SACRED HEART COLLEGE, THEVARA
(AUTONOMOUS)

DEPARTMENT OF CHEMISTRY

CHOICE BASED COURSE CREDIT SEMESTER SYSTEM

SCHEME AND SYLLABI FOR

UNDERGRADUATE PROGRAMME IN

CORE CHEMISTRY

2015

SACRED HEART COLLEGE AUTONOMOUS THEVARA, KOCHI-682013 1944

Dr. Jose John
Principal in Charge
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Thevara, Kochi-682 013

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Preface

Science is the base of all developments in the universe and technology is the level of application of this scientific knowledge. It is a method of discovering reliable knowledge about nature.

Reliable knowledge is knowledge that has a high probability of being true. It is sometimes called justified true belief.

When one uses the scientific method to study or investigate nature or the universe, one is practicing scientific thinking. All scientists practice scientific thinking, of course, since they are actively studying nature and investigating the universe by using the scientific method.

However, the creation of a scientific thinking in society necessitates proper education and guidance. In order to achieve this, one must update the developments in the field of science. An effective science education can be imparted at the undergraduate level only by revamping the present curriculum. To achieve this goal, the curriculum should be revised frequently to incorporate the recent trends science. The present undergraduate curriculum was restructured in 2009 and subsequently modified by the Mahatma Gandhi University in 2013.

By acquiring Autonomous status for our college in 2014, we got the academic freedom to revise the curriculum and constituted various academic bodies to start the work with the view to implement the same from 2015 admission onwards. In this process care has been taken to give emphasis to various aspects such as the creativity of students, knowledge of current developments in the discipline, awareness of environmental impacts due to the development of science and technology, the skills essential for handling equipment and instruments in laboratories and industries, employability, and entrepreneur development.

There is only one undergraduate programme in Chemistry, viz. B. Sc Chemistry.
There are 5 types of courses, viz.

1. Common courses.
2. Core courses.
3. Complementary courses.
4. Open courses.
5. Environmental Science, which is included as a core course in second semester as per the Direction from UGC.

The core course is in the discipline of chemistry and two complementary courses, in Physics And Mathematics.

There are extra credit courses.

- Social work.
- Extra Credit Course-Club activities
- Summer Internship Programme
- Virtual Lab Experiments

B. Sc. CHEMISTRY

The structure of the B.Sc Chemistry programme is as follows:

	Type of course	Number of courses	Credits
1.	**Common courses**	10	38
2.	**Core courses** Chemistry Theory Practical Project Study tour	 12 6 1 1	 37 12 2 0
3.	**Complementary** i. Mathematics ii. Physics	 4 4	 14 14
4.	Open course	1	3
5.	Environmental Science	1	4
	Total	**41**	**124**
	Extra Credit Course		
1.	Social work		1
2.	Club activities		1
3.	Internship Programme.		1
4	Virtual lab Experiment		1

Computation of Grade and Grade points.

For all courses (theory & practical), grades are given on a 07-point scale based on the total percentage of marks. ***(CIA+ESE)*** as given below

Percentage of Marks	**Grade**	**Grade Point**
90 and above	A+ - Outstanding	10
80-89	A - Excellent	9
70-79	B - Very Good	8
60-69	C - Good	7
50-59	D - Satisfactory	6
40-49	E - Adequate	5
Below 40	F - Failure	0

Note: Decimal are to be rounded to the next whole number

Computation of SGPA

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses and the sum of the number of credits of all the courses undergone by a student in a semester.

SGPA (Si) = $\sum(C_i \times G_i) / \sum C_i$

Where $C_i$is the number of credits of the ith course and G_i is the grade point scored by the student in the ith course.

Computation of CGPA

The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

CGPA = $\sum(Ci \times Si) / \sum Ci$

Where Si is the SGPA of the i^{th} semester and Ci is the total number of credits in that semester.

Note: The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Grades for the different semesters and overall programme are given based

On the corresponding SGPA/ CGPA as shown below:

SGPA/*CGPA*	**Grade**
Above 9	***A+ - Outstanding***
Above 8, but below or equal to 9	***A – Excellent***
Above 7, but below or equal to 8	***B -Very Good***
Above 6, but below or equal to 7	***C – Good***
Above 5, but below or equal to 6	***D – Satisfactory***
Above 4, but below or equal to 5	***E – Adequate***
4 or below	***F – Failure***

Note: A separate minimum of 30% marks each for internal and external (for both theory and practical) and aggregate minimum of 40% are required for a pass for a course.

For a pass in a programme, a separate minimum of Grade E is required for all the individual courses. If a candidate secures **F** Grade for any one of the courses offered in a Semester/Programme only **F** grade will be awarded for that Semester/Programme until he/she improves this to **E** grade or above within the permitted period. Candidate secure **E** grade and above will be eligible for higher studies.

MARKS DISTRIBUTION FOR END SEMESTER EXAMINATION AND INTERNAL EVALUATION

Marks distribution for end semester and internal assessments and the components for internal evaluation with their marks are shown below:

Components of the internal evaluation and their marks are as below.

For all courses with practical

a) Marks of theory –End semester Examination : 60
b) Marks of theory –Internal Evaluation : 20

Components of Theory – Internal Evaluation	***Marks***
Attendance	***5***
Seminar/ Assignment (Written assignments, preparation of models, charts, posters etc., field survey, field work)	***5***
Test paper(s)	***10***
Total	***20***

c) Marks of Practical –End semester Examination: 15+15=30 (only in even semesters)

d) Marks of Practical- Internal Evaluation: 5+5=10 (odd and even semesters combined annually)

Components of Practical- Continuous internal assessment	**Marks**
Attendance	2
Record	2
Viva/Model Exam	1
Total	**5**

Project Evaluation: (Max. marks100)

Components of Project-Evaluation	Marks
Continuous internal assessment	25
Dissertation	50
Viva-Voce	25
Total	**100**

Attendance Evaluation

For all courses with practical –
(marks for attendance shall be given considering theory and practical separately, with a minimum eligibility of 75%)

Percentage of attendance for theory	Marks
90 % and above	5
85-89	4
80-84	3
76-79	2
75	1

Percentage of attendance for Practical	Marks
Above 85 %	2
75-85	1
<75	0

CONDONATION OF SHORTAGE OF ATTENDANCE

Candidate can seek condonation of shortage of attendance only once in a 2 year course and twice in other courses of longer duration. Following are the rules regarding attendance requirement:-

1. Every candidate is to secure 75% attendance of the total duration of the course.

2. A candidate having a shortage of 10% can apply for condonation of shortage in prescribed form on genuine grounds. Condonation of shortage of attendance if any should be obtained at least 7 days before the commencement of the concerned semester examination.

3 It shall be the discretion of the Principal to consider such applications and condone the shortage on the merit of each case in consultation with the concerned course teacher and HoD.

4. Unless the shortage of attendance is condoned, a candidate is not eligible to appear for the examination.

SYLLABUS FOR CORE CHEMISTRY COURSES

Semester – I

15U1CRCHE01 – Theoretical and Inorganic Chemistry-I

Credits - 2 (36 hours)

1. **Chemistry as a discipline of science** **(3 hrs)**

What is Science? - Scientific statements - Scientific methods – Observation - Posing a question - Formulation of hypothesis – Experiment – Theory – Law - Revision of scientific theories and laws. Evolution of chemistry - Alchemy - Branches of chemistry. Components of a research project - Introduction, review of literature, scope, materials and methods, results and discussion, conclusions and bibliography.

2. **Basic Concepts in Chemistry** **(3 hrs)**

Atomic mass and Molecular mass. Isotopes, isobars and isotones – Mole concept – Molar volume – Oxidation and reduction – Oxidation number and valency - Variable valency - Equivalent mass. Methods of expressing concentration: Weight percentage, molality, molarity, normality, formality, mole fraction, ppm and millimoles. Numerical Problems related to basic concepts.

3. **Analytical Chemistry I** **(9 hrs)**

Quantitative Analysis. Primary standard-secondary standard, quantitative dilution – problems. Calibration of volumetric apparatus. Acid base titrations- titration curves –pH indicators. Redox titrations – Titration curve - Titrations involving $KMnO_4$ and $K_2Cr_2O_7$- Redox indicators. Complexometric titrations – EDTA titrations - titration curves – metal ion indicators and characteristics.

Errors in Chemical Analysis. Accuracy, precision, Types of error-absolute and relative error, methods of eliminating or minimizing errors. Methods of expressing precision: mean, median, deviation, average deviation and coefficient of variation. Significant figures and its application.

4. **Atomic Structure** **(9 hrs)**

Introduction to atomic structure based on historical development – Rutherford's atom model and its limitations - Failure of classical physics – Black body radiation – Compton Effect - Planck's quantum hypothesis - Photoelectric effect – Generalization of quantum theory -Atomic spectra of hydrogen and hydrogen like atoms – Ritz-combination principle– Bohr theory of atom – Calculation of Bohr radius, velocity and energy of an electron - Explanation of atomic spectra – Rydberg

equation – Limitations of Bohr theory - Sommerfield modification - Louis de Broglie's matter waves – Wave-particle duality - Electron diffraction - Heisenberg's uncertainty principle.

5. **Quantum Mechanical Model of Atom (12 hrs)**

Operator algebra – Linear and Hermitian operators - Laplacian and Hamiltonian operators – Eigen functions and Eigen values of an operator - Postulates of quantum mechanics - Well behaved functions. Time independent Schrödinger wave equation - Application to particle in a one dimensional box –Normalization of wave function - Particle in a three-dimensional box-Degeneracy. Application of Schrödinger wave equation to hydrogen atom – Conversion of Cartesian coordinates to polar coordinates - The wave equation in spherical polar coordinates (derivation not required) - Radial and Angular functions (derivation not required) – Orbitals and concept of Quantum numbers (n, l, m).Radial functions - Radial distribution functions and their plots – Shapes of orbitals (s, p and d).

Schrödinger equation for multi-electron atoms: Need for approximation methods.Electron spin – Spin quantum number - Pauli's Exclusion principle - Hund's rule of maximummultiplicity - Aufbau principle – Electronic configuration of atoms.

Text Books

1. Jeffrey A. Lee, *The Scientific Endeavor: A Primer on Scientific Principles and Practice*, PearsonEducation, 1999.

2. C.N.R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.

3. Robert H. Hill and David Finster, *Laboratory Safety for Chemistry Students*, 1st Edition, Wiley, Hoboken, NJ, 2010.

4. M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.

5. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.

6. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1,* 5th Edition, S. Chand and Sons, New Delhi, 2012.

7. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.

8. A.K. Chandra, *Introductory Quantum Chemistry*, 4th Edition, Tata McGraw Hill Publishing

Company, Noida, 1994.
9. R.K. Prasad, *Quantum Chemistry*, 4th Edition, New Age International(P) Ltd., New Delhi, 2012.

10. B.K, Sen, *Quantum Chemistry – Including Spectroscopy*, 3rd Edition, Kalyani publishers, NewDelhi, 2010.

References

1. T.F Gieryn, *Cultural Boundaries of Science,* University of Chicago Press, Chicago, 1999.

2. H. Collins and T. Pinch, *The Golem: What Everyone Should Know about Science*, Cambridge University Press, Cambridge, 1993.

3. C.R. Kothari, *Research Methodology: Methods and Techniques*, 2nd Revised Edition, New Age International Publishers, New Delhi, 2004.

4. *Guidance in a Nutshell - Compilation of Safety Data Sheets,* European Chemicals Agency, Finland, Version 1.0, December 2013.

5. J. D. Lee, Concise Inorganic Chemistry, 5thedn., Blackwell Science, London (Chapter 1)

6. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rdedn., Oxford University Press(Chapter 1)

7. B. Douglas, D. Mc Daniel, J. Alexander, Concepts and models in Inorganic Chemistry (Chapter 1)

8. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8thEdition, Brooks/Cole, Thomson Learning, Inc., USA, 2004

9. D.A. McQuarrie, *Quantum Chemistry*, 2nd Edition, University Science Books, California, 2008.

10. M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press,New Delhi, 2002.

11. P.W. Atkins and R.S. Friedman, *Molecular Quantum Mechanics*, 3rd Edition,Oxford University Press, New York, 1997.

12 I.N. Levine, *Quantum Chemistry*, 6th Edition, Pearson Education Inc., New Delhi, 2009.

13. Jack Simons, *An Introduction to Theoretical Chemistry*, 2nd Edition, Cambridge University Press,Cambridge, 2005.

Semester – II

15U2CRCHE02 – Theoretical and Inorganic Chemistry-II

Credits - 2 **(36 hours)**

1. Elements and Periodic Properties (4 hrs)

Modern periodic law – Long form periodic table. Periodicity in properties: Atomic and ionic radii – Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity. Electronegativity scales: Pauling and Mullikan scales. Effective nuclear charge – Slater rule and its applications

2. Chemical Bonding – I (9 hrs)

Introduction – Type of bonds – Octet rule and its limitations.

