereoselective synthesis, asymmetric synthesis.

Optical activity in the absence of chiral carbon-biphenyls, allenes and spiranes. Stereochemistry of compounds containing nitrogen, sulphur and phosphorus. Conformational analysis of cycloalkanes and decalins. Effect of conformation on reactivity. Polarimetry: Plane polarized light, instrumentation, acid-catalyzed muta rotation of glucose, Optical rotatory dispersion.

Geometrical Isomerism: Cis-trans isomerism resulting from double bonds, monocyclic compounds & fused ring systems. E, Z-notations, detemination of configuration of geometrical isomers by physical & chemical methods, syn & anti isomers.

References:

1.Organic Chemistry-P.Y.Bruice (Pearson Education Pvt. Ltd.,New Delhi),2002.

2.Stereochemistry, Conformation and Mechanism-P.S.Kalsi (Wiley Eastern,New Delhi)1993.

3.Stereochemistry of Carbon Compounds-E.L.Eliel (Tata McGraw Hill, New. Delhi) 1994.

4.Advanced Organic Chemistry-Reactions, mechanisms & structure-J.March (Wiley, NY)2000.

5.Organic Chemistry-Vol. -1,2 &3-Mukherji, Singh and Kapoor. (Wiley Eastern,) 1994.

6.A Guide book of mechanisms in Organic Chemistry-P.Sykes (Orient- Longman) 1985.

7.Organic Chemistry-R.T. Morrison and R.N. Boyd (Prentice Hall, New Delhi) 1994.

8.Organic Chemistry 4thEdn. –S.H. Pine et al (McGraw-Hill, London) 1987.

9.Advanced Organic Chemistry- R.A. Carey and R.J. Sundberg (Plenum, New York)1990.

10.Modern Concepts of Advanced Organic Chemistry-R.P. Narein (Vikas, Delhi) 1997.

11.A Text book of Organic Chemistry-Tewari, Vishnoi and Mehrotra (Vikas, New Delhi)1998.

12.A Text book of Organic Chemistry-3rd Edn. -R.K. Bansal, (New Age, New Delhi) 1997.

13.Organic Chemistry-3rd Edn- F.A. Carey (Tata McGraw Hill, New Delhi) 1996.

15.Pathway to Organic Chemistry – Structure and Mechanism, P. Bhattacharjee, Arunabha

Sen Books and Allied Pvt. Ltd., Kolkta, India, 2012

ChL 1.2 Organic Chemistry-I

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

1. Acid + Phenol
2. Phenol + Base
3. Base + Neutral
4. Acid + Base
5. Phenol + Neutral
6. Acid + neutral
7. & 8, 9 10

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. Laboratory techniques in Organic chemistry V.K. Ahluwalia, Pooja Bhagat & Renu Aggarwal, I.K. International Publishing House, Pvt.Ltd.2005.
8. Laboratory Manual of Organic Chemistry, Raj K. Bansal. 5th edition, New Age international, 2008.
9. Practical Organic Chemistry F.G. Mann, B.C Saunders, Fourth edition, Pearson India, 2009.

Ch 1.3 PHYSICAL CHEMISTRY – I **64 hrs**

Course objectives:

- To learn laws of thermodynamics and their applications
- To study the rate of chemical reaction
- To learn about surface chemistry and catalysis
- To understand the concept of electrochemistry

Course outcome:

Help the students to gain knowledge and theoretical concept of

- thermodynamics,
- chemical kinetics,
- surface chemistry and
- electrochemistry.

UNIT I **16 hrs**

Thermodynamics

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). Entropy of vaporization and Trauton's rule, Van't Hoff's equation, Nernst heat theorem. 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 – chemicalpotential 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 II **16 hrs**

Chemical Kinetics and Phase Equilibria

Chemical Kinetics: Complex reactions- parallel, consecutive and reversible reactions. Chain reactions (H_2-halogen reactions). Branched chain reactions- general rate expression, explosion limits Photochemical (H_2-halogen reactions) (Qualitatively) and oscillatory reactions.

Reactions in Solution: Ionic reactions - salt and solvent effects. Substituent effects on the rates of reactions - Hammett and Taft equations, linear free energy relationships.

Theories of Reaction Rates: Activated complex theory and its applications to reactions in solution.

Phase Equilibria: Introduction, derivation of phase rule, applications of phase rule to Two-component systems (ferric chloride-water system), three-component systems (two solids + one liquid system, and three liquid systems).

UNIT III **16 hrs**

Surface Chemistry and Catalysis

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, Michaelis-Menten equation, effect of temperature, pH and concentration on enzyme catalysis.
Homogeneous & 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 IV **16 hrs**

Electrochemistry

Electrolytic solutions, 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] (qualitatively).
Thermodynamics of electrolytic cells, Half-cell reactions, reversible electrodes, single electrode potential, standard electrode potentials, electrochemical series, Nernst equation. Electrochemical energy systems - introduction, fundamentals of batteries, dry cell, Li batteries and other secondary and reserved batteries. Fuel cells, Types of fuel cells, H_2 O_2 fuel cells, Methanol oxygen fuel cells.

References:

1. *Quantum Chemistry*, R.K. Prasad, 4th Edition, New Age International Publishers, New Delhi, 2010.
2. *Principles of Physical Chemistry (Comprehensive UGC Syllabus)*, B.R. Puri, L.R. Sharma, M.S. Pathania, 46th Edition, Vishal Publishing House, Jalandhar, India, 2012.
3. *Physical Chemistry – A Molecular Approach*, Donald A. McQuarrie, John D. Simon, 3rd Edition (Viva Student Edition), Viva Books Pvt. Ltd., New Delhi, 2011.
4. *Elements of Physical Chemistry*, B.R. Puri, L.R. Sharma, M.S. Pathania, 1st Edition, Vishal Publishing House, Jalandhar, India, 2013.
5. *Physical Chemistry*, N.B. Singh, S.S. Das, R.J. Singh, 2nd Edition, New Age International Publishers, New Delhi, 2007.
6. *Atkins' Physical Chemistry*, Peter Atkins, 8th Edition, Jolio De Paula, International Student Edition, Oxford University Press, New York, 2010.
7. *Physical Chemistry*, Ira N Levine, 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.
8. *Physical Chemistry,* R. Stephen Berry, Stuart A. Rice, John Ross, 2nd Edition, Oxford University Press, New York, 2007.
9. *Chemical Kinetics,* K.J. Laidler, 3rd Edition, Pearson Education Pvt. Ltd., New Delhi, 2004.
10. *Electrochemistry,* B.K. Sharma, Krishna Prakashan Media (p) Ltd, 1998.
11. *Fundamentals of Molecular Spectroscopy*, Colin N. Banwell, Elaine M. McCash, 4th

Edition,Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
12. *Thermodynamics, Kinetic Theory, and Statistical Thermodynamics*, Francis W. Sears Gerhard L. Salinger, 3rd Edition, Narosa Publishing House, New Delhi, 1998.
13. *An Introduction to Electrochemistry*, Samuel Glasstone, Litton Educational Publishing, Inc., New York, 2008.
14. *Industrial Electrochemistry*, D. Pletcher and F.C. Walsh, Chapman and Hall, 2nd Edition, 1984.
15. *Industrial Electrochemistry*, F. C. Walsh D. Pletcher, Kluwer Academic Pub, 2nd Edition, 1990.

ChL 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. Reaction kinetics (i) To study the effect of ionic concentration on the rate constant of the reaction.
3. Reaction kinetics (ii) To study the effect of ionic concentration on the rate constant of the reaction.
4. Conductrometric titration of a strong acid v/s strong base.
5. Conductrometric titration of a weak acid v/s strong base.
6. Potentiometric redox titration ($K_2Cr_2O_7$ v/s FAS).
7. Potentiometric redox titration ($KMnO_4$ v/s FAS).
8. Potentiometric titration (CAS v/s FAS).
9. Determination of pKa value of weak electrolyte (acetic acid) by conductometric titration.
10. Determination of pKa value of weak electrolyte (formic acid) by potentiometric titration.
11. Partial molar volume of ethanol-water system.

REFERENCES:

1. Advanced Practical Physical Chemistry, J.B.Yadav, Krishna Prakashan Media, 2014.
2. College Practical Chemistry, V.K. Ahulwalia, Sunitha Dhigra Adarsh Gulati, Universities Press (India) Limited, 2012.
3. Experimental Physical Chemistry, V.D.Athawale, Parul Mathur, New age international publication, 2007.
4. Practical Physical Chemistry, B. Vishwanathan, P.S.Raghavan, 2012.
5. Experimental Physical Chemistry: Laboratary Text, Arthur Halpern, Geoge McBane, 3rd Edition, 2006.
6. Physical Chemistry Practical, Saroj Kumar Maity, Naba Kumar Ghosh, New Central Book Agency (P) Limited, 2012.
7. Vogel's Quantitative Chemical Analysis, J Mendham, 6th edition. Pearson, 2009.
8. Practical Physical chemistry, Findlay Alexander, 17th Edition, 1906.
9. Experiments in Physical Chemistry, Carl Garland Joseph Nibler, David Shoemaker, 8th Edition, 2011.
10. Practical Physical chemistry, James Brierley firth, Van Nostrand, 1916.
11. Findlay's Practical Physical chemistry, B.P. Levitt, 9th Edition, 2012.
12. Experiments in Physical Chemistry, J. M. Wilson, R. J. Newcombe, A. R. Denaro, 2nd Edition, 2013.
13. A Manual of Practical Physical Chemistry (Classic Reprint), Francis William Gray, 2018

Ch 1.4 ANALYTICAL CHEMISTRY-I

64 hrs

Course Objective

- To learn about the selection rule for UV, IR & NMR.
- To Determine the vibrations for a different molecule and identify whether they are active/inactive for UV, IR & NMR.
- To justify the difference in intensity between Stokes and anti-Stokes lines.
- To analyze the deferent molecules & to understand the applications

Course Outcome:

- Describe the selection rule for UV, IR & NMR.
- Determine the vibrations for a various molecule and identify whether they are Active / Inactive for UV, IR & NMR .
- Determine whether the molecular vibrations of a triatomic molecule are Raman active.
- Explain/ Justify the difference between Stokes and anti-Stokes lines in a Raman spectrum.

Unit I **16 hrs**

Statistical Analysis of Data in Analytical Chemistry

Data Analysis: Classification of analytical methods Principles of sampling the sampling step. Methods for sampling solid, liquid and gaseous samples. Types of instrumental analysis.

Errors in Chemical Analysis: Errors, types of errors, Accuracy and Precision, Limitations of analytical methods, determinate and indeterminate errors, minimization of errors. distribution of random errors, the normal error curve, Gaussian curve. Statistical treatment of finite samples, measure central tendency -mean, medium, range, average deviation, relative average deviation, standard deviation and variance. Confidence limits, Comparison of an experimental mean and a true mean. F-test, rejection of result - Q-test, Student's t-test. significant figures. Least square methods. Correlation and regression.

Unit II **16 hrs**

Classical Methods for Quantitative Analysis

Volumetric Titrations:

a. **Acid-Base:** Theory of indicators, Ex: Phenolphthalein, Methyl red. Titration curves for mono functional acid and base, pH calculations.
b. **Complexometry:** Theory of metal ion indicators, EDTA titrations, suitability of polydentate ligands as titrants, expressions for the different forms of EDTA in solution as a function of pH. Masking and demasking.
c. **Redox:** Mechanism of indicator action, criteria for the selection of indicators. Feasibility of redox titration. Titration of multicomponent system. Nernst equation. Applications.

Non Aqueous Titrations:

a. **Precipitation:** Solubility product. Theoretical principles of precipitation: Titration curve, end point detection, Applications.
b. **Gravimetry:** Quantitative precipitation, *Precipitation from Homogeneous Solution (PFHS)*, Formation and treatment of precipitates, co-precipitation, post precipitation. Conditions for precipitation, washing, drying and igniting the precipitates, Important precipitating agents such as DMG, oxime, thiocyanate and their significance in inorganic analysis.