Ionic Bond: Factors favoring the formation of ionic bonds - Lattice energy of ionic compounds - Born-Lande equation (derivation not expected) – Solvation enthalpy and solubility of ionic compounds –Born-Haber cycle and its applications –Properties of ionic compounds - Polarisation of ions – Fajan'srules and its applications.

Covalent Bond: Lewis theory. Valence Bond Theory. Coordinate bond. Hybridization: Definition and characteristics VSEPR theory: Postulates– hybridizations – Applications – Shapes of molecules- sp ($BeCl_2$, C_2H_2), sp^2 (BF_3, C_2H_4), sp^3 (CH_4, CCl_4, NH_3, H_2O, NH_4^+, H_3O^+ and SO_4^{2-}), sp^3d (PCl_5), sp^3d^2 (SF_6) and sp^3d^3 (IF_7) and SF_4, ClF_3, XeF_2, IF_5, XeF_4, IF_7 and XeF_6. Limitations of VBT. Properties of covalent compounds. Polarity of covalent bond – Percentage of ionic character –Dipole moment and molecular structure.

3. Chemical Bonding – II (9 hrs)

Covalent Bond: Molecular Orbital Theory – LCAO - Bonding and anti-bonding molecular orbitals – Bond order and its significance. MO diagrams of homonuclear and heteronuclear diatomic molecules. H_2, He_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, CO and NO – Comparison of bond length, magnetic behavior and bond energy of O_2, O_2^+, O_2^{2+}, O_2^- and O_2^{2-}.

Resonance structures of borate, carbonate and nitrate ions – Comparison of bond energy.

Comparison of VB and MO theories.

Metallic Bond: Free electron theory, valence bond theory and band theory (qualitative treatment only) –Explanation of metallic properties based on these theories.

Intermolecular Forces: Induction forces and dispersion forces: Van der Waals forces, ion-dipole, dipole-dipole, ion-induced dipole, dipole-induced dipole and induced dipole-induced dipole interactions.

Hydrogen bond: Intra and inter molecular hydrogen bonds – Effect on physical properties.

4. Nuclear Chemistry (9 hrs)

Nuclear particles, nuclear forces, nuclear size, nuclear density, stability of nucleus, binding energy, magic numbers, packing fraction, n/p ratio. Nuclear models – liquid drop model and shell model.

Natural radioactivity, modes of decay, decay constant, half-life period, average life, radioactive equilibrium, Geiger-Nuttal rule, units of radioactivity, radiation dosage.

Induced radioactivity, nuclear reactions induced by charged projectiles, neutrons and γ rays, fission reactions, fusion reactions, spallation reactions, preparation of transuranic elements, Q values of nuclear reactions. Fertile and fissile isotopes, chain reaction, stellar energy.

5. Analytical Chemistry II (5 hrs)

Gravimetric analysis: Systematic steps in gravimetric analysis. Illustrations using iron and barium estimation.

Separation and purification techniques – Filtration, Crystallization and precipitation – concept of solubility product as applied in group separation of cations – problems. Fractional distillation, Solvent extraction.

Chromatography - Classification of methods elementary study of adsorption, paper, thin layer, column, ion exchange and gas chromatographic methods. HPLC.

Text Books

1. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
2. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1*, 5th Edition, S. Chand and Sons, New Delhi, 2012.
3. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 2007.
4. H. J. Arnikar, *Essentials of Nuclear Chemistry*, New Age.

5. R. Gopalan, *Elements of Nuclear Chemistry*, Vikas Publ. House.
6. Vogel's *Textbook of Quantitative Chemical Analysis* 6th Edn, Pearsons Education Ltd.
7. R. D. Day, A. L. Underwood, *Quantitative analysis*,6th Edn.,Prentice Hall of India Pvt. Ltd.

References

1. J. D. Lee, Concise Inorganic Chemistry, 5th Edn., Blackwell Science, London(Chapter 2-5)
2. C. N. R. Rao, University General Chemistry, Macmillan India (Chapter 3)
3. F. A. Cotton, G. Wilkinson and P. L. Gaus, Basic Inorganic Chemistry, 3rd edn., John Wiley
4. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd Edn., Oxford University Press
5. J. E. Huheey, E. A. Keiter, R. L. Keiter, Inorganic Chemistry, 4th edn., Harper Collins, 1993.
6. G. Wulfsberg, *Inorganic Chemistry*, Viva Books
7. W. L Jolly, *Inorganic Chemistry*, Tata McGraw Hill.
8. M. N. Greenwood and A. Earnshaw, *Chemistry of the elements* 2nd edn, Butterworth
9. H. J. Emeleus, A. G. Sharpe, *Modern Aspects of Inorganic Chemistry*, Universal Book Stall
10. A.K. Chandra, *Introductory Quantum Chemistry*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 1994.
11. R.K. Prasad, *Quantum Chemistry*, 4th Edition, New Age International(P) Ltd., New Delhi, 2012.
12. I.N. Levine, *Quantum Chemistry*, 6th Edition, Pearson Education Inc., New Delhi, 2009.
13. J David Brown, The Chemical Bond in Inorganic Chemistry,Oxford Science Publication
14. D.A. McQuarrie, *Quantum Chemistry*, 2nd Edition, University Science Books, California, 2008.
15. P.W. Atkins and R.S. Friedman, *Molecular Quantum Mechanics*, 3rd Edition, Oxford University Press, New York, 1997.
16. J.B. Rajam and L.D. Broglie, *Atomic Physics*, 7th Edition, S. Chand and Co. Pvt. Ltd., New Delhi, 1999.
17. S. Glasstone, *Source Book on Atomic Energy*, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, 1967.

18.D. A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry, 8th edn, Brooks/Cole Nelson (Chapters 12-17).

19. G. D. Christian, Analytical Chemistry, John Wiley and Sons.

15U2ARENV1- Theory-Environment Science

Credit – 4 **72 Hours**

1. The multidisciplinary nature of environmental studies (2 hrs)

Definition, scope and importance, Need for public awareness

2. Natural resources (8 hrs)

2.1 Renewable and non-renewable resources:

2.1.1 Forest resources: Use of over exploitation, deforestation, case studies. Timber, mining, dams and their effects on forests and tribal people.

2.1.2 Water resources: Use and over utilization of surface and ground water, floods, drought, conflicts over water, dams- benefits and problems

2.1.3 Mineral resources: Use of exploitation and environmental effects of extracting and using mineral resources, case studies.

2.1.4 Food resources: World food problems, changes caused by agriculture and overgrazing, effect of modern agricultural fertilizers- pesticides, water logging, salinity, case studies.

2.1.5 Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.

Case studies

Land resources: Land as a resources, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources
- Equitable use of resources for sustainable lifestyles

3. Ecosystems (6 hrs)

- Concept of an ecosystem
- Structure and function of an ecosystem
- Producers, consumers and decomposers
- Energy flow in the ecosystem
- Ecological succession
- Food chains, food webs and ecological pyramids

- Introduction, types, characteristic features, structure and function of the following ecosystem:-

    a. Forest ecosystem
    b. Grassland ecosystem
    c. Desert ecosystem
    d. Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries)

4. Biodiversity and its conservation (8 hrs)

- Introduction- definition: genetic, species and ecosystem diversity
- Biographical classification of India
- Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and option values
- Biodiversity at global, national and local level
- India as mega-diversity nation
- Hot-spots of biodiversity
- Threats of biodiversity: : habitat lose, poaching of wildlife, man- wildlife conflicts
- Endangered and endemic species of India
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

5. Environmental Pollution (8 hrs)

Definition

- Causes, effects and control measures of:
    a. Air Pollution
    b. Water pollution
    c. Soil pollution
    d. Marine pollution
    e. Noise pollution
    f. Thermal pollution
    g. Nuclear pollution
- Solid waste management: Causes, effects and control measures of urban and industrial wastes
- Role of an individual in prevention of pollution
- Pollution case studies
- Disaster management: floods, earthquake, cyclone and landslides

6. Social Issues and the Environment **(7 hrs)**

- From unsustainable to sustainable development
- Urban problem relate to energy
- Water conservation, rain water harvesting, water shed management
- Resettlement and rehabilitation of people, its problem and concerns

Case studies

- Environmental ethics: Issues and possible solutions
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Case studies

- Wasteland reclamation
- Consumerism and waste products
- Environment Protection Act
- Air (Prevention and Control Pollution) Act
- Water (prevention and control of Pollution) Act
- Wildlife Protection Act
- Forest conservation Act
- Issues involved in enforcement of environmental legislation
- Public awareness

7. Human Population and the Environment **(6 hrs)**

- Population growth, variation among nations
- Population exploitation- Family welfare programme
- Environment and Human health
- Human rights
- Value education
- HIV/AIDS
- Women and child welfare
- Role of information technology in environment and human health
- Case studies

8. Field work **(27 hrs)**

- Visit to a local area to document environmental assets- river/forest/grassland/hill/ mountains.
- Visit to a local polluted site urban/rural/industrial/agricultural.
- Study of common plants, insects, birds.
- Study of simple ecosystem, pond, river, hill slopes etc.
- Each student has to submit a field report on any one of the above topics which forms the basis for evaluation of field work for 25 marks.

Reference

1. Agarwal, K.C.2001 Environmental Biology. Nidhi Publ.Ltd.Bikaner.
2. Bharucha Erach, The Biodiversity of India. Mapin Publication Pvt.Ltd, Ahamadabad-380013, India , Email: mapin@iccnel.net (R)
3. Brunner R.C, 1989, Hazardous Waste Incineration, McGraw Hill Inc.480p
4. Clark R.S, Marine Pollution, Clanderson Press Oxford (TB)
5. Cunningham, W.P.Cooper, T.H.Gorhani,E & Hepworth, M.T.2001, Environmental Encyclopedia, Jaico Publ House, Mumbai, 1196p
6. De A.K, Environmental Chemistry, Wiley Eastern Ltd.
7. Down to Erath, Centre for Science and Environment (R)
8. Gleick, H.P.1993. Water in crisis, Pacific Institute for studies in Dev, environment & Security. Stockolm env. Institute. Oxford Univ. Press.473p
9. Hawkins R.E, Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
10. Heywood, V.H & Watson , R.T. 1995, Global Biodiversity Assessment, Cambridge Univ.Press1140p
11. Jadhav, H & Bhosale, V.M,1995, Environmental Protection and Laws.Himalaya Pub House, Delhi284p
12. Mck inney, M.L & schoch R.M. 1996. Environmental Science system & Solutions, Web enhanced edition , 639p
13. Mhaskar A.K, Matter Hazardous, Tecno-Science publication(TB)
14. Miller T.G. Jr., Enviromental Science, Wadsworth Publicating Co. (TB)
15. Odum, E.P. 1971. Fundamentals of ecology. W.B. Saunders Co. USA, 574p
16. Rao M.N & Datta, A.K.1987, Waste Water treaement, Ofxord & IBH Publ, Co. Pvt.Ltd.345p
17. Sharma B.K.2001. Environmental Chemistry. Goel Publ. House, Meerut
18. Survey of the Environment. The Hindu (M)
19. Townsend C, Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)
20. Trivedi R.K, Handbook of Environemental Laws, Rules, Guidelines, Compliances and Standards, Vol I and II, Enviro Media (R)
21. Trivedi R.K and P.K Goel , Introduction to air pollution, Techno-Science Publication (TB)

22. Wagner K.D, 1998. Environmental Management. W.B Saunders Co. Phi;Adelphia, USA 499p

(M) Magazine
(R) Reference
(TB) Textbook

Semester – III

15U3CRCHE03 –Organic Chemistry-I

Credits - 3 **(54 hours)**

Aim

To impart an understanding of basic theory and concepts of Organic chemistry and to inculcate an interest in Organic Chemistry.

Objectives

- To have a basic understanding about the classification and nomenclature of organic compounds, fundamentals of organic reaction mechanism, aromaticity and stereochemistry
- To make students capable of understanding and studying organic reactions
- To have exposure to various emerging areas of organic chemistry.
- To develop skills required for the qualitative analysis of organic compounds.

1. Classification and nomenclature of organic compounds (4 hrs)

1.1 Classification of organic compounds.

1.2 Rules of IUPAC system of nomenclature of organic compounds such as alkanes, alkenes, alkynes, cycloalkanes, bicycloalkanes, alkyl halides, alcohols and phenols. Aldehydes, ketones, carboxylic acids and its derivatives, amines, nitro compounds. (*Both aliphatic and aromatic*)

References

1. I. L. Finar, Organic Chemistry -, 6th Edition. Vol.- I, Pearson Education (p-26,70,93,131,531, 145,176, 202, 223,245,256,367,360,571)
2. M. K. Jain and S. C. Sharma, 'Modern Organic Chemistry' 3rd Edition, Visal Publishing Company Co. (p.92-112)
3. K.S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House(Chapter 3).
4. S. C. Pal, Nomenclature of Organic Compounds, Narosa Publishing Company

Further Reading

1. P. Y. Bruice, 'Organic Chemistry' - 3rd Edn. Pearson Education. (Chapter-1)
2. C. N. Pillai 'Organic Chemistry' Universities Press.