Unit III **16 hrs**

Instrumental Methods for Quantitative Analysis

Spectrophotometric Method: Basic principle and Instrumentation, Beer-Lambert's law, molar absorptivity, Sandell sensitivity, Calibration with standards: standard addition, internal standard addition, limit of detection, limit of quantification, photo electric colorimeter, merits and limitations.

Nephelometry and Turbidimetry: Light scattering, Principles, Instrumentation and applications.

Coulometric Methods: Principles and techniques, Instrumentation, advantages and applications.

Amperometry: Principle, amperometric titration curves, amperometric indicators, biamperometric titrations, advantages and applications.

UNIT IV **16 hrs**

Basic concepts in electrochemical techniques

Electrochemical Cell: Components, conduction, reactions, liquid junctions, salt bridge representation. Faradaic and non-faradaic currents. Reversible and irreversible cells.

Electrode Potential: Nature, measurement, sign convention, effect of concentration. Standard electrode potential, calculation limitations,

Cell Potential: Thermodynamics, liquid junction potential, effect of current, ohmic potential,

Polarization: Sources, overvoltage, concentration polarization, mechanism of mass transport,

Membrane Electrodes: Classifications, properties, principle, design of ion selective electrodes, membrane potential, selectivity, crystalline liquid membrane and enzyme electrodes, Glass Electrode: Composition, hygroscopicity, asymmetry potential, acid and alkali errors.

Potentiometric methods: Reference electrodes- calomel, silver/silver chloride and hydrogen electrodes, potentiometric titrations and applications.

Conductrometric methods: Definitions, conductance measurement, conductrometric titrations and applications

ChL 1.4 Applied Analysis I

1. Determination of total hardness of water sample
2. Determination of alkalinity of water sample
3. Determination of P^{Ka} value of weak acid
4. Estimation of TDS in a water sample
5. Determination of COD of a water sample
6. Colorimetric determination of Cu
7. Determination of Phosphorus by volumetric method
8. Determination of dissolved oxygen (DO) by Winkler's method
9. Determination of nitrate in water samples.
10. Colorimetric determination of methylene blue
11. Analysis of lead in industrial effluents by spectrophotometry

Reference books:

1. Principle of Quantitative Chemical Analysis – Robert de levie, International edition (1997) McGraw Hill Co.
2. Quantitative Analysis- Day and Underwood, Prinitce Hall Indian, Pvt Ltd 6thedition(1993).
3. Vogel's Textbook of quantitative chemical analysis- Revised by G.H.jaffery, J. Bassett, J. Mendhm and R.C. Denney ELBS 5th edition (1998).
4. Quantitative Chemical Analysis: D.C Harris W.M. Freeman and Co, NY, USA, Ed, (1995).
5. Introduction to Instrumental Analysis – R.D Brun, McGraw Hill Book company(1982).
6. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York, 2005.
7. Analytical Chemistry, G.D. Christian, 6th edition, John Wiley & Sons, Inc, India, 2004.
8. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, Prentice Hall, Inc. New Delhi, 1993
9. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd., New Delhi, 2003.
10. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
11. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, Blackwell Sci., Ltd. Malden, USA, 2000.
12. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
13. Practical Volumetric Analysis, Peter A C McPherson, RSC, Cambridge, UK, 2015.
14. Analytical Chemistry for Technicians, John Kenkel, 4th edition. CRC Press, London, 2014.
15. Undergraduate Instrumental Analysis, J.W. Robinson, E.M. Skelly Frame, G. M. Frame II, 6th edn. Marcel Dekker, New York, 2009. Instrumental methods of chemistry analysis, H Kaur. 2014.

Ch 2.1: INORGANIC CHEMISTRY - II 64 hrs

Course Objectives:

- Examine and apply the Wade's rules and Framework electron counting for boranes, carboranes and metallocarboranes.
- To know the geometry and Coordination numbers in coordination compounds and predict the d-orbital splittings in octahedral, square planar and tetrahedral complexes.
- To learn bonding and structural elucidation metal carbonyls by using magnetic and X-ray evidences. To know the Metal clusters and their different types, bonding in metal clusters.
- To be able to describe various types of reduction of oxide ores like chemical and electrolytic reductions and also Ellingham diagram. oxidation states of lanthanides and their extraction and separation, stereochemistry, spectral and magnetic properties.

Course Outcome:

- To impart knowledge on the higher boranes P-S cage compounds and S-N compounds.
- Understanding coordination numbers and their geometry, CFT of coordination compounds and their d-orbital splitting pattern. Interpretation of MO energy level diagrams for octahedral and tetrahedral complexes.
- To be able to understand the preparative methods, structure and bonding of metal carbonyls.
- To be able to understand the different methods of reduction of oxide ores, especially chemical and electrolytic reductions and also learn Latimer and Frost diagrams, effect of complexation on potential. To be able to explain the extraction properties and separation of lanthanides.

UNIT I **16 hrs**

Rings and Cages: Chemistry of higher boranes, classification, structures and M.O. description of bonding, framework electron counting, Wade's rules, chemistry of B_5H_9, $B_{10}H_{14}$ and $B_nH_n^{2-}$. carboranes and metallocarboranes. Conversion of carboranes into boranes, examples with calculations. Cyclophosphazenes, phosphazene polymers, P-O and P-S cage compounds. S-N compunds: binary sulphur nitrides- S_4N_4, S_2N_2 and $(SN)_x$. Borazines and boron nitride, Isopoly and heteropoly acids of transition metals.

Unit II **16 hrs**

Coordination chemistry –I: Coordination numbers 2-10 and their geometry, crystal field theory of coordination compounds, d-orbital splittings in octahedral, square planar and tetrahedral fields, spectrochemical series of ligands and the effect of covalency, Jahn-Teller effect.
Structural evidences for ligand field splittings – hydration, ligation and lattice energies, site preference energies. MO theory of coordination compounds- MO energy level diagrams for octahedral and tetrahedral complexes. Electronic absorption spectra of complex ions. Stepwise and overall formation constants, factors affecting stability of metal complexes, determination of binary formation constants by pH-metry and spectrophotometry.

Unit III **16 hrs**

Metal Carbonyls and Cluster: Metal Pi-acceptor complexes: metal carbonyls – preparative methods, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, magnetic and X-ray evidences of structures, reactions metal carbonyls. Metal carbonylates and carbonyl halides – preparation and important reactions. Chemistry of metal nitrosyls – preparation, structure and bonding; dinitrogen and dioxygen complexes. Metal-metal bonding in carbonyls and halides, evidences for M-M bonding, factors favouring M-M bond formation. Metal clusters- bi-, tri-, tetra-, penta- and hexanuclear metal clusters, bonding in metal clusters. Zintl ions and Chevrel phases.

Unit IV: Concept of Reduction of Ores and Inner Transition Metals **16 hrs**

Methods of reduction of oxide ores, Ellingham diagram, chemical and electrolytic reductions, reduction potentials, Latimer and Frost diagrams, effect of complexation on potential.

Lanthanides and actinides: electronic structure, oxidation states, extraction and separation of lanthanides, stereochemistry, spectral and magnetic properties of lanthanide and actinide complexes.

References:

1. J. E Huheey, E.A..Keiter, R.L.Keiter & O K Medhi: Inorganic Chemistry (4th edn.),Pearson, 2006.
2. Shriver, Atkins and Langford: Inorganic Chemistry (3rd edn.) OUP, 1999.
3. J.D.Lee: Concise Inorganic Chemistry, (5th edn.) Blackwell Science, 2000.
4. B.E.Douglas, D.McDaniel &A Alexander: Concepts & Models of Inorganic Chemistry, Wiley 2001
5. W.W. Porterfield: Inorganic chemistry – A Unified Approach, Elsevier, 2005.

ChL-2.1: INORGANIC CHEMISTRY-II

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 available chlorine in bleaching powder.
6. Estimation of amount of copper present in $CuSO_4$ solution.
7. Separation and estimation of Copper and Iron in a solution mixture.
8. Separation and estimation of Nickel and Iron in a solution mixture.
9. Estimation of Chlorate in potassium chlorate solution.

REFERENCES:

1. Vogel's Textbook of quantitative chemical analysis- Revised by G.H.jaffery, J. Bassett, J. Mendhmand R.C. Denney ELBS 5thedition (1998).
2. Concise coordination Chemistry , - R Gopalan , V Ramalingam, vikas Publicatin 2nd Edition,2008
3. College Practical Chemistry, - V k Ahluwalia Sunita Dhingra, Adarsh Gulati, Universities Press (India) Limited, 2rd Edition, 2005
4. Analytical Chemistry, - G.D. Christian, BrwkslCole Publishing Co, 4th Edition, Vol. 1, 2003
5. Text Book of Practical Inorganic Chemistry, Kaza Somasekhara Rao, Kalyani Publishers, 1st Edition 2004.
6. Principles of Inorganic Chemistry,- Puri, Sharma, Khalia,Vallabh Publications, 29th Edition,2004.

Ch 2.2 ORGANIC CHEMISTRY-II **64 hrs**

Course objectives:

- To learn about aliphatic, aromatic nucleophilic and electrophilic substitution reactions.
- The types of substitution reaction, addition reaction, and stereochemistry.
- To understand the difference between conformation and configurations. Stereochemistry of saccharides, monosaccharide and general structural degradation technique of the polysaccharides.
- Heterocyclic compounds synthesis and reactivity and applications.

Course outcome:

Students will gain the knowledge about:

- Aliphatic, Aromatic Nucleophilic substitution reactions.
- Named reaction and their application.
- Understand the importance of carbohydrates and synthesis, to learn the general structural degradation of carbohydrates.
- To understand the physical and chemical properties of heterocyclic compound

UNIT I **16 hrs**

Aliphatic Nucleophilic Substitution Reactions: Mechanism and scope of aliphatic nucleophilic substitution reactions-S_N1, S_N2 and S_Ni. Stereochemistry of nucleophilic substitution reactions, allylic nucleophilic substitution reactions, neighboring group participation and anchimeric assistance. Factors influencing the rates of nucleophilic substitution reactions.

Aliphatic Electrophilic Substitution Reactions: Bimolecular mechanisms-S_E1, S_E2 and S_Ei mechanism. Electrophilic substitution reactions accompanied by double bond shifts.

Aromatic Electrophilic and Nucleophilic Substitution Reactions: Mechanism of aromatic electrophilic substitution reactions, Arenium ion mechanism, orientation and reactivity, energy profile diagram. The ortho/para ratio, ipso attack, orientation in other ring systems. Mechanism of Vilsmeir-Haack reaction, Pechmann reaction and Fries rearrangement. Mechanisms of aromatic nucleophilic substitution reactions- S_NAr, S_N1 & aryne mechanism.Von-Richter rearrangement, Bischler-Napieralske reaction, diazonium coupling, Sommelet-Houser rearrangement, Smiles rearrangement.

UNIT II **16 hrs**

Formation and Hydrolysis of Esters: Plurality of mechanism. Mechanism of esterification reactions. Ester hydrolysis-$A_{AC}2$, $B_{AC}2$, $A_{AC}1$ & $A_{AL}1$ mechanism. Trans esterification.

Addition to Carbon-Carbon Multiple Bonds: Addition reactions involving electrophiles, nucleophiles and free radicals. Cyclic mechanisms. Orientation and stereochemistry. Addition of halogens, hydrogen halides, carboxylic acids and amines. Addition to cyclopropanes, hydroboration, Michael addition. Addition of oxygen across double bonds.

Addition to Carbon-Hetero Multiple Bonds: Electrophilic, nucleophilic and free radical additions to C=O and C=N systems. Addition of Grignard reagents. Reformasky reaction, aldol condensation, Knoevenagel condensation, Perkin reaction and Wittig reactions.

UNIT III **16 hrs**

Carbohydrates

Configuration and conformation of monosaccharides, Chemistry of important derivatives of monosaccharides-ethers, esters, acetals, ketals, deoxysugars, aminosugars, Osazones. Structure of disaccharides-maltose, cellobiose and sucrose. Fischer Kilanisynthesis, Ruffs degradation. General methods of structural degradation of polysaccharides-methylation, partial hydrolysis, periodate oxidation, Smith degradation. Structures of cellulose, chitin, starch and glycogen.

UNIT IV **16 hrs**

Chemistry of Heterocyclic Compounds

Introduction, saturated and unsaturated heterocycles, three membered heterocycles - structure, reactivity, synthesis and reactions of aziridines, epoxides. Four membered heterocyclic compounds - Synthetic methods, physical and chemical properties of azetidines, thietanes. Five membered simple - synthesis & reactions of derivatives of furan, pyrrole, thiophene & Six membered heterocycles- synthesis & reactions of derivatives of pyridine. Seven membered heterocycles- azepines, oxepines. Fused heterocycles – indole & quinolone. Biological importance of heterocycles.

References:

1.Organic Reactions and Their Mechanisms- P.S. Kalsi (New Age, New Delhi),1996.

2.Advanced Organic Chemistry 4th Edn- J. March (Wiley, NY) 2000.

3.Organic Reaction Mechanisms- Bansal (Tata McGraw Hill, New Delhi) 1978.

4.Organic Chemistry-Vol. –I & II-Mukherji, Singh and Kapoor. (WileyEastern, New Delhi) 1985.

5.Mechanism and Theory in Organic Chemoistry-Lowry and Richardson Harper and Row, 1987.

6. An Introduction to the Chemistry ofHeterocyclic Compounds-Acheson (Wiley –Eastern) 1987.

7.Heterocyclic Chemistry-J. Joule & G. Smith, (Van-Nostrand, ELBS), 1978.

8.Reaction Mechanisms in Organic Chemistry-Mukherji, Singhand Kapoor (McMillan) 1978.

9.Organic Chemistry-P.Y. Bruice (Pearson Education, New Delhi) 2002.

10.A Guide Book to Mechanisms in Organic Chemistry – Peter Sykes.1995.

11. Heterocyclic Chemistry, R.R Gupta, M. Kumar and V. Gupta, Springer Verlag. 1998.

12. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme. 1995.

13.Heterocyclic Chemistry, J.A Joule, K. Mills and G.F. Smith, Chapman and Hall. 1995.

14.Organic Chemistry of Natural Product Gurdeep R Chatwal, Volume-2. 1983.

ChL 2.2 Organic Chemistry-II

1) Preparation of nitroaniline from Acetanilide.
2) Preparation of p-bromoaniline from Acetanilide.
3) Preparation of Benzamide from Benzoyl chloride.
4) Preparation of Adipicacid from Cyclohexanol.
5) Preparation of Benzyl alcohol and benzoic acid by Cannizzaro reaction.
6) Preparation of Benzoic acid from benzaldehyde by $KMnO_4$ oxidation.
7) Isolation of Caffeine from tea leaves
8) Isolation of Piperine from pepper

Books Recommended:

1. Advanced Practical Organic Chemistry, N.K. Vishnoi.1979.
2. A Hand Book of Organic Analysis, H.T Clarke.1967.
3. Text Book of Practical Organic Chemistry, Arthur I Vogel, ELBS.5th Edition.1989.
4. Laboratory Manual of organic chemistry, Raj K Bansal, 5Th Edition, New Age International, 2008.
5. Systematic Laboratory Experiments in Organic, Chemistry Arun Sethi, New Age International, 2003.Laboratory techniques in Organic chemistry V.K., Ahluwalia, Pooja Bhagat & Renu Aggarwal, I.K. International Publishing House Pvt. Ltd. 2005.
6. Practical Organic Chemistry F.G. Mann, B.C Saunders, Fourth edition, Pearson India,2009.

Ch 2.3 PHYSICAL CHEMISTRY-II **64 hrs**

Course objectives:

- To understand the concept of black body radiation, Schrödinger equation and its significance
- Hybridization and geometry of molecules in HMO and its application
- To learn about Maxwell-Boltzmann statistics and its applications. Calculation of different types of energies by statistical thermodynamics.
- To know about types of corrosion and methods of prevention of corrosion.

Course outcome:

Students are able to gain the knowledge about:

- quantum mechanics,
- chemical bonding in diatomic,
- statistical thermodynamics and
- corrosion and metal finishing.

UNIT I **16 hrs**

Quantum Mechanics-1

A brief resume of black body radiation, and atomic Spectra-Bohr's theory of hydrogen atom. Photoelectric and Compton effects, de-Broglie concept, uncertainty principle, operators, matrix representation and commutation relationships, Schrodinger equation, significance and characteristics of wave function, eigen functions and eigen values. Probabilities, normalisation and orthogonality. Postulates of quantum mechanics. Solution of Schroedinger wave equation for exactly solvable problems such as particle in a box (1D and 3D), particle in a ring, harmonic oscillator, rigid rotor and hydrogen atom (separation of r,θ,ϕ equations and their solutions), Quantum numbers and their characteristics, orbital diagrams.

UNIT II **16 hrs**

Chemical Bonding in Diatomic

Hybridization and geometry of molecules in terms of molecular orbitals (bond angle, dihedral angle), localised and delocalised molecular orbitals.

Conjugated and aromatic molecules: Huckel molecular orbital (HMO) theory of linear conjugated systems (ethene, allyl & butadiene systems) and aromatic molecules (benzene as an example). Calculation of delocalization energies, bond order & charge density. An introduction to Extended Huckel Theory and its simple applications (as a means to explain modern theoretical methods: Semi empirical and ab initio SCF methods).

UNIT III **16 hrs**

Statistical Thermodynamics

Micro and macrostates, phase space and ensembles. Concept of distribution - thermodynamic probability and most probable distribution - Maxwell-Boltzmann distribution law. Maxwell's distribution of molecular velocities. Maxwell-Boltzmann statistics and applications, Bose-Einstein and Fermi-Dirac statistics. Evaluation of Lagrange's undetermined multipliers, Partition functions - definitions and separations, evaluation of translational, rotational, vibrational and

electronic partition functions for monoatomic, diatomic and polyatomic gaseous molecules. Calculations of thermodynamic functions entropy and equilibrium constant in terms of partition functions, entropy of monoatomic gas - Sackur-Tetrode equation, comparison of 3rd 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-T3 law.

UNIT IV **16 hrs**

Corrosion and Its Control: Introduction, Types of corrosion (atmospheric, environmental and microbial). Galvanic series – merits and demerits, thermodynamics and kinetics of corrosion, mechanism of corrosion, factors effecting rate of corrosion, corrosion rate measurement, corrosion failure and passivity. Methods of prevention of corrosion, corrosion problems in practice.

Metal Finishing: Introduction- EMF series, 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 (Ni, Zn, brass, bronze). Electro less plating of Cu and Ni.

References:

1. Physical Chemistry, 5th Ed., - Atkins, (ELBS) 1995.
2. Introductory Quantum Chemistry – A.K. Chandra (Tata McGraw Hill) 1994.
3. Thermodynamics - Rajaram and Kuriokose (East-West) 1986.
4. Statistical Thermodynamics, M. C. Gupta (Wiley eastern Ltd.) 1993.
5. Corrosion engineering by Mars G. Fontana (Tata McGraw Hill) 2005.
6. A text book of engineering chemistry, C. Muthukumar, D. H. Manjunatha, K. Gurushantha, (Himalaya Publication) 2018.

ChL 2.3 Physical Chemistry Practicals - II

1. Determination of mean ionic activity co-efficient of weak acid (formic acid) conductometric method.
2. Determination of mean ionic activity co-efficient of weak acid (acetic acid) by conductometric.
3. Determination of pKa 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 BaCl2 solution conductometrically.
10. Determination of strength of $NiSO_4$ solution using BaCl2 solution conductometrically.
11. Heast of solution of benzoic acid.
12. Heat of solution of salicylic acid.

References:

1. Advanced Practical Physical Chemistry, J.B.Yadav, Krishna Prakashan Media, 2014.
2. College Practical Chemistry, V.K. Ahulwalia, Sunitha Dhigra Adarsh Gulati, Universities Press (India) Limited, 2012.
3. Experimental Physical Chemistry, V.D.Athawale, Parul Mathur, New age international publication, 2007.
4. Practical Physical Chemistry, B. Vishwanathan, P.S.Raghavan, 2012.
5. Experimental Physical Chemistry: Laboratary Text, Arthur Halpern, Geoge McBane, 3rd Edition, 2006.
6. Physical Chemistry Practical, Saroj Kumar Maity, Naba Kumar Ghosh, New Central Book Agency (P) Limited, 2012.
7. Vogel's Quantitative Chemical Analysis, J Mendham, 6th ed. pearson 2009.
8. Practical Physical chemistry, Findlay Alexander, 17th Edition, 1906.
9. Experiments in Physical Chemistry, Carl Garland Joseph Nibler, David Shoemaker, 8th Edition, 2011.
10. Practical Physical chemistry, James Brierley firth, Van Nostrand, 1916.
11. Findlay's Practical Physical chemistry, B.P. Levitt, 9th Edition, 2012.
12. Experiments in Physical Chemistry, J. M. Wilson, R. J. Newcombe, A. R. Denaro, 2nd Edition, 2013.
13. A Manual of Practical Physical Chemistry (Classic Reprint), Francis William Gray, 2018.

Ch 2.4 CHROMATOGRAPHY AND SCPECTROSCOPY **64 hrs**

Course objectives:

To learn about

- Learn how to find solutions for problems encountered when running HPLC analysis by diagnosing symptoms and implementing appropriate preventative measures.
- Basic principles of Spectroscopy, UV/Electronic Spectroscopy.
- Microwave Spectroscopy and Vibrational and Spectroscopy, IR and Raman Spectroscopy.
- Nuclear Magnetic Resonance Spectroscopy.

Course outcome:

Students will acquire knowledge about

- This course is ideal for those who have experience using HPLC and now want to develop their skills further.
- IR Spectrophotometer-Instrumentation, sample handling techniques.
- Applications of IR and Raman spectroscopy.
- Applications of NMR spectroscopy in structure elucidation and medical diagnostics.

UNIT I **16 hrs**

Chromatographic Techniques

Fundamentals of Chromatography: General description, definition, terms and parameter used in Chromatography, classification of Chromatographic methods, criteria for selection of stationery phase, and mobile phase, nature of adsorbents, factor influencing the adsorbent, Nature and type of mobile phase and stationery phase

Elution Chromatography: Van Demeter's equation, and its modern version, optimization of column performance, interrelationships-capacity factor, selectivity factor, column resolution, distribution constant and applications of conventional column Chromatography, advantages and limitations.

Paper Chromatography: Definition, mechanism, Methodology selection of mobile phase, advantages and applications.

Thin Layer Chromatography (TLC): Definition, mechanism, efficiency of TL Plates. Methodology selection of stationery phase, and mobile phase, preparation of plates, spotting development, identification and detection, reproducibility of RF values, advantages and applications.

Ion Exchange, Affinity, Size exclusion & Gel Chromatography: Definition, mechanism, Methodology, advantages and applications.

Gas Chromatography (GC): Principle, comparison of GSC and GLC, instrumentation column packed and tubular, study of detector-thermal conductivity, flame ionization, election capture and mass spectrometry (GC-MS), factors affecting separation, applications.

High pressure liquid Chromatography (HPLC): apparatus, pump, column packing, characteristics of liquid Chromatographic detector-UV, IR, refractometer and fluorescence detector, RP & NP-HPLC, Super critical fluid chromatography, advantages and application.

UNIT II **16 hrs**

Unifying Principles: Electromagnetic radiation, dual nature, regions of the spectrum, interaction of electromagnetic radiation with matter

UV/Electronic Spectroscopy: Basic principles, Beer-Lambert law, molar absorptivity, energy levels, types of electronic transitions. Franck - Condon principles, ground and excited electronic states of diatomic molecules. Chromophores, auxochromes, electronic spectra of polyatomic molecules, charge transfer spectra. Instrumentation and application. Factors affecting the positions of UV bands. Woodward–Fieser rules. Emperical rules to calculate $\lambda_{max.}$ Application of UV spectroscopy in the structural study of organic molecules.

Microwave Spectroscopy- The rotation and classification of molecules, rotation spectra of diatomic and polyatomic molecules. Rigid and non-rigid rotator models. Determination of bond lengths, isotope effect on rotation spectra. Stark effect, nuclear and electron spin interaction.