2. Organic reaction mechanisms (18 Hrs)

2.1 Meaning of reaction mechanism- Drawing electron movements with arrows- curved arrow notation. Half headed and double headed arrows. Nature of bond fission – homolytic and heterolytic.

2.2 Types of reagents – Electrophiles and Nucleophiles- Types and sub-types of following organic reactions with definition and at least one example of each- Substitution, Addition reactions, Elimination and Rearrangement.

2.3 Reactive intermediates with examples – carbocations, carbanions, carbenes, nitrenes and free radicals.

2.4 Electron displacement effects - Inductive, electrometric, mesomeric, resonance, hyper conjugation and steric effects- steric inhibition of resonance.

2.5 Aliphatic nucleophilic substitutions, mechanism of S_N1,S_N2- effects of structure, substrate, solvent, nucleophile and leaving groups - Stereochemistry- Walden inversion

2.6 Elimination Reactions:-Hoffmann and Saytzeff rules- *cis*and *trans* eliminations – mechanisms of E1 and E2 reactions. Elimination *versus* substitution.

2.7 Addition reactions- mechanisms of addition of Bromine – inductomeric effect, mechanisms of addition of hydrogen halides to double bonds - Markonikoff's rule and peroxide effect.

2.8 Polymerisation reactions-Types of polymerization - free radical, cationic and anionic – polymerisations –including mechanism.

2.9 Pericylic Reactions: Classification- electrocyclic, sigmatropic, cycloaddition reactions-Examples Diels- Alder reaction- Stereochemical aspects- Effect of substituents.

References

1. Peter Sykes, A Guide book to Mechanism in Organic Chemistry: 6th Edition, Pearson Education. (chapters 1,4,5,6,7,8,9,10)
2. P. S. Kalsi' 'Organic Reactions and their Mechanisms'' New Age International Publishers. (Chapters- 4, 5,11,12,16)
3. K.S. Tewari and N.K. Vishnoi 'Organic Chemistry', 3rd Edition, Vikas Publishing House. (Chapter 5)
4. M. K. Jain and S.C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter 3,4)
5. R. T. Morrison and R. N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India, (Chapters-5,8,9).

6. I. L. Finar, Organic Chemistry, 6th Edition. Vol.- I, Pearson(chapters-4,5,20,21)

Further Reading

1. J. March, 'Advanced Organic Chemistry', IV Edn, John Wiley & Sons, NY.
2. S. M. Mukherjee and S.P. Singh 'Reaction Mechanism In Organic Chemistry', Macmillan
3. Reinhard Bruckner, 'Advanced Organic Chemistry' Elsevier
4. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press.
5. V. K. Ahluwalia, Green Chemistry, *Ane Books* India.

3. Stereochemistry of organic compounds (16 hrs)

3.1 Stereoisomerism - definition - classification - optical and geometrical isomerism

3.2 Projection formulae - Fischer, flying wedge, Sawhorse and Newman projection formulae - notation of optical isomers -D-L notation- Cahn-Ingold-Prelog rules - R-S notations for optical isomers with one and two asymmetric carbon atoms - erythro and threo representations.

3.3 Optical isomerism - optical activity - optical and specific rotations - conditions for optical activity - asymmetric centre -- chirality - achiral molecules - meaning of (+) and (-), Elements of symmetry -. Prochirality- Racemization - methods of racemization (by substitution and tautomerism) - Resolution - methods of resolution -mechanical, seeding, biochemical and conversion to diastereoisomers - Asymmetric synthesis (partial and absolute synthesis). Optical activity in compounds does not containing asymmetric carbon atoms-Biphenyls and allenes.

3.4 Geometrical isomerism - *cis*-trans, *syn*-anti and E-Z notations - geometrical isomerism in maleic and fumaric acids and unsymmetrical ketoximes - methods of distinguishing geometrical isomers using melting point, dipole moment, dehydration and cyclisation.

3.5 Conformational analysis - introduction of terms - conformers, configuration, dihedral angle, torsional strain - Conformational analysis of ethane and n-butane using energy profile diagrams - conformers of cyclohexane (chair, boat and skew boat forms) - axial and equatorial- bonds-ring flipping showing axial equatorial interconversion, conformation of methyl cyclohexane.

References:

1. R. T. Morrison and R.N Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India. (Chapters-4, 13)
2. I. L. Finar, 'Organic Chemistry '- Vol.- 6th Edition I, Pearson Education (Chapters-3,4,17)
3. M. K. Jain and S.C. Sharma, 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapters-6,7)
4. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House. (Chapter-6)

Further Reading

1. D. Nasipuri, 'Stereochemistry of Organic Compounds', New Age International Publishers
2. P. S. Kalsi, 'Stereochemistry, Conformation and Mechanisms'' New Age International Publishers.
3. C. N. Pillai, 'Organic Chemistry' Universities Press.
4. P. Y. Bruice, 'Organic Chemistry' - 3rd Edn. Pearson Education.
5. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press

4. Aromaticity (16 hrs)

4.1 Concept of resonance- resonance energy in benzene. Heat of hydrogenation and heat of combustion of Benzene, mention of C-C bond lengths and orbital picture of Benzene. Structure of naphthalene and anthracene (Molecular Orbital picture and resonance)

4.2 Concept of aromaticity – aromaticity (definition), Huckel's rule – application to Benzenoids – Benzene, Naphthalene, Anthracene, Phenanthrene and Non–Benzenoid compounds – cyclopropenylcation, cyclopentadienyl anion and tropylium cation.

4.3 General mechanism of electrophilic substitution- mechanism of halogenation, nitration, Friedal Craft's alkylation and acylation, sulphonation. Orientation of aromatic substitution – Definition of *ortho*, *para* and *meta* directing groups. Ring activating and deactivating groups with examples -Electronic interpretation of various groups like -NO_2 and –OH. Orientation of (i). Amino, methoxy and methyl groups (ii). Carboxy, nitro, nitrile, carbonyl and sulfonic acid groups. (iii). Halogens. (*Explanation by taking minimum of one example from each type is required*).

4.4 Reactivity of naphthalene towards electrophilic substitution. Nitration and sulphonation.

4.5 Aromatic Nucleophilic substitutions- bimolecular displacement mechanism- Elimination –

Addition mechanism - Benzyne intermediate, Reactivity and orientation in Aromatic Nucleophilic substitutions.

References:

1. R. T. Morrison and R.N Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India. (Chapters- 15,26)
2. I. L. Finar, 'Organic Chemistry '- Vol.- 6th Edition I, Pearson Education (chapters-20,21)
3. M. K. Jain and S.C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapters- 14,15,16)
4. K. S. Tewari and N. K. Vishnoi 'Organic Chemistry', 3rd Edition, Vikas Publishing House, (Chapter- 11,12)
5. Peter Sykes, A Guide book to Mechanism in Organic Chemistry :, 6thEdition, Pearson Education (Chapter 6)

Further Reading

1. P. S. Kalsi' 'Organic Reactions and their Mechanisms'' New Age International Publishers. (Chapters-4,5,11,12,16)
2. S. H. Pine 'Organic Chemistry' - - McGraw Hill
3. J. March, 'Advanced Organic Chemistry', IV Edn, John Wiley & Sons, NY
4. Paula Y. Bruice, 'Organic Chemistry' - 3rd Edn. Pearson Education.
5. J.Clayden, N.Greeves, S.Warren and P.Wothers, Organic Chemistry, Oxford University Press

5. Supramolecular Chemistry (3hrs)

5.1. Classification- electrocyclic, sigmatropic, cycloaddition reaction-Examples
5.2. Diels- Alder reaction- Stereochemical aspects- Effect of substituents.

References:

1. P. Sykes, A Guide book to Mechanism in Organic Chemistry, 6th Edition, Orient Longman(Chapter-12 and p.198)
2. P.S. Kalsi' 'Organic Reactions and their Mechanisms'' New Age International Publishers. (Chapter-17)
3. M. K. Jain and S. C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co.(Chapter -47)
4. P. Y. Bruice, 'Organic Chemistry' - 3rd Edn. Pearson Education. (Chapter-28)

Further Reading

1. R. Bruckner, 'Advanced Organic Chemistry' Elsevier
2. J. March, 'Advanced Organic Chemistry', IV Edn, John Wiley & Sons, NY
3. S. H. Pine 'Organic Chemistry', McGraw Hill
4. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press.

Semester – IV

15U4CRCHE04 – Organic Chemistry-II

Credits - 3 **(54 hours)**

Aim

*To give the students a thorough knowledge about the chemistry of some selected functional groups with a view to develop proper aptitude towards the study of organic compounds and their reactions***.**

Objectives

To enable the students-

- To learn the chemistry of alcohols, phenols, carboxylic acids, derivatives of Carboxylic acids, Sulphonic acids, carbonyl compounds, poly nuclear hydrocarbons, active methylene compounds and Grignard reagents.

- To understand and study Organic reaction mechanisms.

1. Hydroxy compounds (8 hrs)

1.1 Monohydric alcohols: Classification, physical properties–hydrogen bonding-distinction between primary, secondary and tertiary alcohols - Ascent and descent in alcohol series dihydric alcohols:

1.2 Oxidative cleavage – Lead tetra acetate, Periodic acid - Pinacol - Pinacolone rearrangement – mechanism.

1.3 Phenols – Acidity of phenols- effects of substituents – comparison of acidity with alcohols.

1.4 Preparation and uses of nitrophenol, picric acid, catechol, resorcinol and quinol

1.5 Mechanisms of Reimer –Tiemann reaction, Lederer- Mannase reaction, Fries rearrangement

References

1. R. T. Morrison and R. N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India, (Chapters-6,24)
2. I. L. Finar, Organic Chemistry - 6th Edition. Vol- I, Pearson. (6,8,11,26)
3. M. K. Jain and S.C. Sharma, 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapters-19,20)
4. K.S. Tewari and N K Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House(Chapters-16,17)

Further reading

1. B. S. Bahl, 'Advanced organic Chemistry', S. Chand.
2. John McMurry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
3. C. N. Pillai 'Organic Chemistry' Universities Press.

2. Ethers and Epoxides (3 hrs)

2.1 Synthesis and reactions of epoxides -Cleavage of ether linkages by HI- Ziesels method of estimation of alkoxy groups- Claisen rearrangement –mechanism.

2.2 Elementary idea of anisole and phenetol.

References

1. R. T. Morrison and R.N Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India. (Chapter-6)
2. I. L. Finar Organic Chemistry, 6th Edition. Vol- I, Pearson. (chapter 7and p.1126)
3. M. K. Jain and S.C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-21)
4. K. S. Tewari and NK Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-18)
5. B.S. Bahl, 'Advanced Organic Chemistry', S. Chand.

Further reading

1. B. S. Bahl 'Advanced Organic Chemistry', S. Chand.
2. John McMurry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
3. C. N. Pillai 'Organic Chemistry' Universities Press.

3. Aldehydes and Ketones (12 hrs)

3.1 Structure and reactivity of the carbonyl group - acidity of alpha hydrogen.

3.2 Comparative studies of - aldehydes and ketones - aliphatic and aromatic aldehydes - formaldehyde and acetaldehyde-

3.3 Mechanism of nucleophilic additions to carbonyl groups with special emphasis on Claisen, Claisen-Schmidt, Benzoin, Aldol, Perkin and Knoevenagel condensations.

3.4 Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction. Oxidation and reduction of aldehydes and ketones - Baeyer-Villiger oxidation-Cannizzaro's reaction, Meerwein-Pondorof Verley, Clemmensen, Wolff-Kishner, $LiAlH_4$ and $NaBH_4$ reductions (mechanisms expected).

3.5 Use of acetal as protecting group.

References

1. R. T. Morrison and R.N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India. (Chapter-18)
2. I. L. Finar, Organic Chemistry 6th Edition, Vol.- I, Pearson. ((Chapters-8,27)
3. M. K. Jain and S.C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-22)
4. K.S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-19)
5. B.S. Bahl 'Advanced organic Chemistry', S. Chand

Further reading

1. Paula Y. Bruice, 'Organic Chemistry' - 3rd Edn. Pearson Education Asia.
2. John McMurry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
3. C.N.Pillai'Organic Chemistry'Universities Press.

4. Carboxylic and Sulphonic acids (18 hrs)

4.1 Structure of carboxylate ion- effects of substituents on acid strength of aliphatic and aromatic carboxylic acids

4.2 Ascent and descent in fatty acid series- Hell-Volhard- Zelinsky reaction -Mechanism of decarboxylation.

4.3 Preparation of functional derivatives of carboxylic acids- acid chlorides, esters anhydrides and amides – their importance

4.4 Methods of preparation and chemical reactions of anthranilic acid,cinnamic acid, acrylic acid, oxalic acid, malonic acid, citric acid, adipic acid, maleic acid, fumaric acid and coumarin.

4.5 Preparation and reactions of benzene sulphonic acid, benzene sulphonyl chloride and *otho* and *para* toluene sulphonyl chlorides- uses

References

1. R. T. Morrison and R.N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India.
2. I. L. Finar Organic Chemistry 6th Edition. Vol.- I, Pearson. (Chapters-9, 25,28)
3. M.K.Jain and S.C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-22)
4. K.S Tewari and NK Vishnoi 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-20,21,28)

5. B.S. Bahl, 'Advanced organic Chemistry', S. Chand

Further reading

1. A. K. Bansal, A Textbook of Organic Chemistry, New Age International.
2. John McMurry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
3. C.N.Pillai'OrganicChemistry',UniversitiesPress.

5. Carbonic acid derivatives (3 hrs)

5.1 Preparation- reactions and structure of urea, thiourea and semi carbazide, manufacture of urea.

5.2 Preparation and basicity of guanidine.

References

1. R. T. Morrison and R.N Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India.
2. I. L .Finar Organic Chemistry -, 6th Edition. Vol.- I, Pearson. (Chapter-16)
3. M. K. Jain and S.C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-)
4. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-20)
5. B.S. Bahl 'Advanced organic Chemistry', S. Chand

Further reading

1. A. K. Bansal, A Textbook of Organic Chemistry, New Age International.
2. John McMurry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
3. C. N. Pillai, 'OrganicChemistry' Universities Press.

6. Organometallic compounds (3 hrs)

6.1. Grignard reagents-formation, structure and synthetic applications.

6.2. Reformatsky reaction, alkyl lithium and organo copper reagents-Gilman reagent

References

1. I. L. Finar, Organic Chemistry - 6th Edition. Vol - I, Pearson. (Chapter-15, p 424-430)
2. R. T. Morrison and R.N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India.
3. M.K.Jain and S.C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co.
4. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-27)

5. B.S. Bahl ‘Advanced organic Chemistry’, S. Chand

Further reading

1. Paula Y. Bruice, ‘Organic Chemistry’ - 3rdEdn. Pearson Education Asia.
2. John McMurry, ‘Organic Chemistry’ - Vth Edition -Thompson Asia Pvt Ltd
3. C. N. Pillai ‘OrganicChemistry’UniversitiesPress.

7. Compounds containing active methylene groups (4 hrs)

7.1. Synthetic uses of malonic ester, acetoacetic ester and cyanoacetic ester.
7.2. Keto-enol tautomerism of ethyl acetoacetate
7.3. Alkylation of carbonyl compounds via enamines.

References

1. I. L.Finar, Organic Chemistry, 6th Edition. Vol- I, Pearson. (Chapter-10,13)
2. R. T. Morrison and R. N. Boyd, ‘Organic Chemistry’, 6th Edition - Prentice Hall of India. (Chapter-25)
3. M. K. Jain and S.C. Sharma ‘Modern Organic Chemistry’, 3rd Edition, Vishal Publishing Company Co. (Chapter-)
4. K. S. Tewari and N. K. Vishnoi, ‘Organic Chemistry’, 3rd Edition, Vikas Publishing House (Chapter-32)
5. B.S. Bahl ‘Advanced organic Chemistry’, S. Chand

Further reading

1. John McMurry, ‘Organic Chemistry’ - Vth Edition -Thompson Asia Pvt Ltd
2. C. N. Pillai, ‘Organic Chemistry’, Universities Press.

8. Poly nuclear hydrocarbons and their derivatives (3 hrs)

8.1 Classification –reactions of naphthalene, anthracene, phenanthrene and biphenyl.
8.2 Elementary idea of naphthyl amines, naphthols, naphthaquinone and anthraquinone.

References

1. I. L. Finar, Organic Chemistry, 6th Edition. Vol- I, Pearson. (Chapter-29)
2. M. K. Jain and S. C. Sharma ‘Modern Organic Chemistry’, 3rd Edition, Vishal Publishing Company Co. (Chapter- 16)
3. K.S. Tewari and N. K. Vishnoi, ‘Organic Chemistry’, 3rd Edition, Vikas Publishing House (Chapter- 25)
4. B. S. Bahl ‘Advanced organic Chemistry’, S. Chand.

Further reading

1. C. N. Pillai, ‘Organic Chemistry’ Universities Press.
2. A. K. Bansal, A Textbook of Organic Chemistry, New Age International.
3. John McMurry, ‘Organic Chemistry’ - Vth Edition -Thompson Asia Pvt Ltd.
4. S. H. Pine ‘Organic Chemistry’,McGraw Hill
5. A. K. Bansal, “A Textbook of Organic Chemistry’, New Age International Publishers

Semester – V

15U5CRCHE05– Inorganic Chemistry - I

Credits - 3 **(54 hours)**

Aim

To know more about the chemistry of transition and inner transition metals, coordination compounds, organometallic compounds, acids and bases and bioinorganic Chemistry.

Objectives

- To understand the general characteristics of the d and f block elements
- To study the physical and chemical properties of d and f block elements
- To study the various theories of coordination compounds
- To study isomerism exhibited by metal complexes
- To understand the classification, properties and applications of organometallic compounds.
- To study the concepts of acids and bases.
- To understand the importance and various functions of metals in biological systems.

1. Chemistry of d and f block Elements (9 hrs)

General characteristics of d-block elements with special reference to electronic configuration, oxidation states, variable valency, metallic character, colour, magnetic properties, catalytic properties and ability to form complexes. Comparison of the properties of second and third transition series with first transition series.

Chemistry of lanthanides – electronic structure, oxidation states, lanthanide contraction, consequences of lanthanide contraction, magnetic properties, spectral properties and separation of lanthanides by ion exchange and solvent extraction methods (Brief study).

Chemistry of actinides – electronic configuration, oxidation states, actinide contraction, position of actinides in the periodic table, comparison with lanthanides in terms of magnetic properties and spectral properties (Brief study).

References

1. J. D. Lee, Concise Inorganic Chemistry 5th edn., Wiley India Pvt. Ltd. 2008
2. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi 2010

Further Reading

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry, Pearson 2006.
2. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry 6th edn., John Wiley, New York. 1999.
3. D. F. Shriver and P.W. Atkins, Inorganic Chemistry 3rd edn., Oxford University Press. 2009

2. Coordination Chemistry (18hrs)

Ligands, classification based on the number of donor atoms, chelating ligands, bridging ligands, isomerism in complexes-Structural isomerism only:
IUPAC nomenclature, coordination number and possible geometries of complexes from C. N 3 to 12, Stereo isomerism- geometrical and optical isomerism of complexes with 4 and 6 coordination numbers. Stability of complexes - stepwise stability constant and overall stability constant, factors affecting the stability of metal complexes. EAN, Chelates and chelate effect.
Magnetic behavior of complexes- Diamagnetic and paramagnetic complexes, explanation, effective magnetic moment, spins only magnetic moments, calculation of spin only magnetic moment. Quenching of magnetic moment.
Theories of bonding in coordination compounds– Werner's theory of coordination, primary and secondary valences of metal ions.
Valence bond theory- of octahedral, tetrahedral and square planar complexes, high spin and low spin complexes- inner and outer orbital complexes, explanation of magnetic properties, limitations of valence bond theory.
Crystal filed theory- splitting of d-orbitals in octahedral, tetrahedral complexes, strong and weak field ligands, pairing energy, explanation of colour and magnetic properties of complexes, limitation of CF theory.
Jahn-Teller distortion and splitting of d orbitals in tetragonal and square planar fields, Jahn-Teller distortion in Cu (II) complexes.
MO theory- evidence for metal ligand covalency, MOE diagram of complexes of octahedral symmetry (sigma bonding only). Explanation of Δ in the Oh and Td complexes using MOE diagram.
Substitution reactions in metal complexes- Labile and inert complexes, ligand substitution reactions in octahedral complexes, S_N1 and S_N2 substitution reactions.
Substitution reactions of square planar complexes – Trans effect and applications of trans effect.

References

1. J. D. Lee, Concise Inorganic Chemistry 5th edn., Wiley India Pvt. Ltd.2008.
2. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry,31st Milestone Publishers, New Delhi 2010
3. G. L. Meissler, D.A Tarr, Inorganic Chemistry,3rd Edn. Pearson Education, 2004.
4. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, Pearson 2006
5. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry 6th edn., John Wiley, New York 1991.

Further Reading

1. B. Douglas, D. Mc Daniel, J. Alexander, Concepts and models of Inorganic Chemistry, 3rd edn., John Wiley, 2006.
2. M. N. Greenwood and A. Earnshaw, Chemistry of the elements 2nd edn, Butterworth. 1997.

3. Organometallic Compounds (9 hrs)

Definition, classification of organometallic compounds, Ylides, classification on the basis of hapticity, naming of organometallic compounds, 18 electron rule, metal-alkene complexes, metal-

alkyne complexes, carbene and carbyne complexes. Metallocenes – ferrocene (preparation and structure only). Zeise's salt – preparation, properties and structure.

Catalytic properties of organometallic compounds - alkene hydrogenation, synthesis of water gas – shift reaction, Zeigler-Natta polymerization

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry,31st Edn. Milestone Publishers, New Delhi 2010
2. G. L. Meissler, D. A Tarr, Inorganic Chemistry,3rd Edn. Pearson Education,2004.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, Pearson 2006

Further Reading

1. R. C. Mehrothra and A. Singh, Organometallic chemistry, New age publishers.
2. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry 3rd edn., John Wiley, New York.1995.
3. A. G. Sharpe, Inorganic Chemistry, 3rd Edn. Pearson.

4. Acids and bases (8 hrs)

Definition- Bronsted-Lowry, Lux-Flood, Solvent system, Usanovich and Lewis definitions. Self-study. Strength of lewis acids and bases: Factors affecting strength of acids and bases: Solvent effect, Leveling and differentiating solvents. Effect of substituent, steric factor, charge on the species, Electronegativity, hydration, oxidation number of the central atom, resonance effect,

Hard and Soft acids and bases. HSAB Theory, basis of HSAB theory, Symbiosis, Applications of HSAB Concept. Stability of complexes, mode of coordination, predicting feasibility of reactions.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, 31st Edn. Milestone Publishers, New Delhi 2010.
2. G. L. Meissler, D. A Tarr, Inorganic Chemistry,3rd Edn. Pearson Education 2004.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, Pearson 2006.
4. J. D. Lee, Concise Inorganic Chemistry 5th edn., Wiley India Pvt. Ltd.2008.
5. M. Clyde Day,and J. Selbin Theoretical inorganic chemistry 2nd Edn. Reinhold Book Corp. 2008.
6. B. Douglas, D. Mc Daniel, J. Alexander, Concepts and models of Inorganic Chemistry 3rd edn., John Wiley. 2006.

5. Bioinorganic Chemistry (10 hrs)

Essential and trace elements in biological systems, Myoglobin and Hemoglobin, role of myoglobin and hemoglobin in biological systems, mechanism of oxygen transport, cooperativity, Bohr effect, Phosphate effect.

Cytochromes- Structure and function.

Metalloenzymes: Inhibition and poisoning of enzymes. A brief study of the following metalloenzymes and their functions. Carbonic anhydrase, Carbonic peptidase, cytochrome oxidase,

cytochrome P450, Peroxidase, catalases, superoxide dismutase and Nitrogenase. (Structure is not expected)

Role of alkali and alkaline earth metals in biological systems, Na/K pump.

Metal deficiency: Deficiency of Iron, Copper and Zinc.

Metal toxicity. Toxicity of Copper, Iron, Calcium, Plutonium, Mercury and Cadmium. Metals as carcinogens. Treatment of metal toxicity. Chelation therapy.

Anti-cancer drugs – cisplatin and carboplatin. (An outline study.)

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2010.
2. G. L. Meissler, D. A Tarr, Inorganic Chemistry, 3rd Edn. Pearson Education, 2004.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry,5th Ed. Pearson 2009.
4. F.A.Cotton, G.Wilkinson, P. L. Gaus, Basic Inorganic Chemistry,3rd Edn,John –Wiley,1995
5. B. Douglas, D. Mc Daniel, J. Alexander, Concepts and models of Inorganic Chemistry 3rd edn., John Wiley.
6. Ivano Bertini, Harry B Gray, Stephen J. Lippard, Joan Selvertone Valentine,Bioinorganic Chemistry.Viva Books Pvt Ltd. 2007.

Semester – V

15U5CRCHE06- Organic Chemistry - III

Credit - 3 **(54 hours)**

Aim

To give the students a thorough knowledge about the mechanisms of reactions of some selected functional groups in organic compounds and also to give an outline of applied organic chemistry and the applications of organic chemistry in various spheres of chemical sciences.

Objectives

- To learn the chemistry of nitro compounds, amines, dyes, organic polymers, soaps, detergents and organic reagents.
- To understand and study mechanism of reactions of nitro compounds and amines.
- To have an elementary idea of chemotherapy, organic spectroscopy and photochemistry
- To identify organic compound using UV, IR and PMR spectroscopic techniques

1. Organic compounds containing Nitrogen (20 hrs)

1.1 Nitro compounds- nitromethane- tautomerism- reduction products of nitrobenzene in acidic, neutral and alkaline media- electrolytic reduction and selective reduction of poly nitro compounds- formation of charge transfer complexes.