UNIT III **16 hrs**

IR and Raman Spectroscopy

Vibration-rotation spectra of diatomic and polyatomic molecules (Ex-CO_2 & H_2O), selection rules, linear harmonic oscillator, vibrational energies, zero-point energy, force constants & bond strengths. IR Spectrophotometer-Instrumentation, sample handling techniques, FTIR Spectroscopy. Far IR region - metal-ligand vibrations, normal co-ordinate analysis. Factors affecting band positions and intensities such as effect of hydrogen bonding, phase and solvent on vibrational frequencies, overtones, combination bands, and hot bands. PQR branches and Fermi resonance.

Raman Spectroscopy: Classical and quantum theories of Raman effect, concept of polarizability. Rotational and vibrational Raman spectra, selection rules, Raman activity of vibrations, vibrational - rotational Raman spectra, selection rules, mutual exclusion principle, polarization of Raman lines. Introduction to Laser Raman Spectroscopy. Raman Spectrometer – instrumentation. Applications of IR and Raman spectroscopy in elucidation of molecular structure (Ex- H_2O, N_2O & CO_2 molecules). An introduction to Resonance Raman Spectroscopy.

UNIT IV **16 hrs**

Nuclear Magnetic Resonance Spectroscopy

Magnetic properties of nuclei, theory and measurement techniques, NMR spectrometer, FT NMR and its advantages. Solvents used, chemical shift and its measurements, factors affecting chemical shift. Integration of NMR signals, spin-spin coupling, coupling constant. Shielding and deshielding. Chemical shift, assignment of major functional groups, Classification (ABX, AMX, ABC, A_2B_2), spin decoupling; effects of chemical exchange. Karplus relationships (Karplus curve–variation of coupling constant with dihedral angle), double resonance techniques, NMR shift reagents, solvent effects and Nulear Overhauser Effect. High resolution ^1H NMR. Applications of NMR spectroscopy in structure elucidation of simple organic and inorganic molecules. ^1H NMR in the structural study of organic compounds. Pulse techniques in NMR, two dimensional and solid state NMR. Use of NMR in Medical diagnostics.

ChL 2.4 Applied Analysis II

1. Colorimetric determination of Fe
2. Nepholometric determination of Barium
3. Colorimetric estimation of salicylic acid
4. Analysis of mixture of oxalic acid & sodium oxalate
5. Determation of Ca carbonate in tablet by EDTA titrations
6. Determination strength of $ZnSO_4$ by conductrometric method by using $BaCl_2$ by ppt. method
7. Determination of Vitamin-C in citrus juice by iodometric method
8. Determination saponification value of edible oil
9. Conductrometric determination of chloride content of a sample of industrial effluent.
10. Determination of fluoride in drinking water by spectrophotometry
11. Estimation of mixture of solvents by Gas Chromatography.

References:

1. Fundamentals of Molecular Spectroscopy, Banwell & McCash (Tata McGraw Hill) 2001.
2. Organic Spectroscopy-3rd ed.-W. Kemp (Pagrave Publishers, New York), 1991.
3. Spectrometric Identification of Organic Compounds-Silverstein, Bassler & Monnill (Wiley) 1981.
4. Instrumental methods of analysis, H. Kaur, 2014.
5. Modern spectroscopy, Fourth Edn, J. Michael Hollas,
6. Molecular Structure and Spectroscopy, G Aruldas.
7. Organic spectroscopy by P. S. Kalsi.
8. Introduction to Spectroscopy, Donald L. Pavia
9. Organic Structures from Spectra, by L. D. Field, S. Sternhell, J. R. Kalman.
10. Spectroscopy by Samuel Delvin
11. 2D NMR-Based Organic Spectroscopy Problems by Huggins and Gurst.

Ch. 3.1 ORGANOMETALLIC CHEMISTRY **64 hrs**

Course objectives:

To learn about:

- organometallic Synthesis and its applications
- introduction of Transition Metal Complex
- transition Metal-Carbon Pi Complexes,
- industrial Organometallic Reaction

Course outcome:

Students will acquire knowledge about:

- Properties and applications of various organometallic compounds, and Carbene complexes and metallocycles, arene complexes.
- Structure and bonding, reactivities of Zeies's salt.
- The concept of Fluxional isomerism and Isolobal concept, Industrial Catalysts.
- Hydrogenation and Polymerization of olefins and acetylenes.

Unit I **16 hrs**

Organometallic Synthesis and its applications

Introduction, Main group organometallics- preparation, properties and applications of organometallic compounds of Li, Mg, Hg, Zn, Cd and Sn. Synthetic applications of organo-transition metal compounds: organocuprates. Hydrozirconation, transmetallation reactions by organopalladiums and organonickels, carbonylation by metal carbonylates, decarbonylation, carbene complexes and metallacycles, arene complexes.

UNIT II

Introduction to Transition Metal Complex: Nomenclature and Classification- on the basis of hapticity, composition, position of metal in the periodic table and nature of metal carbon bonds, bond energies and stability. 18electron rule. Transition metal alkyls and aryls- types, general characteristics, routes of synthesis, stability and decomposition pathways.

Transition metal to carbon multiple-bonded compounds carbenes, carbynes, structure and bonding, synthetic routes, nature of bond-agostic interactions, structural characteristics and reactivity. Tebbe's reagent.

Unit III **16 hrs**

Transition Metal-Carbon Pi Complexes

Transition metal-carbon pi complexes: various Preparative methods, nature of bonding, Catalysis by organometallic compounds:16- and 18-electron rules, structural features of olefinic (Zeies's salt-structure and bonding), η^5- cyclopentadienyl (ferrocene and its structure and bonding), η^6- benzene and other arenes. Stability concept of cyclic compounds. Important reactions relating to nucleophilic and electrophilic attack on ligands. Fluxional isomerism in various olefin, allyl, dienyl and cyclopentadienyl complexes. Isolobal concept, representation, structures and examples

Unit IV **16 hrs**

Industrial Organometallic Reaction

Oxidative addition, insertion, deinsertion and reductive elimination reactions. Homogeneous catalysis by organometallics- hydrogenation, hydrosilation, hydrocyanation and isomerization of olefins, immobilisation of homogeneous hydrogenation catalysts,

Hydrocarbonylation of olefins (oxo reaction–cobalt and rhodium oxo catalysts), carbonylation of alcohols- Monsanto acetic acid process. Fischer –Tropsch reaction, Water Gas Shift reactions.

Polymerization of olefins: Ziegler-Natta & metallocene polymersiations.

References:

1.J.P. Collman, L.S.hegedus, J.R.Norton and R.G.Finke: Principles and Applications of
2.Organotransition Metal Chemistry, University Science Books, 1987.
3.R.C. Mehrotra and A. Singh: Organometallic Chemistry, New Age International, 1999.
4.R.H. Crabtree: Organometallic Chemistry of Transition Metals, Wiley, 1999.
5.F.A. Cotton and G.Wilkinson : Advanced Inorganic Chemistry, Wiley, 1991.

ChL 3.1 Inorganic Chemistry III

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

References:

1. Vogel's Textbook of quantitative chemical analysis- Revised by G.H.jaffery, J. Bassett, J. Mendhmand R.C. Denney ELBS 5thedition (1998).
2. Concise coordination Chemistry, - R Gopalan, V Ramalingam, vikas Publicatin 2nd Edition,2008
3. College Practical Chemistry, - V k Ahluwalia Sunita Dhingra, Adarsh Gulati, Universities Press (India) Limited, 2rd Edition, 2005
4. Analytical Chemistry, - G.D. Christian, BrwkslCole Publishing Co, 4th Edition, Vol. 1, 2003
5. Text Book of Practical Inorganic Chemistry, Kaza Somasekhara Rao, Kalyani Publishers, 1st Edition 2004.
6. Principles of Inorganic Chemistry, - Puri, Sharma, Khalia, Vallabh Publications, 29th Edition,2004.

Ch 3.2: REACTION MECHANISMS AND NATURAL PRODUCTS **64 hrs**

Course Objective:

- To impart knowledge of mechanisms of substitution, addition, elimination reaction and different bond formation through some named reactions in organic chemistry.
- To teach the concepts and critical bond forming reactions in organic synthesis and molecular rearrangements.
- To introduce synthesis and reactivity of aliphatic and aromatic heterocyclic compounds, and importance of some natural products.
- To study the mode of bond formation in sigma and pi bonding system along with types of bonds present in the molecules.

Course Outcome:

The students will acquire knowledge of,

- Reaction conditions, products formation and mechanisms of some named reactions.
- Mechanistic aspects in nucleophilic and electrophilic substitution through different molecular rearrangements.
- Conversion of different functional group via rearrangement reaction
- Classification and importance of various natural products, mechanisms of bond formation in electrocyclic, sigmatropic and electrocyclic reactions,.

Unit I **16 hrs**

Organic Name Reactions: Reactions, Mechanisms and synthetic uses of the following: Stolbe condensation, Darzen condensation, Gattermann-Koch reaction, Cannizzaro reaction, Chichibabin reaction, Benzoin condensation, Claisen-Schmidt condensation, Claisen reaction, Simon-Smith reaction, Stork Enamine reactions, Sharpless asymmetric epoxidation, Hofmann-Loffler-Freytag reaction, Suzuki coupling, Woodward and Prevost Hydroxylation, Bucherer reaction, Ullmann reaction. Wittig reaction-Mitsunobu reaction. Mannich reaction, Barton reaction, Umpolung reaction. Reactions of phosphorus ylides, Reactions of sulfur ylides-with carbonyl compounds.

Unit II **16 hrs**

Molecular Rearrangements: Classification and general mechanistic treatment of nucleophilic, electrophilic and free radical rearrangements. Intermolecular and Intramolecular migration, nature of migration and migratory aptitudes. Mechanism of Wagner-Meerwein, Dienone-Phenol, Pinacol-Pinacolone, Demaynov, Benzil-Benzilic acid, Fries, Wolff, Favorskii, Neber, Benzidine, Baeyer-Villiger, Beckmann, Lossen, Curtius, Schmidt, Stevens, Shapiro, Baker-Venkatraman and Amadori rearrangement. Photo-Fries rearrangement.

Unit III **16 hrs**

Natural Products:

Introduction, Structure and synthesis of cholesterol. Estrone, progesterone, testosterone, Biosynthesis of cholesterol- any two steps.

Alkaloids: Introduction, Classification. Isolation and general methods of structural elucidation. Structure and synthesis of quinine, morphine, thiophine, flavones and isoflavones, Biological importance of alkaloids.

Terpinoids: Introduction, Classification and general methods of structural elucidation. Chemistry of pinene, camphor, Biological importance of terpinoides.

Anthocyanins: Introduction, general Nature of anthocyanin. Structure and synthesis of Anthocyanidins.

Unit IV **16 hrs**

Pericyclic Reactions: Classifications of Pericyclic reactions, salient features Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl systems. Woodward-Hoffmann correlation diagram and FMO approach.

Electrocyclic Reactions: Introduction, Con-rotatory & dis-rotatory Process/bond formation. 4n, (4n+2) and allyl systems.

Cycloaddition reaction: Supra facial and Antra facial addition,[2+2],[4+2],[6+2]cyclo additions.

Sigmatropic reactions: Supra facial and Antra facial bond formation of H, [1,3] & [1,5] - Sigmatropic shifts. Claisen, Cope, Oxy-Cope and Aza-Cope rearrangements.