1.2 Amines- isomerism- stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines - Structural features affecting basicity of aliphatic and aromatic amines. Quaternary amine salts as phase-transfer catalysts. Comparative study of aliphatic and aromatic amines.

1.3 Preparation of alkyl and arylamines (reduction of nitro compounds, nitriles), reductive amination of aldehydes and ketones, Gabriel-Phthalimide reaction, Hoffmann bromamide reaction.

1.4 Diazonium salts-preparation, synthetic transformations of aryldiazonium salts, azo Coupling - Mechanisms of Sandmeyer's and Gatterman reactions – Schiemann and Gomberg reactions

1.5 Preparation and uses of Phenyl hydrazine.

1.6 Diazomethane and diazoacetic ester - preparation, structure and synthetic uses.-Arndt-

Eistert synthesis- mechanism –Wolff rearrangement –mechanism.

1.7 Curtius rearrangement and its mechanism.

References

1. I. L. Finar, '*Organic Chemistry*', 6th Edition, Vol. I, Pearson. (Chapters - 13, 22, 23, 24).
2. R. T. Morrison and R. N. Boyd, '*Organic Chemistry*', 6th Edition - Prentice Hall of India, (Chapters - 22, 23).
3. M. K. Jain and S. C. Sharma '*Modern Organic Chemistry*', 3rd Edition, Vishal Publishing Company Co. (Chapter - 22).
4. K. S. Tewari and N. K. Vishnoi, '*Organic Chemistry*', 3rd Edition, Vikas Publishing House (Chapter- 22, 23, 24).
5. B. S. Bahl, '*Advanced Organic Chemistry*', S. Chand.

Further Reading

1. P. Y. Bruice, 'Organic Chemistry' - 3rd Edn. Pearson Education Asia.
2. John McMurry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
3. C. N. Pillai 'Organic Chemistry' Universities Press.
4. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press.

2. Dyes (5 Hrs)

2.1. Theory of colour and constitution. Classification - according to structure and method of application.

2.2. Preparation and uses of 1) Azo dye-methyl orange and Bismark brown, 2) Triphenyl methane dye -Malachite green, 3) Phthalein dye - phenolphthalein and fluroescein, 4) Vat dye – indigo, 5) Anthraquinone dye - alizarin.

References

1. I. L. Finar, Organic Chemistry, 6th Edition. Vol - I, Pearson. (Chapter-31)
2. M. K. Jain and S. C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-22)
3. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-38).
4. B. S. Bahl, 'Advanced Organic Chemistry', S. Chand.

Further Reading

1. John McMurry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
2. C. N. Pillai, 'Organic Chemistry' Universities Press.

3. Organic Photochemical Reactions (3 hrs)

3.1. Introduction- Photochemical versus Thermal reactions. Reactions:

3.2. Norrish reactions of acyclic Ketones. Patterno-Buchi, Photo-Fries reactions.

References

1. I. L. Finar, Organic Chemistry -, 6th Edition. Vol.- I, Pearson. (p.-901-904).
2. M. K. Jain and S. C. Sharma 'Modern Organic Chemistry', 3rd Edition, Visal Publishing Company Co. (Chapter-22)

Further Reading

1. J. March, 'Advanced Organic Chemistry', IV Edn, John Wiley & Sons, NY,
2. C. N. Pillai 'Organic Chemistry', Universities Press
3. John McMurry, 'Organic Chemistry', Vth Edition, Thompson Asia Pvt Ltd.

4. Organic Polymers (4 hrs)

4.1. Synthesis and applications of the following polymers- Polyesters- terephthalates, polyamides- Nylon 6 and Nylon 6,6, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes, PVC and Teflon.

4.2. Synthetic rubbers –SBR and Nitrile rubber- structure and applications.

References

1. M. K. Jain and S.C. Sharma 'Modern Organic Chemistry', 3rd Edition, Visal Publishing Company Co. (Chapter-22)
2. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-37)
3. R. T. Morrison and R.N Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India, (Chapter- 31)
4. Billmeyer F.W., Text book of polymer science, Jr.John Wiley and Sons, 1994.
5. Gowariker V.R., Viswanathan N.V. and JayaderSreedhar, Polymer Science, Wiley Eastern Ltd., New Delhi.

Further Reading

1. B. S. Bahl 'Advanced organic Chemistry', S. Chand
2. B. K. Sharma Polymer Chemistry, Goel Publishing House, Meerut, 1989.

5. Some important aliphatic hydrocarbons (2 hrs)

5.1 Cycloalkanes- relative stabilities.

5.2 Butadiene – structure and stability, 1,4 addition and its mechanism.

References

1. I. L. Finar, Organic Chemistry, 6th Edition. Vol.- I, Pearson. (Chapter-19 and p127-129)
2. M. K. Jain and S. C. Sharma, 'Modern Organic Chemistry', 3rd Edition, Visal Publishing Company Co. (Chapter-22)
3. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-8 and p.293).

Further Reading

1. B.S. Bahl, 'Advanced Organic Chemistry', S. Chand

6. Soaps and Detergents (3 hrs)

6.1 Composition of soaps- detergent action of soap
6.2 Synthetic detergents- - their functions – comparison between soaps and detergents-
6.3 Environmental aspects. LAS and ABS detergents

References

1. I. L. Finar, Organic Chemistry, 6th Edition. Vol- I, Pearson. (p.-323)
2. M. K. Jain and S. C. Sharma, 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-22)
3. K. S. Tewari and N. K. Vishnoi 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-36).

Further Reading

1. B. S. Bahl 'Advanced Organic Chemistry', S. Chand
2. John McMurry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd

7. Chemotherapy (5 hrs)

7.1. Drugs- introduction –classification –mode of action
7.2. Elementary idea of the structure and mode of action of the following drugs Sulphanilamides, Amphicillin and Chloramphenicol,
7.3. Elementary idea of the structure and application of Chloroquine, Paracetamol, Analginand Aspirin.
7.4. Drugs in cancer therapy- Chlorambucil.

References

1. I. L. Finar, Organic Chemistry -, 6th Edition. Vol - I, Pearson. (Chapter-18)
2. M. K. Jain and S.C. Sharma 'Modern Organic Chemistry', 3rd Edition, Visal Publishing Company Co. (Chapter-22)
3. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-39)

Further Reading

1. B. S. Bahl, 'Advanced Organic Chemistry', S. Chand
2. John McMurry, 'Organic Chemistry', Vth Edition, Thompson Asia Pvt Ltd.

8. Chemistry of Organic Reagents (4 hrs)

8.1. Analytical reagents – Tollens reagent, Fehling solution, Schiff's reagents, Borsche's reagent, Benedict solution-(Procedure not required)
8.2. Applications of Synthetic reagents –NBS, Lead tetra acetate, Periodic acid, OsO_4, Ozone, LDA, Raney Nickel, Selenium dioxide, DCC (elementary idea)

References

1. A. I. Vogel, 'A Text Book of Practical Organic Chemistry', Longman.
2. F. G. Mann and B.C. Saunders, 'Practical Organic Chemistry', 4th edn. Pearson Education
3. N. K. Vishnoi, 'Advanced Practical Organic Chemistry', Vikas Publishing House.
4. M. K. Jain and S. C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-22)

Further Reading

1. J. March, 'Advanced Organic Chemistry', IV Edn, John Wiley & Sons, NY

2. John McMurry, 'Organic Chemistry' - Vth Edition, Thompson Asia Pvt Ltd
3. C. N. Pillai 'Organic Chemistry', Universities Press.

9. Structure elucidation (8 hrs)

9.1. Introduction to UV, IR and NMR spectroscopy.

9.2. UV, IR and NMR spectral characteristics of simple molecules such as ethylene, butadiene, benzene, acetaldehyde, acetone, acetophenone, crotonaldehyde, ethanol, ethyl acetate, acetic acid, aniline, acetamide

9.3. Problems pertaining to the structure elucidation of simple organic compounds using IR and PMR spectroscopic techniques

9.4. Mass spectrometry- Introduction-EI ionisation- Determination Molecular mass by MS (Elementary idea- fragmentation study not required)

References

1. R. T. Morrison and R. N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India. (Chapter-17).
2. I. L. Finar, Organic Chemistry, Vol - I, 6th Edition, Pearson education (Chapter-1).
3. M. K. Jain and S. C. Sharma, 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-44)
4. K. S. Tewari and N. K .Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House,(Chapter-26).

Further Reading

1. W. Kemp, 'Organic Spectroscopy', Longman, 1995.
2. D. L. Pavia, G. M. Lampman and G. S. Kriz, 'Introduction to Spectroscopy', Thomson Brooks Cole.
3. Paula Y. Bruice, 'Organic Chemistry', 3rd Edn. Pearson Education, Asia.

Semester V

15U5CRCHE07 - Physical Chemistry - I

Credit – 3 **54 Hrs**

1. Gaseous State (12 hrs)

Kinetic molecular model of gases: pressure of an ideal gas, derivation of gas laws, Maxwell's distribution of velocities – molecular velocities (average, root mean square and most probable velocities) Collision diameter, mean free path, viscosity of gases – temperature and pressure dependence. Relation between mean free path and coefficient of viscosity. Barometric distribution law, Law of equipartition of energy, degrees of freedom and molecular basis of heat capacities. Real gases: compressibility factor z, van der Waals equation of state – derivation and application in explaining real gas behavior. Virial equation of state, van der Waals equation expressed in virial form – calculation of Boyle temperature, Isotherms of real gases, continuity of states. Critical phenomena. Liquefaction of gases (based on Joule-Thomson effect).

References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co. Jalandhar, Chapters 1, 2.
2. K. L. Kapoor, A Textbook of Physical Chemistry, Volumes 1, Macmillan India Ltd, Chaper 1.
3. P.Atkins and J Paula, The elements of Physical chemistry, 7th edn., Oxford University Press, Chapter 1
4. F. A. Alberty and R J Silby, Physical Chemistry, 3rd Edn, John Wiley, Chapter 17.

2. Liquid State (6 hrs)

Intermolecular forces in liquids (qualitative idea only), Structure of liquids. Unusual behavior of water. Surface tension of liquids, surface tension and temperature, interfacial tension, surface active agents, the Parachor and chemical constitution (atomic and structural parachor).Viscosity of liquids, experimental determination of viscosity coefficient, its variation with temperature.

References

1. K. L. Kapoor, A Textbook of Physical chemistry, Volumes 1, Macmillan India Ltd Chapter 2,3
2. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co., Chapter 3.

3. Symmetry (3hrs)

Symmetry of molecules-symmetry elements and symmetry operations – centre of symmetry, plane of symmetry, proper and improper axes of symmetry, combination of symmetry elements, molecular point groups, Schoenflies symbols, crystallographic point groups symmetry.

4. Solid State (12 hrs)

The nature of the solid state- anisotropy- Structural distinction between liquid and solid, crystalline state, space lattice, crystal lattices, unit cell, crystal systems, the law of constancy of interfacial angles, the law of rational indices, Miller indices, equation, law of rational indices - Miller indices. Seven crystal systems and law of symmetry, fourteen Bravais lattices. X-ray diffraction, Bragg's law, detailed study of simple, face centered and body centered cubic systems – Bragg's X-ray diffractometer method and powder method. Analysis of powder diffraction patterns of NaCl and KCl, density of cubic crystals, identification of cubic crystal from crystallographic data.

References

1. K. L. Kapoor, A Textbook of Physical chemistry, Volume 1, Macmillan India Ltd Chapters 2, 3.
2. P. Atkins and J. Paula, The elements of Physical chemistry, 7th edn., Oxford University Press, Chapter 23.
3. A. McQuarrie, J. D. Simon, Physical Chemistry – A molecular Approach, Viva Books Pvt. Ltd, Chapter 29.
4. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical Chemistry, Vishal Publishing Co, Chapter 5.

5. Liquid Crystals (3 hrs)

Liquid crystals thermographic behaviour. Classification, structure of nematic and cholestric phases. Applications of liquid crystals.

6. Surface Chemistry (6 hrs)

Adsorption – types, adsorption of gases by solids – factors influencing adsorption – Freundlich adsorption isotherm – Langmuir adsorption isotherm (derivation).The BET theory (no derivation) – use of BET equation for the determination of surface area. Applications of adsorption.

7. Solutions **(12 hrs)**

Introduction - Binary liquid solutions – Raoult's law- ideal and non-ideal solutions- Gmix, V_{mix}, and S_{mix} for ideal solutions. Vapour pressure-composition and boiling point-composition curves of ideal and non-ideal binary liquid solutions. Fractional distillation of binary liquid-liquid solutions – distillation of immiscible liquids, partially miscible liquid-liquid systems. Critical solution temperature (CST) – the lever rule, introduction to ternary liquid solutions.

Solubility of gases in liquids – Henry's law. Distribution of a solute between two solvents – Nernst distribution law. Colligative properties of dilute solutions – vapour pressure lowering, Boiling point elevation and freezing point depression (thermodynamic derivation). Molar mass determination-related problems- Osmotic pressure –laws of osmotic pressure - Reverse osmosis – purification of sea water. Abnormal molecular masses – van't Hoff factor – degree of association and degree of dissociation.