References:

1. O.L. Chapman, Organic Photochemistry. Vol I & II. Marcel Decker.1967.
2. Francis A Carey and R. J. Sundberg, Advanced Organic Chemistry-Part A &(Plenum).1977.
3. Mukherji Singh and Kapoor, Organic Chemistry, Vol 1-3, (WileyEastern, New Delhi).1996.
4. Synthetic Organic Chemistry- G.R.Chatwal (Himalaya, Bombay), 1994.
5. Organic Reaction Mechanisms, V.K.Ahluwalia&R.K.Parashar (Narosa) 2006
6. Organic Chemistry, Vol I-II, I.L.Finar,(Longmann ELBS, London), 1973.
7. Advanced Organic Chemistry- ReactionMechanisms, ReinhardBruckner(Academic) 2005.
8. Pericyclic reactions, S.M Mukherji (The McMillan Bangalore), 1979.
9. Organic Reactions and their mechanisms- P.S.Kalsi (New Age, New Delhi), 1996.
10. Organic Chemistry Vol I & II by I.L. Finar, ELBS.1964.
11. Reaction Mechanism in Organic Chemistry by S.M.Mukherji and S.P.Singh, MacMillan (India).1984.
12. Organic Chemistry of Natural Products. By Gurdeep R. Chatwal., Himalaya Publishing House. 1983.
13. Chemistry of Natural Products, S.N. Bhat.1996.
14. Organic Chemistry – Natural Products, O.P. Agarwal, Vol. II, GOEL Publishing House, Meerut, India, 2004.
16. Introduction to Alkaloids – G.A. Swan.1967.
17. The Alkaloids - K.W. Bently.2000.

18. Chemistry of Natural Products by Sujata V. Bhat, Bhimsen A. Nagasampagi, Meenakshi Sivakumar. 2005.

ChL 3.2 Organic Chemistry III

1. Estimation of amines by bromination method.
2. Estimation of phenols by bromination method.
3. Estimation of Amino acids.
4. Determination of saponification value of an oil sample.
5. Estimation of glucose by Fehling solution method.
6. Estimation of glucose by Iodometric method.
8. Estimation of Keto group by oxime method.
9. Estimation of Ascorbic acid.
10. Determination of amide by hydrolysis method.
11 Estimation of Acid and Amid in a given mixture.
12. Estimation of Carboxylic acid group.
13. Estimation of Amide Volumetric method.

References:

1. Advanced Practical Organic Chemistry, N.K. Vishnoi.1979.
2. A Hand Book of Organic Analysis, H.T Clarke.1967.
3. Systematic Quantitative Organic Analysis, H. Middleton, Edward Arnold Lts.1941.
4. Text Book of Practical Organic Chemistry, Arthur I Vogel, ELBS. 1941.
5. Quantitative Analysis, Day and Underwood, Prentice/Hall Pvt. Ltd. 6th Edition. 1993.
6. 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).
7. 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.
8. Laboratory techniques in Organic chemistry V.K. Ahluwalia, Pooja Bhagat&Renu Aggarwal, I.K. International Publishing House Pvt. Ltd. 2005.
9. Practical Organic Chemistry, F.G. Mann, B.C Saunders, Fourth edition, Pearson India,2009.

Ch 3.3 PHYSICAL CHEMISTRY - III **64 hrs**

Course Objectives:

- Improve their knowledge of the basic information radioactivity and applications in nuclear chemistry.
- To demonstrate the application of spectroscopic and electrochemical methods in mechanistic studies of photochemical reactions, broad variety of photochemical systems and their applications
- Describe the essential conditions of the various electroanalytical techniques; polarogram, polarographic measurements, Coulometry, Cyclic voltammetry, Electrogravimetry.
- Put light on atomic structure based on quantum mechanics and their theories for periodic properties of the atoms, approximate methods for solving the Schrödinger equation.

Course Outcome:

- Understand and explain the concept of basics and applications in nuclear power, medical treatment, isotopic labelling, and carbon dating.
- Able to propose a method suitable for mechanistic studies of a particular homogeneous or heterogeneous photochemical system as well as suggest the type of photomaterial for a specific application.
- Specific application of Electroanalytical Techniques.
- Basic non-relativistic quantum mechanics, the time-dependent and time-independent Schrödinger equation for simple potentials like for instance the harmonic oscillator and hydrogen like atoms.

UNIT I 16 hrs

Nuclear and Radiation Chemistry

Nuclear structure and stability: Nuclear properties - nuclear forces, mass defect and binding energy. Nuclear Stability-Liquid drop, shell and collective models.

Nuclear Reactions, Energy and Nuclear Power reactors - Nuclear fission and fusion.

Types of nuclear power reactors, basic features and components of a nuclear power reactor. An introduction to breeder reactors.

Radiation chemistry- units of radiation energy, G-value Dose, chemical Dosimetry: Fricke and Ceric sulphate dosimeters, Radiation chemistry of water.

Radiation Detectors -ionization chambers, proportional and Geiger-Muller, scintillation and semiconductor radiation detectors.

Applications of Radioisotopes: C^{14} dating, Medical, agricultural and industrial applications.

Health and Safety Aspects: Biological effects of radiation, Hazards in radiochemical work. Radiation protection. Radioactive waste management.

UNIT II 16 hrs

Photochemistry

Inroduction, Quantum yield and its determinations, experimental methods in photochemistry, Actinometry. Laws, kinetics of photochemistry and reactions. Frank- Condon principle. Absorption and emission spectra- effect of solute-solvent interactions on electronic spectra-spectral shifts.

Photophysical pathways- Jablonski diagram, Radiationless transitions and selection rules. Flourescence and phosphorescence- theory and applications. Photochemical kinetics of unimolecular and bimolecular processes. Quenching-collisions in the gas phase, solution (Stern-Volmer equation) & by added substances. Photophysical Reactions-Types-Photo-dissociation, Isomerisation and other rearrangement reactions with specific examples.

UNIT III 16 hrs

Electroanalytical Techniques

Introduction to electrodes and electrochemical cells. 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.

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 16 hrs

Quantum Mechanics-2

Need of approximate methods in quantum chemistry. Approximate methods of solving Schroedinger equation for problems of chemical interest - variation and perturbation methods. Application of variation method to H & He atoms, the structure of many electron systems/atoms (secular equations & determinants), Spin-orbit interaction, antisymmetry and Pauli exclusion principle. Angular momenta (commutations, relations, operators), Term symbols, Russell-Saunders terms and coupling schemes, Slater orbitals and SCF method for many electron systems.

Molecular wave functions: Born-Oppenheimer approximations. Covalent bond –valence bond and molecular orbital approaches with comparisons. MO theory applied to homonuclear and heteronuclear diatomics by LCAO methods, correlation diagrams, non-crossing rule.

References:

1. Principles of Radiochemistry, Eds: Sood, Ramamoorthy & Reddy (IANCAS, BARC Mumbai)
2. Radiation Chemistry: An Overview, D.B. Naik and S. Dhanya (BARC, Mumbai)
3. Nuclear and Radiation Chemistry –Friedlander, Kennedy Macias & Miller (Wiley) 1981
4. Essentials of Nuclear Chemistry- H.J.Arnikar (Wiley Eastern) 1987.
5. An Introduction to Radiation Chemistry, Spinks and Woods (Wiley, New York) 1990
6. Fundamentals of Photochemistry – Rohatgi and Mukherje (New Age Bangalore) 2000.

ChL 3.3 Physical Chemistry Practicals III

a. Conductometry

1. Determination of hydrolysis constants (aniline hydrochlride etc.).
2. Titration of a mixture of acetic acid, monochloro and trichloacetic acids with NaOH.
3. Determination of concentrations/amounts of sulphuric acid, acetic acid and copper sulphate by conductometric titration with sodium hydroxide.
4. Determination of strength of oxalic acid by conductometric titration with sodium hydroxide.
5. Determination of strength and amount of HCl and NH_4Cl mixture by conductometric method
6. Determination of pH and pK_a of a given weak acid at various dilutions.
7. Determination of activity coefficient of Zinc ions in 0.002M $ZnSO_4$.

b. Potentiometry

1. Determination of pK values of maleic acid/malonic and phosphoric acid by potentiometric titration with sodium hydroxide using glass electrode.
2. Determination of acidic and basic dissociation constants and isoelectric point an amino acid.
3. Determination of pK_a values of functional groups in amino acids using a pH meter.
4. Determination of activity coefficient of an electrolyte at different molalities.
5. Determination of pKa values of mono,di and tri-acid base.

References:

1. Advanced Practical Physical Chemistry, J.B.Yadav, Krishna Prakashan Media, 2014.
2. College Practical Chemistry, V.K. Ahulwalia, Sunitha Dhigra Adarsh Gulati, Universities Press (India) Limited, 2012.
3. Experimental Physical Chemistry, V.D.Athawale, Parul Mathur, New age international publication, 2007.
4. Practical Physical Chemistry, B. Vishwanathan, P.S.Raghavan, 2012.
5. Experimental Physical Chemistry: Laboratary Text, Arthur Halpern, Geoge McBane, 3rd Edition, 2006.
6. Physical Chemistry Practical, Saroj Kumar Maity, Naba Kumar Ghosh, New Central Book Agency (P) Limited, 2012.
7. Vogel's Quantitative Chemical Analysis, J Mendham, 6th ed. pearson 2009.
8. Practical Physical chemistry, Findlay Alexander, 17th Edition, 1906.
9. Experiments in Physical Chemistry, Carl Garland Joseph Nibler, David Shoemaker, 8th Edition, 2011.
10. Practical Physical chemistry, James Brierley firth, Van Nostrand, 1916.
11. Findlay's Practical Physical chemistry, B.P. Levitt, 9th Edition, 2012.
12. Experiments in Physical Chemistry, J. M. Wilson, R. J. Newcombe, A. R. Denaro, 2nd Edition, 2013.
13. A Manual of Practical Physical Chemistry (Classic Reprint), Francis William Gray, 2018

Ch 3.4 ADVANCED ANALYTICAL TECHNIQUES **64 hrs**

Course Objectives:

- to explain the principles, techniques and instrumentation involved in X-Ray diffraction techniques and basics of photoelectron spectroscopy,
- interpretation of photoelectron spectra of simple molecules and applications of photoelectron spectroscopy.
- to understand about the NMR of ^{13}C, ^{19}F ^{19}F, ^{31}P NMR, ^{31}P, NQR.
- UV, Electron Spin Resonance, mass and Mössbauer spectroscopy.

Course Outcome:

At the completion of this unit students should be able to:

- demonstrate the ability to apply basics of X-Ray Diffraction Techniques, evaluate the mass spectra of organic compounds, evaluate the photoelectron spectra of small molecules, UV, IR, ^{1}H and ^{13}C NMR and mass spectroscopic techniques
- demonstrate and interpret ^{13}C, ^{19}F & ^{31}P spectra of simple inorganic compounds and NMR of paramagnetic complexes.
- apply important concepts and principles of Mössbauer Spectroscopy to study the Fe^{2+} / Fe^{3+} and Sn^{2+} / Sn^{4+} compounds and draw conclusions about their Mössbauer Spectra.
- demonstrate knowledge about the structural elucidation of organic molecules.

UNIT I **16 hrs**

X-Ray Diffraction Techniques: Origin and production of X-rays, interaction of X-rays with matter, absorption, scattering and diffraction. Crystal structure –unit cell, lattices, planes and Miller indices, reciprocal lattice, Bragg's law, instrumentation – applications. Chemical analysis by X-ray diffraction & fluorescence, determination of particle size and micro/macro strains (Sherrer's Equation).

Photoelectron spectroscopy: Basic principles, Photoelectron spectra of simple molecules, Auger transitions, measurement techniques. Applications.

SEM & AFM- Basic principles, Instrumentation & Applicatons

UNIT II **16 hrs**

NMR of Nuclei Other Than Proton: ^{13}C chemical shift & factors affecting it Coupling constants. Decoupling-Noise decoupling & broad band decoupling. Off-resonance proton decoupling-some representative examples. ^{19}F & ^{31}P NMR- Predicting the spectra of simple inorganic compounds, NMR of paramagnetic complexes.

Electron Spin Resonance Spectroscopy: Basic principles, hyperfine couplings, the 'g' values, factors affecting 'g' values, isotropic and anisotropic hyperfine coupling constants, Zero Field splitting and Kramer's degeneracy. Measurement techniques and Applications to simple inorganic and organic free radicals and to inorganic complexes.

UNIT III **16 hrs**

Mass Spectrometry: Basic principles, Instrumentation -Mass spectrometer, interpretation of mass spectra, resolution, molecular ions, meta-stable ions, isotope ions and Nitrogen rule. Fragmentation processes-representation of fragmentation, basic fragmentation, types and rules. Factors influencing fragmentations and reaction pathways. McLafferty rearrangement. Fragmentations ion analysis, ion abundance, retro Diels-Alder fragmentation. Fragmentation patterns-some representative examples, Application in structure elucidation. High resolution mass spectrometers.

UNIT IV **16 hrs**

Mössbauer Spectroscopy: The Mössbauer effect, quadrupole interactions, measurement techniques and spectrum display, isomer shifts, Zeeman effect, application to the study of Fe^{2+} and Fe^{3+} compounds, Sn^{2+} and Sn^{4+} compounds (nature of M-L bond, coordination number and structure), detection of oxidation states and inequivalent Mössbauer atoms.

NQR Spectroscopy: Quadrupolar nuclei, electric field gradient, nuclear quadrupole coupling constants, energies of quadrupolar transitions, effect of magnetic field. Applications.

Composite problems involving the applications of UV, IR, ^{1}H and ^{13}C NMR and mass spectroscopic techniques. Structural elucidation of organic molecules.

ChL 3.4 Analytical Chemistry I

1. Nepholometric determination of sulphate/phosphate.
2. Determination of BOD of a water sample
3. Analysis of Na_2CO_3 / $NaHCO_3$ in washing and baking soda by acid base titration
4. Determination of iron in mustard seed by spectrophotometry
5. Determination of copper by potentiometric titration using EDTA.
6. Conductrometric determination of total acidity of waste water.
7. Photocatalytic degradation of organic dyes
8. Spectral data analysis and structural elucidation of organic molecules (each any two)
9. Determination of Total Nitrogen in the soil sample by Kjedhal's method.
10. Determination of urea and uric acid by spectrophotometry
11. Spectrophotometric determination of Sulphur / phosphorus present in soil.

References:

1. Fundamentals of Molecular Spectroscopy, Banwell & McCash (Tata McGrawHill)2001.
2. Organic Spectroscopy-3rd Ed.-W.Kemp(Pagrave Publishers, New York), 1991.
3. Spectrometric Identification of Organic Compounds - Silverstein,Bassler & Monnil l(Wiley)1981.
4. Applications of Absorption Spectroscopy of Organic Compounds-Dyer (Prentice Hall, NY)1965.
5. Spectroscopy of Organic Compounds-3rd Ed.-P.S.Kalsi (New Age, New Delhi)2000.
6. E.A.V.Ebsworth, D.W.H.Ranklin and S.Cradock: Structural Methods in Inorganic Chemistry, Blackwell Scientific, 1991.
7. R.S.Drago: Physical Methods for Chemists, Saunders College Publishing, 1992.
8. D.N.Satyanarayana: ElectronicAbsorption Spectroscopyand Related Techniques,
9. G.Aruldhas, Molecular Structure and Spectroscopy, Prentice Hall, 2001
10. J. A. Iggo: NMR Spectroscopy in Inorganic Chemistry, Oxford University Press, 1999.
11. C.N.R.Rao and J.R. Ferraro: Spectroscopy in Inorganic Chemistry, Vol I&II(Academic)1970
12. Analytical Chemistry-Open Learning: Mass spectrometry.
13. Spectroscopic Methods in Organic Chemistry - Williams and Fleming, TMH.
14. Elements of X-ray diffraction' B.D. Cullity and S.R.Stock, 2001,Prentice Hall, Inc. USA
15. Transmission electron microscopy" D.B. Williams and C.Barry Carter, 4 volumes, Springer, 1996. USA
16. Spencer, Michael, Fundamentals of Light Microscopy, Cambridge UniversityPress,1982.
17. David B. Williams, C.Barry Carter," Transmission Electron Microscopy:A Textbook for Materials Science" ,Springer, pub. 2009.
18. Joseph I Goldstein, Dale E Newbury,Patrick Echlin and David C Joy,"Scanning Electron Microscopy and X-Ray Microanalysis", 3rd Edition , 2005
19. B.D.Cullity and S.R.Stock,"Elements of X-Ray Diffraction" Third edition,Prentice Hall, NJ , 2001.
20. G.W.H. Hohne, W.F. Hemminger, H.-J. Flammersheim ,"Differential Scanning Calorimetry",Springer, 2nd rev. a. enlarged ed., 2003.
21. 'Fundamentals of light microscopy and electronic imaging' Douglas B. Murphy, 2001, Wiley-Liss, Inc. USA

ChL 4.4 Analytical Chemistry II

1. Analysis of saccharin in tablets by argentometric titration.
2. Determination of mercury in algaecide by EDTA titration.
3. Determination of CaO in the given cement solution
4. Determination of sulphate in ground water samples by Spectrophotometric method
5. Determination of CO_2 in the sewage water sample
6. Determination of potassium in soil by flame photometry.
7. Cyclic voltammetric determination of Potassium ferri cyanide in the given solution.
8. Nephalometric determination of phosphate in domestic waste water.
9. Analysis of copper in bronze alloy by iodometric titration
10. Synthesis of nano metal oxides by Sol-gel method.
11. Identification of Caffeine in the given solution by HPLC.

Reference books:

1. Principle of Quantitative Chemical Analysis – Robert de levie, International edition (1997) McGraw Hill Co.
2. Quantitative Analysis- Day and Underwood, Prinitce Hall Indian, Pvt Ltd 6th edition (1993).
3. Vogel's Textbook of quantitative chemical analysis- Revised by G.H.jaffery, J. Bassett, J. Mendhm and R.C. Denney ELBS 5th edition (1998).
4. Quantitative Chemical Analysis: D.C Harris W.M. Freeman and Co, NY, USA, Ed, (1995).
5. Introduction to Instrumental Analysis – R.D Brun, McGraw Hill Book company (1982).
6. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, Prentice Hall, Inc. New Delhi, 1993
7. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd., New Delhi, 2003.
8. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, Blackwell Sci., Ltd. Malden, USA, 2000.
9. Practical Volumetric Analysis, Peter A C McPherson, RSC, Cambridge, UK, 2015.
10. Analytical Chemistry for Technicians, John Kenkel, 4th edition. CRC Press, London, 2014.
11. Instrumental methods of analysis, H. Kaur, 2014.

Ch 4.1 COORDINATION AND BIOINORGANIC CHEMISTRY 64 hrs

Course Objectives:

To learn about:

- spectral and magnetic properties of transition metal complexes
- reaction mechanisms in transition metal complexes
- metal ions in biological systems
- bio molecule system in transport and storage

Course Outcome:

After the completion of this students should be able to:

- Interpretation of spectral bands: Orgel diagrams, Tanabe-Sugano diagrams, Charge transfer bands. and Origin, measurement of magnetic susceptibility – Gouy and Faraday methods.
- Kinetics & mechanistic aspects of substitutions. reactions and Role of Metal ions in biological systems,Various Metallo proteins as enzymes:
- Specific enzymes, structure & functions examples...
- Transport and storage proteins, Biological nitrogen fixation and Metals in medicine & metal complexes as drugs

UNIT I

Spectral and Magnetic Properties of Complexes **16 hrs**

Spectral and Magnetic properties of complexes: Terms, states, microstates and calculations. Term symbols for d^n ions, derivation of terms for p^2 and d^2 systems. Comparison of d^n and d^{10-n} systems Energy orders of various terms and spectroscopic states. Spectroscopic ground states, selection rules: Spin selection rule and Loporte selection rule. Nature of spectral bands- band shapes, band intensities, band widths, spin-orbit coupling.

Orgel diagrams, Tanabe-Sugano diagrams, interpretation of spectra of octahedral and tetrahedral complexes. Charge transfer bands – origin, types, and characteristics. Type of magnetic behaviour, orbital contribution, spin orbit coupling, gauss theorem, measurement of magnetic susceptibility – Gouy and Faraday methods.

Unit II **16 hrs**

Reaction Mechanisms in Transition Metal Complexes

Reaction Mechanisms in Transition Metal Complexes: Energy profile of a reaction, inert and labile complexes, kinetics of octahedral substitution and mechanistic aspects. Acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism and evidences in its favour. Anation reactions, reactions without M-L bond cleavage. Substitution reactions in square planar complexes, trans series, trans effect, mechanisms of substitution. Electron transfer reactions- inner sphere and outer sphere reactions, complimentary and non-complimentary reactions.

Unit III **16 hrs**

Metal ions in Biological Systems

Metal ions in biological systems, essential and trace metals, disease due to metal deficiency and treatment: Iron, zinc, copper, manganese, sodium, potassium, magnesium and calcium. Metal complexes as therapeutic agents: Metal complexes in cancer therapy, metal complexes for the treatment of rheumatoid arthritis, vanadium in diabetes, metal complexes as radio diagnostic agents. Treatment of toxicity due to inorganics: Chelation therapy and requirements of a

chelate/antidote. Mechanism of antidotes with poison rendering it inert: Arsenic, lead, mercury, iron, copper, plutonium, cyanide and carbon monoxide poisoning. Ion transport across membranes and active transport of ions across biological membranes, ionophores. Metal complexes in transmission of energy: Chlorophyll, photosystems–I and II in cleavage of water and model systems.

Unit IV **16 hrs**

Biomolecule System in Transport and Storage

Transport and storage of dioxygen, heme proteins, oxygen uptake, functions of haemoglobin, myoglobin, hemerythrin and hemocyanins, synthetic oxygen carriers. Metal storage and transport: Ferritin, transferrin and ceruloplasmin. Electron transfer proteins: Cytochromes, iron–sulphur proteins. Metalloproteins as enzymes: Carboxy peptidase, carbonic anhydrase, catalases, peroxidases, cytochrome P–450, cytochrome c–oxidase, superoxide dismutase, copper oxidases and vitamin B12 coenzyme. Biological nitrogen fixation, in vivo–andin vitro– nitrogen fixation.

References:

1. D.N. Satyanarayana: Electronic absorption Spectroscopy and Related Techniques, OUP, 2001.
2. F. Basolo and R.G.Pearson: Inorganic Reaction Mechanisms, Wiley Eastern, 1979.
3. W.W. Porterfield: Inorganic chemistry – A Unified Approach, Elsevier, 2005.
4. R.L.Dutta and A Syamal : Elements of Magneto chemistry, Affiliated east-West, 1993.
5. J. E Huheey, R.L. Keiter and A.L. Keiter: Inorganic Chemistry(4^{th} edition),Addison Wesley, 2000.
6. M.N. Hughes: Inorganic Chemistry of Biological Processes, (2^{nd} edition.) Wiley, 1988.
7. I.Bertini. H.B.Gray, S.J.Lippard and J.S.Valentine: Bioinorganic Chemistry, Viva Books, 1998.

ChL 4.1 Inorganic Chemistry IV

1. Analysis of Cement.
2. Estimation of Copper in Brass.
3. Estimation of chloride by using sliver nitrate.
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.

References:

1. Vogel's Textbook of quantitative chemical analysis- Revised by G.H.jaffery, J. Bassett, J. Mendhmand R.C. Denney ELBS 5thedition (1998).
2. Concise coordination Chemistry, - R Gopalan, V Ramalingam, vikas Publicatin 2^{nd} Edition,2008
3. College Practical Chemistry, - V k Ahluwalia Sunita Dhingra, Adarsh Gulati, Universities

Press (India) Limited, 2rd Edition, 2005
4. Analytical Chemistry, - G.D. Christian, BrwkslCole Publishing Co, 4th Edition, Vol. 1,2003
5. Text Book of Practical Inorganic Chemistry, Kaza Somasekhara Rao, Kalyani Publishers, 1st Edition 2004.
6. Principles of Inorganic Chemistry, - Puri, Sharma, Khalia, Vallabh Publications, 29th Edition,2004.

Ch 4.2 Modern Interfaces of Organic Chemistry **64 hrs**

Course Objective:

- To impart knowledge of different reducing agents, metal catalysis, reagents and their current applications in synthetic organic chemistry.
- To acquire knowledge different oxidising agents with their reaction condition for the synthesis of organic molecules and functional group interconversion.
- Planning of drug design and different functional group transformation.
- Retrosynthetic analysis of different organic molecules.