References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co. Jalandhar, Chapters 15, 24, 25
2. K. L. Kapoor, A Textbook of Physical chemistry, Volume 4, Macmillan India Ltd,
3. *"Physical Chemistry",* K. J. Laidler and J. M. Meiser, 3rd Edition, Houghton Mifflin Comp., New York, International Edition (1999).

Semester V

15U5CRCHE08 - Physical Chemistry - II

Credit – 3 **36 hrs**

1. Introduction to spectroscopy **2hrs**

Introduction: electromagnetic radiation, regions of the spectrum, interaction of electromagnetic radiation with molecules, various types of molecular spectroscopic techniques, Born-Oppenheimer approximation.

2. Rotational spectroscopy **4 hrs**

Rotational spectrum: diatomic molecules, energy levels of a rigid rotator, selection rules, determination of bond length.

3. Vibrational spectroscopy **6 hrs**

Vibrational spectrum: the simple harmonic oscillator – energy levels, force constant, selection rules. Anharmonic oscillator – pure vibrational spectra of diatomic molecules, selection rules, fundamental frequencies, overtones, hot bands. Degrees of freedom for polyatomic molecules, concept of group frequencies – frequencies of common functional groups in organic compounds.

4. Raman spectroscopy **4 hrs**

Raman spectrum: quantum theory of Raman Effect (elementary idea), concept of polarizability, qualitative treatment of pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules, rule of mutual exclusion.

5. Electronic spectroscopy **5 hrs**

Electronic spectrum: concept of potential energy curves for bonding and anti-bonding molecular orbitals, electronic transition, the Frank-Condon principle, dissociation energy. Polyatomic molecules – qualitative description of σ, π and n- molecular orbitals, their energy levels and the respective transitions.

6. NMR Spectroscopy **6 hrs**

NMR spectroscopy: basic principles of NMR spectroscopy – nuclear spin, Larmor precession. Proton magnetic resonance (^{1}H NMR or PMR) – nuclear shielding and deshielding, chemical shift and molecular structure. Spin-spin splitting and coupling constant. First order spectra – interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, ethyl acetate, toluene, acetophenone.

7. Mass Spectroscopy **3 hrs**

Mass spectrometry: Basic principle-ionization, fragmentation, separation of ions and representation of the spectrum, application in molecular mass determination.

8. Photochemistry **6 hrs**

Interaction of radiation with matter: Laws of photochemistry – Grothus-Draper law, Stark-Einstein law, examples of photochemical reactions. Beer law and Beer-Lambert's law. Jablonsky diagram, qualitative description of fluorescence, phosphorescence, nonradiative processes (internal conversion, intersystem crossing). Quantum yield, primary and secondary processes. Basic concepts of photosensitized reactions – photosynthesis, dissociation of hydrogen molecule, isomerization of 2-butene, and chemiluminescence.

References

1. Mc Quarrie, J. D. Simon, Physical Chemistry – A molecular Approach, Viva Books Pvt. Ltd,
2. C. N. Banwell and E M Mc Cash, Fundamentals of molecular spectroscopy 4th edn, Tata Mc Graw Hill, Chapters 6, 7.
3. K. L. Kapoor, A Textbook of Physical chemistry, Volumes 4, Macmillan India Ltd Chapter 4
4. I. N. Levine, Physical Chemistry, Tata Mc Graw Hill, Chapter 21.
5. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co., Chapter 21.
6. K. J. Laidler, John H. Meiser, Physical Chemistry, 2nd edn, Chapter 14.
7. K. K. Sharma, L R Sharma, A text book of Physical Chemistry, Vikas Publishing house Chapter 24

Semester V
15U5OCCHE1 - Chemistry in Everyday life

Credit – 3 **72 hrs**

Aim and objectives:

Chemistry is an integral part of everyday life. Whether it is the food we eat, the clothes we wear , the drugs we consume or the cosmetics we apply- there is chemistry in it. A general information of the chemistry behind these will create an awareness as to what is good and what is bad and to be discarded. For example, we come across a myriad of cosmetic products, which claim to increase our quality of life and well being. But in reality are they as advantageous as they claim to be? An insight into the processes involved in their production will give us ample information regarding these. Similarly we can also gather information as to what is the difference between the various types of soaps,their mode of action, why the disparity in their prices and why soaps are preferred over detergents. Likewise, a student can also become enlightened about the pros and cons of using processed food stuff, which is in vogue today. The above mentioned points are some of the benefits a student who opts to study this subject offered as a common course will receive.

1 Food additives and Flavours **(12 Hrs)**

Functional food additives, adulteration , food laws. Food colours - permitted and non – permitted- Toxicology. Flavours – natural and synthetic- Toxicology .Other functional additives- Soft drinks- formulation Health drinks.

2 Soaps **(7 Hrs)**

Soaps – Introduction , detergent action of soap. Toilet soap, bathing bars, washing soaps, liquid soap manufacture- additives, fillers and flavours. Significance of acidity and alkalinity.

3 Synthetic Detergents **(9 Hrs)**

Detergents- Introduction, detergent action, types of detergents-cationic, anionic, amphiphilic detergents. Common detergent chemicals. Additives, excipients colours and flavours. Enzymes used in commercial detergents. Environmental hazards.

4 Cosmetics **(12 Hrs)**

Cosmetics- Introduction, classification – bathing oils, face creams, toilet powder, skin products, dental cosmetics, hair dyes, shaving cream, shampoo, general formulation of each type. Toxicology of cosmetics.

5 Plastics, Paper and Dyes **(14 Hrs)**

Plastics in everyday life. Brief idea of polymerization-Thermoplastic and thermosetting polymers. Use of PET, HDPE, PVC, LDPE, PP, ABS. Recycling of plastics. Biodegradable plastics. Environmental hazards of plastics. News print paper, writing paper, paper boards, cardboards. Organic materials, wood,

cotton, jute and coir. International recycling codes, and symbols for identification. Natural and synthetic dyes (basic idea only).

6 Drugs **(6 Hrs)**

Chemotherapy- types of drugs- analgesics, antipyretics, antihistamines, antacids tranquilizers, sedatives, antibiotics, antifertility drugs.

7 Chemistry and Agriculture **(12 Hrs)**

Fertilizers- natural, synthetic, mixed, NPK fertilizers. Excessive use of fertilizers and its impact on the environment. Bio fertilizers. Plant growth hormones.

Pesticides- Classification-insecticides, herbicides, fungicides. Excessive use of pesticides –environmental hazards. Bio pesticides. Antiseptics and Disinfectants-Oils - vegetable oils, mineral oil, essential oil-Sugars, artificial sugars

References:

1. T.P. Coultate, Food- The Chemistry of its components. Royal Society of Chemistry, London(Paper back)
2. Shashi Chowls,Engineering Chemistry, Danpat Rai Publication.
3. B.K. Sharma. Industrial Chemistry
4. CNR Rao- Understanding chemistry, Universities Press.
5. Puri and Sharma. Advanced Organic Chemistry.
6. Brown, Insect control by chemicals
7. A. K. De, Environmental Chemistry, New age International Ltd.
8. S. S. Dara, A Textbook of Environmental chemistry and pollution control, S.Chand & Company Ltd.
9. Tisdale, S.L., Nelson, W.L. and Beaton, J. D. Soil Fertility and Fertilizers, Macmillian Publishing Company, New York, 1990.
10. Buchel, K.H. Chemistry of Pesticides, John Wiley & Sons, New York, 1983
11. P.C Pall, K. Goel, R.K Gupta, Insecticides,pesticides and agrobased industries.
12. Gowariker V.R., Viswanathan N.V. and Jayader Sreedhar, Polymer Science, Wiley Eastern Ltd., New Delhi.
13. I.I Singh, V.K Kapoor, Organic Pharmaceutical Chemistry

Semester VI

15U6CRCHE09 - Inorganic Chemistry - II

Credit - 3 **54 hrs**

Aim

The aim of the course is to impart knowledge about processes in metallurgy, and transfer more information about metal carbonyls, structure of solids, Inorganic polymers, metal carbonyls, non-aqueous solvents and the necessity of environment protection

Objectives: To understand the principle of metallurgical processes, the preparation and uses of inorganic polymers, importance of non-aqueous chemistry, metal carbonyls, the structure of solids and the general characteristics of p-block elements.

To understand the importance of our environment and its protection.

1. Metallurgy **(9hrs)**

Methods of concentration of ores- Gravity, magnetic and electrostatic separations, Froth flotation and leaching. Calcination and Roasting. Reduction to free metal- smelting and electrometallurgy, hydrometallurgy. Goldschmidt Thermite Process. Refining of metals- electrolytic, ion exchange, zone refining, vapour phase refining and oxidative refining. Thermodynamics of the oxidation of metals to metal oxides - Ellingham diagrams. Extractive metallurgy of U, Ti ,Th and Ni.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry,31st Ed.Milestone Publishers, New Delhi 2010.
2. S. Prakash, G. D. Tuli, S. K. Basu and R. D. Madan, Advanced Inorganic Chemistry, 5th edn, 2012, Volume I, S Chand.
3. A. Cottrel, An introduction to metallurgy, 2nd edn., University press. 1990.

2. Metal Carbonyls and Metal clusters **(9hrs)**

Preparation and properties of mononuclear carbonyls. Structures of $Mo(CO)_6$, $Fe(CO)_5$ and $Ni(CO)_4$. Polynuclear carbonyls, bridged carbonyls and bonding in carbonyls. Metal clusters - carbonyl and halide clusters, low nuclearity carbonyl clusters and high nuclearity carbonyl clusters, electron counting schemes for $Rh_6(CO)_{16}$ and $[Os_6(CO)_{18}]^{2-}$, metal only clusters (Zintl ions). Quadruple bond – structure of $Re_2Cl_8^{2-}$.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, 31st Ed. Milestone Publishers, New Delhi 2010
2. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, Pearson 2006
3. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry 6th edn., John Wiley, New York,1998.

Further Reading

1. D. F. Shriver and P.W. Atkins, Inorganic Chemistry 3rd edn., Oxford University Press,2009.
2. G. S. Sodhi, Organometallic Chemistry, Ane books Ltd, New Delhi, 2009.

3. Inorganic Polymers (6 hrs)

Inorganic polymers – general properties, comparison with organic polymers, glass transition temperature. Sulphur based polymers – polymeric sulphur nitride and chalcogenic glasses (preparation, properties and uses). Phosphorus based polymers – polyphosphazenes and polyphosphates. Silicon based polymers – silicones and silicone rubber (preparation, properties and uses).

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry,31st Edn. Milestone Publishers, New Delhi,2010.
2. S. Prakash, G. D. Tuli, S. K. Basu and R. D. Madan, Advanced Inorganic Chemistry,Volume I, S Chand.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, 4th edn., Pearson 2006

4. Non aqueous solvents (4hrs)

Classification of solvents, characteristics of solvents, reactions in liquid ammonia, Alkali metal solution in liquid ammonia, their important properties.

Liquid sulphur dioxide and liquid HF (acid base, amphoteric, solvation, oxidation – reduction, complex formation)

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry,31st Milestone Publishers, New Delhi,2010
2. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, 4th edn., Pearson 2006.
3. M. Clyde Day, and J. Selbin, Theoretical Inorganic Chemistry, 2nd Edn. Reinhold Book Corp. 2008.

5. Compounds of s and p block Elements (10 hrs)

Macrocyclic ligands:- crown ethers and cryptands, Macrocyclic effect, Alkali metal complexes with crown ethers and cryptands, their applications.

Boron hydrides – diborane (preparation, properties and bonding), B5H9, B4H10 (structure only). Closo carboranes, boron nitride, borazine, boric acid. Peroxy acids of sulphur. Oxides and oxy acids of halogens (structure only), superacids, interhalogen compounds, pseudohalogens, electropositive iodine, fluorocarbons. Fluorides, oxides and oxy fluorides of xenon (structure only).

References

1. J. D. Lee, Concise Inorganic Chemistry 5th edn., Blackwell Science, London,2008.
2. B. R. Puri, L. R. Sharma, K C Kalia, Principles of Inorganic Chemistry, 31st Edn.Milestone Publishers, New Delhi,2010.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, 4th edn., Pearson 2006.
4. D. F. Shriver and P.W. Atkins, Inorganic Chemistry, 3rd edn., Oxford University Press, 2006.
5. M. N. Greenwood and A. Earnshaw, Chemistry of the elements 2nd edn, Butterworth, 1997.

6. Structure of Inorganic Solids (9 hrs)

Close packing of spheres, ccp and hcp arrangements. Interstitial sites in close packing, Tetrahedral, Octahedral sites. Radius ratio, Limiting radius ratio for trigonal, tetrahedral and octahedral sites.(only values). Use of limiting radius ratio in the structural determination of ionic crystals. Structure of ionic crystals of NaCl, CsCl, ZnS. Defects in crystals – stoichiometric and non-stoichiometric defects,.Cosequences of defects. extrinsic and intrinsic defects .Impurity defects. semiconductors, n-type, p-type, Superconductivity – an introduction.

References.

1. B. R. Puri, L. R. Sharma, K C Kalia, Principles of Inorganic Chemistry, 31st Edn.Milestone Publishers, New Delhi,2010.
2. J. D. Lee, Concise Inorganic Chemistry 5th edn., Blackwell Science, London,2008.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, 4th edn., Pearson 2006
4. D. F. Shriver and P.W. Atkins, Inorganic Chemistry, , 3rd edn., Oxford University Press.
5. G.L. Meissler, D.A Tarr, Inorganic Chemistry, Pearson Education
6. B. Douglas, D. Mc Daniel, J. Alexander, Concepts and models of Inorganic Chemistry 3rd edn., John Wiley.
7.A. R. West, Solid State Chemistry and its applications, John Wiley.

7. Water quality parameters (7hrs)

Standards for drinking water-Determination of turbidity (nephelometric method)-determination of pH-determination of total dissolved solids-total hardness-total alkalinity-acidity-chloride-determination of dissolved oxygen (DO), BOD and COD. Estimation of coliform count.

References.

1. B.K Sharma Environmental Chemistry, 12th Edn., Goel Publishing House,2011.
2. B. R. Puri, L. R. Sharma, K C Kalia, Principles of Inorganic Chemistry, 31st Edn.Milestone Publishers, New Delhi, 2010.
3. A.K Dee, Environmental Chemistry, 3rd Edn., New Age International Pvt. Ltd.,1996.
4. Sodhi. G.S., Concepts of Environmental Chemistry, Narsa Publication House, 2009.
5. Sindhu. P. S., Environmental Chemistry, New Age International Pvt. Ltd., 2011.

6. Balaram Pani, Environment Chemistry, I. K. International Publishing House Ltd.,2007.
7. Thomas G Spiro, Chemistry of Environment, Prentice Hall of India., 2006.
8. Raghavan Nambiar., Environmental Studies, Scitech Publications (India) Pvt. Ltd.,2008.

Semester – VI

15U6CRCHE10 – Organic Chemistry - IV

Credit - 3 **(54 hours)**

Aim

To give an outline of bio-organic chemistry and chemistry of natural products

Objectives

To enable the students

- To learn in detail the chemistry of carbohydrates, heterocyclic compounds, amino acids, proteins and nucleic acids
- To have a thorough idea on the structures of carbohydrates and some heterocyclic compounds.
- To understand the structure and functions of enzymes, proteins and nucleic acids. To study the fundamentals of terpenoids, alkaloids, vitamins, lipids and steroids. To have an elementary idea of supramolecular chemistry and Green Fluorescent Proteins.

1. Natural products (12 hrs)

1.1. Natural Products - Terpenoids - isoprene rule. Structure elucidation of citral and geraniol.
1.2. Alkaloids - general methods of isolation –classification – structure elucidation and synthesis of conine, piperine and nicotine.
1.3. Vitamins – classification- structure (elementary idea) of vitamin A, C and B_1, B_2, B_6
1.4. Lipids – biological functions – oils and fats – common fatty acids- extraction and refining- hydrogenation – rancidity- identification of oils and fats – saponification value, acid value, iodine value and RM value.

References

1. I. L. Finar, Organic Chemistry - Volume I & II - Pearson Education(Chapters 8,14,17)
2. M. K. Jain and S. C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-42,43,40,38)
3. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-40,41)
4. R. T. Morrison and R.N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India. (Chapter-33)

Further reading

1. S. P. Bhutani, Chemistry of Biomolecules, Ane Books Pvt Ltd
2. O.P. Agarwal, Chemistry of Natural Products - Goel Publications

2. Carbohydrates (14 hrs)

2.1. Classification - constitution of glucose and fructose.
2.2. Reactions of glucose and fructose - osazone formation. Mutarotation and its mechanism. Epimerisation.
2.3. Configuration of monosaccharides
2.4. Cyclic structure. Pyranose and furanose forms. Determination of ring size. Haworth projection formula.
2.5. Chain lengthening and chain shortening of aldoses. Inter conversion of aldoses and ketoses.
2.6. Disaccharides - reactions and structure of sucrose and maltose. Ring structure
2.7. Structure and properties of starch and cellulose. (elementary idea). Industrial applications of cellulose.

References

1. I. L. Finar, Organic Chemistry - Volume I & II - Pearson Education(Chapters 18)
2. M. K. Jain and S. C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-35)
3. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-33)
4. R. T. Morrison and R.N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India. (Chapter-34, 35)

Further reading

1. J. F. Robyt, Essentials of Carbohydrate Chemistry, Springer.
2. S. P. Bhutani, Chemistry of Biomolecules, Ane Books Pvt Ltd.

3. Heterocyclic compounds. (10 hrs)

3.1 Aromaticity of heterocyclic compounds.
3.2 Preparation, properties and uses of furan, pyrrole and thiophene.
3.3 Synthesis and reactions of pyridine and piperidine - comparative study of basicity of pyrrole, pyridine and piperidine with amines.
3.4 Synthesis and reactions of quinoline, isoquinoline and indole with special reference to Skraup, Bischler, Napieralskii and Fisher indole synthesis.

References

1. I. L. Finar, Organic Chemistry - Volume I & II - Pearson Education (Chapters 30)
2. M. K.J ain and S. C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-33, 34)
3. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-29, 30)
4. R. T. Morrison and R.N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India. (Chapter-18)

Further reading

1. John McMurry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
2. C. N. Pillai 'Organic Chemistry' Universities Press.

4. Amino acids and Proteins (12 hrs)

4.1 Amino acids- classification, Zwitter ion. Peptide- solution phase peptide synthesis.
4.2 Classification of proteins based on physical and chemical properties and on physiological functions.
4.3 Primary secondary tertiary and quaternary structure of proteins, helical and sheet structures (elementary treatment only). Denaturation of proteins.
4.4 Nucleic acids. Types of nucleic acids -RNA and DNA, polynucleotide chain components - biological functions.
4.5 Supramolecular interactions – Significance in nucleic acids and proteins.
4.6 Green Fluorescent Proteins (elementary idea)

References

1. I. L.Finar, Organic Chemistry - Volume I & II - Pearson Education (Chapter 13,16)
2. M. K. Jain and S. C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-36,37)
3. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-34,35)
4. R. T. Morrison and R.N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India. (Chapter-36)
5. en.wikipedia.org/wiki/Green_fluorescent_protein
6. www.scholarpedia.org/article/fluorescent_protein
7. www.conncoll.edu/ccacad/zimmer/GFP-ww/timeline.html
8. www.gonda.ucla.edu/bri_core/gfp.htm

Further reading

1. O. P. Agarwal Chemistry of Natural Products - Goel Publications

5. Enzymes (3 hrs)

5.1 Nomenclature and classification of enzymes (based on substrate). Chemical nature of enzymes.
5.2 Mechanism of enzyme action. Substrate specificity of enzymes. Enzyme inhibition.

References

1. I. L. Finar, Organic Chemistry - Volume I & II - Pearson Education(Chapter 13,)
2. M. K. Jain and S. C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-36)
3. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-34)
4. R. T. Morrison and R. N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India. (Chapter-36)

Further reading

1. John McMurry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
2. C. N. Pillai, 'Organic Chemistry' Universities Press
3. S. P. Bhutani, Chemistry of Biomolecules, Ane Books Pvt Ltd

6. Steroids (3 hrs)

6.1 Introduction – Diels hydrocarbon- Structure and functions of cholesterol.
6.2 Elementary idea of HDL, LDL, Vitamin D.

References

1. I. L.Finar, Organic Chemistry - Volume II - Pearson Education(Chapter 11)
2. M. K. Jain and S. C. Sharma 'Modern Organic Chemistry', 3rd Edition, Vishal Publishing Company Co. (Chapter-39)
3. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-41)

Further reading

1. O. P. Agarwal Chemistry of Natural Products - Goel Publications

Semester – VI

15U6CRCHE11 - Physical Chemistry – III

Credit – 3 **54 hrs**

1. CHEMICAL THERMODYNAMICS (39 hrs)

1.1 Introduction to Thermodynamics:

Definition of thermodynamic terms, intensive and extensive properties, path and state functions, exact and inexact differentials, reversible and irreversible processes, spontaneous and non-spontaneous processes, internal energy, work and heat, zeroth law of thermodynamics.

1.2 First law of thermodynamics:

Statement and mathematical expression, enthalpy, heat capacity, Cp and Cv relation in ideal gas systems, change in thermodynamic properties of an ideal gas during (i) isothermal/adiabatic, reversible/irreversible processes. Joule-Thomson experiment, Joule-Thomson coefficient μ_{JT}, inversion temperature.

1.3 Thermo chemistry

Enthalpies of formation, combustion, neutralization, solution and hydration; relation between heats of reactions at constant volume and constant pressure. Variation of heats of reaction with temperature – Kirchoff's equation; Hess's law and its application.

1.4 Second law of Thermodynamics:

Limitations of first law – statements of second law, Carnot’s cycle – efficiency of heat engines, Carnot theorem. Entropy – entropy change for various reversible/irreversible processes,Change in

entropy of an ideal gas with pressure, volume and temperature. Third law of thermodynamics- statement and significance.

1.5 Free Energy Functions:

Helmholtz energy and Gibbs energy – variation of Gibbs energy with T and P. Criteria for reversible and irreversible processes. Gibbs-Helmholtz equation. Clausius - Clapeyron equation, applications. Partial molar properties – chemical potential, Gibbs-Duhem equation, chemical potential in a system of ideal gases, concept of activity. Chemical equilibrium: conditions for chemical equilibrium, relation between Kc and Kx – Kp, van't Hoff reaction isotherm. Temperature dependence of Kp – van't Hoff equation. 36 hrs

References

1. R. P. Rastogi, R. R. Misra, An Introduction to Chemical Thermodynamics, 6th edn., Vikas Pub. Pvt. Ltd. (2003), chapters 1, 2, 3, 4, 5.
2. P. Atkins and J Paula, The elements of Physical chemistry, 7th edn., Oxford University Press, Chapters 2,3,4,5.
3. K. K. Sharma, L. K. Sharma, A Textbook of Physical Chemistry, 4th edn, Vikas publishing House, Chapters 6, 7, 8, 9.
4. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co. Jalandhar, Chapters 9,11,12,13.

Further reading

1. J. Rajaram and J. C. Kuriakose, Thermodynamics, ShobanLal Nagin Chand & Co (1986).
2. H. Kuhn and H. D. Fosterling, Principles of Physical chemistry, John Wiley.
3. W. J. Moore, Basic Physical Chemistry, Orient Longman.
4. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A molecular Approach Viva Books Pvt. Ltd.
5. F. A. Alberty and R. J .Silby, Physical Chemistry, John Wiley.
6. G. M. Barrow, Physical Chemistry, 5th edn., Tata McGraw Hill.
7. G. K. Vemulapalli, Physical Chemistry, Prentice-Hall of India Pvt. Ltd. (1997).
8. G. W. Castellan, Physical Chemistry, 3rd edn, Narosa Publishing House, New Delhi, (2004).

2 PHASE EQUILIBRIA (6 hours)

The phase rule, equilibrium between phases – conditions. One component system – water system, sulphur system. Two component systems – solid-liquid equilibrium – simple eutectic, lead- silver system, formation of compounds with congruent melting point ferric chloride- water system, formation of compounds with incongruent melting point sodium sulphate- water system.

References

1. R. P. Rastogi, R. R. Misra, An Introduction to Chemical Thermodynamics, 6th edn., Vikas Pub. Pvt. Ltd. (2003), chapter 9.
2. K. L. Kapoor, A Textbook of Physical chemistry, Volumes 3, Macmillan India Ltd. Chapters 3, 5, 6.
3. P. Atkins and J Paula, The elements of Physical chemistry, 7th edn., Oxford University Press, Chapter 8.
4. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co. Jalandher, Chapter 14.

Further reading

1. W. J. Moore, Basic Physical Chemistry, Orient Longman.
2. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A molecular Approach Viva Books Pvt. Ltd.
3. F. A. Alberty and R. J. Silby, Physical Chemistry, John Wiley.
4. G. M. Barrow, Physical Chemistry, 5th edn., Tata McGraw Hill.
5. G. K. Vemulapalli, Physical Chemistry, Prentice-Hall of India Pvt. Ltd. (1997).
6. G. W. Castellan, Physical Chemistry, 3rd edn., Narosa Publishing House, New Delhi, (2004).
7. H. Kuhn and H. D. Fosterling, Principles of Physical Chemistry, John Wiley.

3 CHEMICAL KINETICS (9 hrs)

Rate of reaction, rate equation, order and molecularity of reactions, Integrated rate expressions for first and second order reactions. Zero order reactions, pseudo-order reactions, half life.