Course Outcome:

The students will acquire knowledge of

- experimental techniques for different catalytic reactions.
- various reagents and their applications in industry
- drug designing and development by using different oxidising and reducing agents, mechanistic pathway of organic reactions
- retrosynthetic approach to planning organic syntheses

Unit I **16 hrs**

Reduction Reactions: Catalytic hydrogenation-homogenous, heterogeneous. Catalytic hydrogenation: Introduction, catalysts and solvents employed, reduction of functional groups, mechanisms and stereochemistry of catalytic hydrogenations, Hydrogenolysis, Rhodium complex and homogeneous catalytic Hydrogenation-Wilkinson's catalyst.

Mechanisms of reduction of conjugated system and carbonyl compounds, Birch reduction, Reduction with hydrazine, and its derivative, Raney Ni, Nonmetallic reduction reagents-N_2H_4, N_2H_2 and related reactions, Reduction with arene sulphonyl derivative of hydrazine, Reaction with diimide and related compounds.

Metal hydride reduction: Reduction with $LiAlH_4$, $NaBH_4$, $NaBH_3CN$, DIBAL-H, Stereo chemistry of reduction and other functional groups, Functional group transformation during reduction, Reduction with diborane and related reactions - 9-BBN, thexylboranes.

Unit II **16 hrs**

Oxidation reactions: Introduction and different oxidative processes, Mechanism of oxidation reaction with chromium salts like chromic acid, chromium trioxide, Jones reagent, PCC, PDC, and manganese salts like MnO_2, $KMnO_4$, peracids, DDQ, periodic acid, Lead tetra acetate, Ozone, Osmium tetroxide, Selenium dioxide, Aluminium isopropoxide, Aluminium tertiary butoxide and their synthetic importance in functional group transformation. Oppenauer oxidations, Halogenation: Halogenation of olefins, carbonyl compounds, Benzyllic and Allylic halogenation, Dehalogenation reactions.

Unit III **16 hrs**

Synthetic Design: Carbon skeleton frame work, Classification of carbon-carbon single bond and double bond forming reaction and their use in carbon skeleton ring formation. Ring forming and ring cleaving reactions, use of Thorpe condensation, Carbene insertion reaction, Friedel-Crafts reaction, 1,3-dipolar addition and Ene reaction in ring formation, Oxidative cleavage of rings and Retro Diel's-Alder reactions.

Planning of organic synthesis: Selection of starting materials and key intermediates during the synthesis. Synthesis of Cubane and Iswarane. Use of Robinson annulation, Dickmann cyclisation, Arndt-Eistert synthesis and Diel's- Alder reaction in organic synthesis.

Functionality: Synthesis of 6- and 7- methoxytetralones, biotin and Penicillin-V with special reference to the introduction of functional groups. Stereo chemical consideration and stereo selectivity during organic synthesis.

Unit IV **16 hrs**

General introduction to disconnection approach. Basic principles and technologies used in disconnection approach. Synthons and synthetic equivalents. Interconversion of functional groups. One group C - X and two group. C - X disconnections.

Chemoselectivity, Protecting groups: Principle of protection of hydroxyl amino carboxylic and carbonyl groups.

Retrosynthesis: Alcohols, carbonyl compounds cyclic and acyclic alkanes, benzocaine, p-methoxyacetophenone, acetonecyanohydrin, 2-methyl-6-methoxy-indole-3- aceticacid, 6-methylquinoline & 1-phenyl-4-p-methoxyphenyl-1,3-butadiene

References:

1. Modern Organic Reactions- H.O. House.1965.
2. Organic Synthesis- R.E. Ireland (Prentice Hall India), 1969.
3. Art in Organic Synthesis- Anand, Bindra & Ranganath-(Wiley New Delhi), 1970.
4. Organic Synthesis a Disconnection Approach- Stuart. 2014.
5. Advanced Organic Chemistry-IV-Ed. Part A & B-F.J. Carrey & R.J. Sundberg (Kluwer) 2001.
6. Modern Methods of Organic Synthesis-N. Carruthers (Cambridge University), 1996.
7. Principles of Organic Synthesis. By R.O.C. Norman and J.M. Coxon. Blackie Academic & Professional.1993.
8. Advanced Organic Chemistry – Reactions, Mechanisms and structure. By Jerry March John Wiely. 2007.
9. Modern Synthetic Reactions by Herbert O. House. 2008.
10. Advanced Organic Chemistry: Reactions and Synthesis, Part A: Structure & Mechanism by Francis A. Carey; Richard J. Sundberg.2015.
11. Guide book to organic synthesis R.K. Mackie and D.M. Smith ELBS.1983
12. Organic synthesis. K. Ahuwalia and Renu Agrawal, Narosa Publication.2001.

ChL 4.2 Organic Chemistry-IV

1. Preparation of benzanilide from benzophenone.
2. Preparation of Benzilic acid from Benzoin.
3. Preparation of 1, 3, 5 tribromobenzene from aniline.
4. Preparation of p-aminoazobenzene from aniline.
5. Preparation of p-chlorotoluene from p-toluidine.
6. Preparation of acetophenone oxime from acetophenone and aniline.
7. Preparation of 3,5-dinitro benzoic acid from Benzoic acid.
8. Preparation of 2,4-dinitro phenol from chlorobenzene.
9. Preparation of Ethyl resorcinol from resorcinol.
10. Thin Layer Chromatography. (Demonstration)

Books Recommended:

1. Advanced Practical Organic Chemistry, N.K. Vishnoi.1979.
2. A Hand Book of Organic Analysis, H.T Clarke.1967.
3. Systematic Quantitative Organic Analysis, H. Middleton, Edward Arnold Lts.2017.
4. Text Book of Practical Organic Chemistry, Arthur I Vogel, ELBS. 1941.
5. Laboratory Manual of organic chemistry, Raj K Bansal, 5Th Edition, New Age International, 2008.
6. Systematic Laboratory Experiments in Organic Chemistry Arun Sethi, New Age International, 2003.
7. Laboratorytechniques in Organic chemistry, V.K. Ahluwalia, Pooja Bhagat & Renu Aggarwal, I.K. International Publishing House Pvt. Ltd. 2005.
8. Practical Organic ChemistryF.G. Mann, B.C Saunders, Fourth edition, Pearson India, 2009.

Ch 4.3 ADVANCED PHYSICAL CHEMISTRY **64 hrs**

Course Objectives

- To understand the concept of symmetry and Symmetry operation and their applications to study Infrared and Raman activity of molecules
- To learn about colloids, their functions and applications.
- To study the basics of polymers, their kinetics and application
- To understand the concept of pharmacokinetics and drug release studies.

Course outcome:

Students will gain the knowledge about

- molecular symmetry and application of group theory for construction of hybrid orbitals and the optical activity of the molecules
- colloids and their applications
- polymer chemistry and their applications
- pharmacokinetics and drug release studies.

UNIT I **16 hrs**

MOLECULAR SYMMETRY AND GROUP THEORY

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, Definition of point group, group multiplication tables (C_2V and C_3V point groups).

Matrix representation of point group, multiplication, Reducible and irreducible representations, character of a representation, properties of irreducible representations, construction of character tables (C_2V and C_3V point groups), orthogonal theorem, Mulliken symbols for irreducible representations, reduction formula.

Applications of Group Theory: Symmetry of normal modes of molecules, Cartesian coordinate method and internal coordinate method, 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 **16 hrs**

Colloids

Introduction, 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 nonelastic 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.

UNIT III **16 hrs**

Polymer Chemistry

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, kinetics of free radical polymerization, chain transfer reactions, anionic polymerization, co-polymerization. Polydispersivity. Properties of Conducting polymers and biomedical polymers.

UNIT IV **16 hrs**

Pharmacokinetics: Introduction to kinetics, ADME Basic terms – clinical pharmacokinetics, toxicokinetics, clinical toxicology, pharmacokinetic models and its uses. Types of pharmacokinetic modeling : Compatrment modeling, non- compatrment modeling. Advantages and disadvantages and uses of pharmacokinetics models. Compatment modeling: One, two and three compartment modeling. One compartment open model – intravenous bolus administration and continuous intravenous infusion, extra vascular administration. zero order absorption extra vascular administration and first order absorption.

REFERENCES:

1. Symmetry and Spectroscopy of Molecules, K. Veera Reddy, New Age International Pvt. Ltd., New Delhi, India, 1998.
2. Group theory and its applications to Chemistry – K.V. Raman, Tata McGraw Hill 1997.
3. Polymer Chemistry, Malcolm P. Stevans, First Indian Edition, Oxford University Press, New York, 2008.
4. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma, M.S. Pathania, 45th Edit ion, 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. Physical Chemistry, N.B. Singh, S.S. Das, R.J. Singh, 2nd Edition, New Age International Publishers, New Delhi, 2007.
8. Atkins' Physical Chemistry, Peter Atkins, 8th Edition, Jolio De Paula, International Student Edition, Osford University Press, New York, 2010.
9. Physical Chemistry, Ira N Levine, 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.
10. Physical Chemistry, R. Stephen Berry, Stuart A. Rice, John Ross, 2nd Edition, Oxford University Press, New York, 2007
11. Polymer Science – A Textbook, V.K. Ahluwalia, Anuradha Mishra, Ane Books India, Noida, 2008.
12. Polymer Science, V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, 5th Edition, New Age International Publishers, New Delhi, 2005.

13. An Introduction to Electrochemistry, Samuel Glasstone, Litton Educational Publishing, Inc., New York, 2008.
14. Industrial Electrochemistry, D. Pletcher and F.C. Walsh, Chapman and Hall, 2nd Edition, 1984.
15. Physical pharmaceutics by Manavalan. Ramasamy, Vignesh Publishers.
16. Physical pharmaceutics pulse publications.
17. Basic Pharmakinetics and Pharmacodynamics by Sara E. Rosenbaum, Wily publication.
18. Biopharmaceutics and Pharmacokinetics by J.S.Kulkarni, A.P.Pawar, V.P. Shedbakkar. CBS publishers and Distributers .

ChL 4.3 PHYSICAL CHEMISTRY PRACTICALS - IV

A. Kinetics and Catalysis

Determination of reaction order and activation parameters, study of acidity/salt/solvent/, catalytic effects on reaction rates of the reactions listed below.

1. Saponification of ethyl acetate by conductivity method.
2. Decomposition of benzenediazonium chloride.
3. Acid catalysed hydrolysis of methyl acetate.
4. To study the effect of ionic strength on the rate constant of the reaction between KI and $K_2S_2O_8$
5. Determination of rate constant of Fe(II) catalyzed decomposition of Hydrogen.

B. Polymer Chemistry

1. Determination of molecular weight and size parameters of polymers by viscometry.
2. Determination of density and viscosity of given liquid.

C. Thermodynamics Experiments

1. Determination of specific heat of liquids and solutions by calorimetry.
2. Determination of heat of solution of KNO_3 in water, integral heat of dilution of H_2SO_4 and heat of ionization of acetic acid and ammonium hydroxide calorimetrically.

D. Spectrophotometry

1. Spectroscopic investigation of partition coefficient of iodine between H_2O and $CHCl_3$.
2. To investigate the reaction between $K_2S_2O_8$ and KI by colorimetric measurements.

REFERENCES:

1. Advanced Practical Physical Chemistry, J.B.Yadav, Krishna Prakashan Media, 2014.
2. College Practical Chemistry, V.K. Ahulwalia, Sunitha Dhigra Adarsh Gulati, Universities Press (India) Limited, 2012.
3. Experimental Physical Chemistry, V.D.Athawale, Parul Mathur, New age international publication, 2007.
4. Practical Physical Chemistry, B. Vishwanathan, P.S.Raghavan, 2012.
5. Experimental Physical Chemistry: Laboratary Text, Arthur Halpern, Geoge McBane, 3rd Edition, 2006.
6. Physical Chemistry Practical, Saroj Kumar Maity, Naba Kumar Ghosh, New Central Book Agency (P) Limited, 2012.
7. Vogel's Quantitative Chemical Analysis, J Mendham, 6th ed. pearson 2009.
8. Practical Physical chemistry, Findlay Alexander, 17th Edition, 1906.
9. Experiments in Physical Chemistry, Carl Garland Joseph Nibler, David Shoemaker, 8th Edition, 2011.
10. Practical Physical chemistry, James Brierley firth, Van Nostrand, 1916.
11. Findlay's Practical Physical chemistry, B.P. Levitt, 9th Edition, 2012.
12. Experiments in Physical Chemistry, J. M. Wilson, R. J. Newcombe, A. R. Denaro, 2nd Edition, 2013.
13. A Manual of Practical Physical Chemistry (Classic Reprint), Francis William Gray, 2018

Ch.EL 3.5-1A ENVIRONMENTAL CHEMISTRY **28 hrs**

UNIT I

Water Pollution and Analysis **14 hrs**

Water resources, origin of waste water, types of water pollutions, their sources and effects. Chemical analysis for water pollution control- objectives of analysis, parameters of analysis, sample collection and preservation. Environmental/public health significance and measurement of color, turbidity, total solids, acidity, alkalinity, hardness, chloride, residual chlorine, sulphate, fluoride, phosphates, and different forms of nitrogen in natural and waste/polluted waters. Heavy metal pollution –public health significance of Pb, Cd, Cr, Hg, As, Cu, Zn, Mn. General survey of the instrumental techniques for the analysis of heavy metals in aquatic systems. Organic loadings-significance and measurement of DO, BOD, COD, TOD and TOC. Phenols, pesticides, surfactants, tannin and lignin as water pollutants and their determination.

UNIT II **14 hrs**

Air Pollution and Analysis

Classification and properties of air pollutants. Emission sources, major emissions from global sources. Behaviour and fate of air pollutants –wet precipitation, dry deposition, interaction at the earth's surface, chemical reactions in the atmosphere, photochemical smog. Effects of air pollution on human health, vegetation and materials, Air pollution sampling and measurement-ambient air sampling, collection of gaseous and particulate air pollutants. Analysis of air pollutants. SO_2 –ambient air measurements, stack gas measurement NOx –Griess-Saltzmann and Jacob-Hocheiser methods, chemiluminescent techniques.CO-NDIR, amperometric, FID & catalytic oxidation methods. Oxidants & ozone-colorimetric, coulometric & chemiluminescent methods. **Hydrocarbons**-total and individual hydrocarbons by chromatographic methods. Particulates optical & mass measurement methods.

References:

1. Environmental Chemistry – Manahan, S.E, Lewis Pub., 4th ed., Columbia(1990)
2. Air Pollution – B.G. Liptak;
3. Water Pollution – B.G. Liptak
4. Chemistry for Environmental Engineering–Sawyer and McCarty, 3rd ed., McGrawHill1978
5. Environmental Chemistry – A.K. De;
6. Environmental Pollution Controland Engineering–C.S. Rao,Wiley-Eastern, New Delhi,1991;
7. Standard Methods for examination of water waste water–15th ed.,Ed.Greenberg, Connors and Jenkins, APHA (1981);
8. Technical Methods of Analysis – R.C. Griffin
9. InstrumentalAnalysis for Water Pollution Control–M.Nancy, Ann Arbor, Michigan 1971

Ch.EL 3.5 - 1B NANOCHEMISTRY **28 hrs**

UNIT I **14 hrs**

Introduction

Basic principles, Bottom up approach, synthesis of nanoparticles, nanostructures, classification of nanostructures, solution process, hydrothermal process, solvothermal, Micro-emulsion, Sol-gel process, Precipitation, Reduction method, Fundamental aspects of vapour-liquid-solid(VLS) and Solution-Liquid-solid process.

Carbon nanotubes – Types, synthesis, purification, functionalization, solubilization. Inorganic Nanotubes - synthesis, solubilization, functionalization, properties and application. Nanowires - synthesis, self-assembly, functionalization, and coating on nanowires.

Applications: in energy storage systems, Bio technological & Bio medical, Display devices, & Waste Water Treatment

UNIT II **14 hrs**

Instrumental Methods in Nanotechnology

X-Ray based characterization: Principles and applications of X-ray diffraction, powder (polycrystalline) and single crystalline XRD techniques;

Electron microscopy techniques: Introduction, Principles and applications of Electron beam, Electron beam interaction with matter. Scanning electron microscopy (SEM/FESEM), transmission electron microscopy (TEM/HRTEM), Electron-diffraction, SAED.

Spectroscopic techniques: UV-VIS Spectrophotometers, IR/FTIR Spectrophotometers, Principles, operation and application for band gap measurements. Raman spectroscopy principles and applications.

Text Books

1. Nanochemistry: A chemical approach to NanomaterialsRoayal Society of Chemistry, Ozin and Arsenault, Cambridge UK 2005,
2. Nanoparticles: From Theory to Applications, G.Schmidt, WileyWeinheim2004.
3. Nanomatrials Chemistry: C.N.R. Rao, A. Muller and A.K. Cheetham, Wiley-VCH, GmbH 2007

References

1. Guozhong Cao, *"Nanostructures and Nanomaterials, synthesis, properties and applications"*, Imperial College Press, 2004.
2. T. Pradeep, *"NANO The Essential, understanding Nanoscience and Nanotechnology"*. Tata McGraw-Hill Publishing Company Limited, 2007.
3. Nanotechnology Principles and Practices: Sulabha K. Kulkarni, 2nd Ed. Capital publishing Company, 2011
4. Bio Engineered Nano MgO: Applied in Water Treatment & Display Devices, Publisher: Scholars' Press 1st Ed 2017.

Ch.EL 3.5 - 1C DYES AND PIGMENTS **28 hrs**

UNIT I **14 hrs**

Color and constitution, classifications of dyes, pigments, effect of conjugations, and polarity of solvent systems and various transitions involved, auxochormes, chormophores, red shift, blue shift- definition and examples.

Azo dyes- classifications, general methods of preparation of azo dyes, mechanisum-characterizations of azodyes, azometal complexes, preparations, characterizations by using physicochemical methods and applications.

UNIT II **14 hrs**

Difference between dyes and pigments, naturally occurring pigments, supra molecular concept, porphyrines, Chorrins. Synthetic macromlcules, phthalcyanines- strcuctural similarities, numbering, naming of Phthalocyanines. Various methods of synthesis (template methods), Chemistry of formation of Phthalocyanines (From phthalic acid and its derivatives) general methods of characterization. Important applications- colorant, non-colorant and medicinal.

Refernces:

1. A text book of Porphyrine- Applicatiions past present and future by K MKadish.
2. Natural Dyes: Sources, Tradition, Technology and Science by D. Cardon.
3. Synthetic Dyes in Biology, Medicine and Chemistry by Edward Gurr.
4. The Chemistry of Synthetic Dyes by K Venkataraman.
5. Synthetic Dyes by Chatwal G R and Madhu Arora.
6. Synthetic dyes by M S Yadav.

Ch.EL 3.5-1D - Fundamentals of herbal medicinal chemistry and applications 28 hrs

Unit -I **14 hrs**

Introduction to herbal plants and medicines. Selection of herbal medicinal plants and characterization of phytochemical constituents.

General methods for isolation and purification of active components. Application of chromatographic techniques in isolation *viz.*, thin layer chromatography (TLC), Column chromatography, High performance liquid chromatography (HPLC), Preparative HPLC, Ultra-performance liquid chromatography (UPLC) and High performance thin layer chromatography (HPTLC).

Application of spectroscopy for characterization of Phyto-chemical constituents ^{1}H and ^{13}C NMR, IR, Mass, CHN Analysis (Only Mention)

Unit –II **14 hrs**

Biological application- Introduction, Selection of suitable biological activity for of separated phytochemical (SAR in Brief).

Introduction to clinical trial phases. Evaluation of Biological activity- Introduction, Antimicrobial- Antibacterial, Antifungal activity, Antioxidant activity- DPPH method, H_2O_2 method, Anthelmintic activity, Anti-inflammatory activity, Antipyretic activity.

Reference

1. Natural products and medicinal chemistry- Gurudeepchatwal and anand
2. Modern Chromatography techniques-Dr.Bhavin Dhaduk and Dr. Khushal kapadiya
3. Antioxidant properties of Spice, herbs and other sources.-Denys J. Charles
4. A hand book of medical laboratory technology II addition-V.H.Talib (Editor)
5. Specroscopy by P.S. Kalasi

Ch.EL 3.5-1E- **Polymer Chemistry**

28 Hrs

Importance of polymers. Basic Concepts:

Monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization: Condensation, addition, radical chain-ionic and co-ordination and co-polymerization. Polymerization conditions and polymer reactions. Polymerization in homogenous and heterogeneous systems, Polymerization Techniques. **08 Hrs**

Polydispersion-average molecular weight concept.

Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular weights. End-group, viscosity, light scattering, osmotic and ultracentrifugation methods. Analysis and testing of polymers-chemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Microscopy. Thermal analysis and physical testing-tensile strength. Fatigue, impact. Tear resistance. Hardness and abrasion resistance.

08 Hrs

Testing of Polymers:

Need for testing-specifications and standards, mechanical-short term (tensile, fluxural, impact, tear resistance, abrasion resistance etc.,) long term (creep and fitigue). Electrical-conductivity, volume resistivity, surface, breakdown voltage, dielectric constant, loss factor, thermal coefficient of thermal expnasion, heat distortion temperature, vicat softening point, low temperature, properties, thermal conductivity.

12Hrs

REFERENCES:

1. Text book of Polymer Science (3rd edition) F.W.Billmayer, A Wiley-Interscience, 1984
2. Contemporary Polymer Chemistry (2nd edition), H.R.Allcock and F.W.Lampe, Prentice Hall, Englewood Cliff's, NewJersy 1981
3. Polymer Science, V.R.Gowswamy424784ariker, N.V.Viswanathan and Jayadev Sreedhar, New Age International (P) Limited, August 1996.
4. Introductory Polymer Chemistry, G.S.Misra, Wiley Eastern Limited, 1993
5. Polymer Science and Technology of Plastics and Rubbers, Premamoy Ghosh, Tata McGraw Hill, 1990
6. Polymer characterisation, Physical Techniques, D.Campbell and J.R. White, Chaopman and Hall, 1989.
7. Principles of Polymer Science Systems, F.Rodriguez, McGraw Hill Book co., 1970.

DAVANGERE UNIVERSITY

Department of Chemistry

M.Sc., Course Pattern and Scheme of Examination under CBCS approved by PG-BOS in chemistry

Question Paper Pattern for Chemistry

A. THEORY PAPERS

The Syllabus of each paper shall be grouped into units of 16 teaching hours Question Papers in all the four semesters shall consist of Parts A, B and C.

Part A shall contain eight (08) very short answer objective type questions carrying 2 marks each drawn from all the four units of the syllabus (2 questions per unit). Five (05) out of eight (08) questions are to be answered.

Part B shall contain six (06) brief and/or long answer questions carrying 05 marks each drawn from all the four units of the syllabus (2 questions per unit). Four (04) out of six (06) questions are to be answered

Part C shall contain six (06) brief and/or long answer questions carrying 10 marks each drawn from all the four units of the syllabus (2 questions per unit). There may be a maximum of three sub-divisions per question, carrying 3 or more marks per sub-division. Four (04) out of six (06) questions are to be answered.

B. ELECTIVE PAPERS

The Question Papers shall consist of Parts A and B.

Part A shall contain six (07) very short answer objective type questions carrying 2 marks. Five (05) questions are to be answered.

Part B shall contain Five (05) brief and/or long answer questions carrying 10 marks each drawn from the two units of the syllabus (At least 2 questions per unit). There may be a maximum of three sub-divisions per question, carrying 3 or more marks per sub-division (3+3+4 or 5+5). Three (03) out of Five (05) questions are to be answered.

Question Paper Pattern:

Paper Name: Inorganic Chemistry

Paper Code: 1.1

Time: 3 Hours **Max. Marks: 70**

Part- A

1. Answer **any five** of the following questions **(2X5 = 10)**

a.

b.

c.

d.

e.

f.

g.

h.

Part- B

Answer **any Four** of the following questions **(5X4= 20)**

2.

3.

4.

5.

6.

7.

Part- C

Answer **any Four** of the following questions **(10X4=40)**

8.

9.

10.

11.

12

13.

Registrar
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