Theories of chemical kinetics: effect of temperature on the rate of reaction, Arrhenius equation, concept of activation energy Collision theory, transition state theory. Thermodynamic parameters for activation – Eyring equation (no derivation needed), enthalpy and entropy of activation. Theory of unimolecular reactions – Lindemann theory.

Kinetics of complex (composite) reactions: Opposing reactions, consecutive reactions, and parallel (simultaneous) reactions. Chain reactions – steady state treatment, hydrogen bromine reaction. Catalysis: Homogeneous catalysis, enzyme catalysis – Michaelis-Menten equation (no derivation needed). Heterogeneous catalysis – surface catalysis, uni and bi molecular reactions on surface. Elementary idea about autocatalysis.

References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical Chemistry, Vishal Pub. Co. Jalandhar, Chapters 7,8, 60.
2. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A molecular Approach Viva Books Pvt. Ltd Chapters 26, 27.
3. K. L. Kapoor, A Textbook of Physical Chemistry, Volumes 4, Macmillan India Ltd, Chapter 6.
4. K. K. Sharma, L. K. Sharma, A Textbook of Physical Chemistry, 4th edn,Vikas publishing House, Chapters 17, 18.

Further reading

1. K. J. Laidler, Chemical kinetics 3rd edn, Pearson education 2004.
2. J Rajaram and J. C. Kuriakose, Kinetics and mechanisms of chemical transformations, Macmillan, 2006.
3. W. J. Moore, Basic Physical Chemistry, Orient Longman.
4. S. H. Marron and J. B. Lando, Fundamentals of Physical Chemistry, Macmillan Ltd. (1996).
5. F. A. Alberty and R. J. Silby, Physical Chemistry, John Wiley.
6. G. M. Barrow, Physical Chemistry, 5th edn., Tata McGraw Hill.
7. G. K. Vemulapalli, Physical Chemistry, Prentice-Hall of India Pvt. Ltd. (1997).
8. G. W. Castellan, Physical Chemistry, 3rd edn., Narosa Publishing House, New Delhi, (2004).
9. H. Kuhn and H. D. Fosterling, Principles of Physical chemistry, John Wiley.

Semester – VI

15U6CRCHE12 - Physical Chemistry – IV

Credit – 3 **54 Hrs**

1. Ionic Equilibrium **12 hrs**

Introduction-concepts of acids and bases, relative strength of acid-base pairs, influence of solvents, Classification of acids and bases as hard and soft acids and bases. Pearson's HSAB concept, applications. Dissociation constants – acids, bases, and polyprotic acids. Ostwald's dilution law. Ionic product of water – pH. Buffer solutions – mechanism of buffer action, Henderson equation. Hydrolysis of salts – hydrolysis constant, degree of hydrolysis, pH of salt solutions. Acid-base indicators, theories, determination of pH by indicators, solubility product principle – applications.

References

1. K. L. Kapoor, A Textbook of Physical chemistry, Volumes 1, Macmillan India Ltd, chapter 4.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co. Jalandhar, Chapter 16.

2. Electrical Conductance **15 hrs**

Introduction - Faraday's laws of electrolysis, electrochemical equivalent, and chemical equivalent- electrolytic conductivity, molar conductivity - Variation of molar conductivity with concentration. Kohlrausch's law – applications.

Ionic mobility – relation with ion conductivity, influence of temperature on ion conductivity, ion conductivity and viscosity – Walden's rule, influence of dielectric constant of solvent on ion conductivity. Abnormal ion conductivity of hydrogen and hydroxyl ions.

Discharge of ions during electrolysis – Hittorf's theoretical device. Transport Numbers – determination by Hittorf's method and moving boundary method.

Debye-Hückel theory of strong electrolytes – the concept of ionic atmosphere, Asymmetry and electrophoretic effect, Debye- Hückel-Onsager equation (no derivation). Activity, mean ionic activity and mean ionic activity coefficients of electrolytes. Ionic strength of a solution, Debye-Hückel limiting law (no derivation). Applications of conductance measurements – Determinations of degree of dissociation of weak electrolytes, ionic product of water, and solubility of sparingly soluble salts, conductometric titrations.

References

1. K. L. Kapoor, A Textbook of Physical chemistry, Volume 1, Macmillan India Ltd.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical Chemistry, Vishal Pub. Co. Jalandhar, Chapter 17.

3. Electromotive Force **15 hrs**

Introduction - Galvanic cells, characteristics of reversible cells. Reversible electrodes – different types, electrode potential – electrochemical series. Representation of cells – e.m.f of cell. Thermodynamics of reversible cells and reversible electrodes – Determination of G, H and S of cell reaction. E.M.F and equilibrium constant of cell reaction, effect of electrolyte concentration on electrode potential and e.m.f (Nerst equation). Concentration cells – electrode concentration cell and electrolyte concentration cells. Types of electrolyte concentration cells – with transference and without transference, liquid junction potential. Fuel cells – the hydrogen-oxygen fuel cell.

Applications of e.m.f measurements – determination of solubility product, determination of pH using hydrogen electrode, quinhydrone electrode and glass electrode. Potentiometric titrations, oxidation reduction indicators.

Irreversible electrode processes – overvoltage. Corrosion of metals – forms of corrosion, corrosion monitoring and prevention methods.

References

1. K. L. Kapoor, A Textbook of Physical chemistry, Volumes 3, Macmillan India Ltd, Chapter 8
2. I. N. Levine, Physical Chemistry, Tata Mc Graw Hill, Chapter 14
3. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry**,** Vishal Pub. Co. Jalandhar, Chapter 18

3. Electrical and Magnetic properties **12 hrs**

Introduction, optical activity, molar refraction, dielectric constant, dipole moment, magnetic properties of molecules, nuclear paramagnetism, NMR spectrometer, the chemical shift, electron spin resonance (ESR).

References

1. A. S. Negi, S. C. Anand, A Textbook of Physical Chemistry, Second Edition, New Age International (P) limited, publishers, Chapter 26.

Semester – VI
15U6ELCHE1 – Advances in Chemistry
(Core Elective)

Credits – 3 **(72 hours)**

1. Advanced Topics in Inorganic Chemistry.

1.1 Nanomaterials **(9 hrs)**

Nanomaterials – synthesis – chemical precipitation, mechano-chemical method, micro emulsion method, reduction technique, chemical vapour deposition and sol-gel method (brief study). Properties and applications of fullerenes, quantum dots and carbon nanotubes. Applications of nano materials - nano composites – nano medicines.

References

1. V. S. Muraleedharan and A. Subramanian, Nano science and nanotechnology, Ane Books Pvt. Ltd. New Delhi, 2009
2. T. Pradeep, Nano; The Essentials, Mc Graw-Hill education, New Delhi, 2006.

1.2. Industrially important materials **(8 hrs)**

Refractory materials - carbides, nitrides, borides. Graphite and graphite oxide, intercalation compounds of alkali metals, carbon monofluoride, intercalation compounds of graphite with metal halides, glass, silicates, zeolites, ultramarines and ceramics.

1.3. Modern Analytical Techniques **(8 hrs)**

1.3.1. Thermo analytical methods: Principle of thermo gravimetry, TGA of calcium oxalate monohydrate, differential thermal analysis, differential scanning calorimetry. Applications.

1.3.2. Colorimetry: Principle, Beer's law, Lambert's law, absorption coefficient, transmittance, opacity, Absorbance, optical density, molar absorption coefficient. Principle of estimation of iron, chromium and ammonia.

Reference.

1. H.H Willard, L.L. Merritt, J.A. Dean, F.A Settle, Instrumental methods of Analysis, CBS Publishers And Distributors, Delhi, 1996.
2. G.H Jeffery, J. Basset, J. Mendham, R.C Denny, Vogel's Textbook of Quantitative Chemical Analysis, ELBS 5th edn. 1996.

2 Advanced topics in Organic Chemistry

2.1. Supramolecular Chemistry (6 hrs)

Introduction-Molecular recognition-Host-guest interactions- types of non-covalent interactions - Importance of molecular recognition in DNA and protein structure

References

1. Helena Dodzuik, Introduction to Supramolecular Chemistry Springer (chapter 1,2**)**

Further reading

1. J. M. Lehn, Supramolecular Chemistry, VCH
2. H. Vogtle, Supramolecular Chemistry, Wiley
3. En.wikipedia.org/wiki/Supramolecular Chemistry

2.2 Retrosynthetic analysis (6 hrs)

Retrosynthetic analysis and disconnection approach. Basic principles and terminology. Retrosynthetic analysis of simple cyclic and acyclic alkenes, alcohols, and carbonyl compounds. Simple problems of reterosynthesis of the above compounds

References

1. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press, 2001.(Chapter 30)
2. Paula Yurkanis Bruice, Organic Chemistry, 2002, (3rd Edition) (chapter 29)

For further Reading

1. S. Warren, Organic Synthesis, The disconnection Approach, John Wiley & Sons, 2004.
2. E. J. Corey, X-M. Cheng (1995). *The Logic of Chemical Synthesis*. New York: Wiley. ISBN 0-471-11594-0.
3. W. Carruthers, 'Modern Methods in Organic Synthesis', Cambridge University Press., 1986.

2.3. Green Chemistry (6 hrs)

Green Chemistry- introduction- need for green chemistry –Twelve principles of green chemistry with examples- polylactic acid (PLA)as a green polymer.

1. V. K. Ahluwalia, Green Chemistry, *Ane Books* India.
2. Anastas, P. T.; Warner, J. C. Green Chemistry: Theory and Practice Oxford University Press: New York, 1998, p.30. By permission of Oxford University Press.
3. Arends I., R. Sheldon, U. Hanefeld, Green Chemistry and Catalysis, 2007 WILEY-VCH, Verlag GmbH & Co. KGaA, Weinheim.

2.4. Advances in Polymers (9 hrs)

Biopolymers - biomaterials. Polymers in medical field. High temperature and fire-resistant polymers. Silicones, Conducting polymers- carbon fibers. (basic idea only).

3. Advanced Topics in Physical Chemistry

3.1 Biophysical Chemistry (10 Hrs)

Protein structure; Amino acids. Primary, secondary and tertiary structure; Protein folding. Significance of Van der Waals force, hydrogen bond and hydrophobic interactions.

Acid-Base equilibrium: .Protonation and deprotonation reactions. Biological significance of pH; Properties of proteins with emphasis on isoelectric pH. Henderson and Hasselbalch equation. Titration curves of amino acids & pK values, Buffers & Stability of their pH.

Thermodynamics and Kinetics. Standard free energy change in biochemical reactions, exergonic, hydrolysis of ATP. Chemical potential. Oxidation/reduction reactions and bioenergetics. Enzyme catalysis. Michael Menton kinetics.

References

1. Principles of Biochemistry- Albert L. Lehninger CBS Publishers & Distributors.
2. Biochemistry – Lubert Stryer Freeman International Edition.
3. Biochemistry - Voet and Voet, John Wiley and Sons.
4. Physical Chemistry for Life Sciences, Peter Atkins and Julio de Paula, 2006, Oxford Press
5. Narayanan, P (2000) Essentials of Biophysics, New Age Int. Pub. New Delhi.
6. Roy R.N. (1999) A Text Book of Biophysics New Central Book Agency.
7. Introduction to Biophysical chemistry, R. Bruce Martin, McGraw-Hill, NY, 1964.
8. Physical Chemistry with applications to Biological systems, Ramond Chnag, Mc Millan publishing Co.inc, New York 1977.
9. Principles of Physical Biochemistry 2nd Edition, K.E. van Holde, W.C. Johnson, P.S. Ho, Pearson Prentice Hall, ISBN 0-13-046427-9.

3.2 Introduction to Computational Chemistry (10 hrs)

Scope of computational chemistry. Building of 3D molecular structures using computer softwares. Coordinate formats. Z-matrix, Cartesian coordinate and PDB formats. Z-matrix of simple molecules H_2O, CO_2 & NH_3. Introduction to Common computational and visualization softwares.

Brief introduction to Hartree Fock, ab initio, semi empirical, DFT and molecular mechanics methods. Basis sets, STO & GTO basis sets. Potential energy surface. Local and Global minima. Single point energy calculations and Geometry optimizations.

Format of input and output files in Computational Chemistry Calculations. (Single point and Optimization Calculations in simple molecules such as molecules H_2O, CO_2 & NH_3 using suitable software package.

References

1. T Clark , Hand book of Computational Chemistry, Wiley, New York.
2. W J Hehre, A J Shusterman, W W Huang, A laboratory book of computational organic chemistry, Wave function Inc.
3. A. R. Leach, Molecular Modeling, Longman.
4. D. C. Young, Computational Chemistry, A practical guide to applying techniques to real world problems, John Wiley
5. F. Jensen, Introduction to Computational Chemistry, John Wiley.
6. Guy H. Grant and W. Graham Richards, "Computational Chemistry", OCP(29)
7. Christopher J. Cramer, John Wiley, "Essentials of Computational Chemistry".

Semester – VI
15U6ELCHE2 – Medicinal and Pharmaceutical Chemistry
(Core Elective)

Credit – 3 **(72 hours)**

Objectives:

The content of this syllabus is designed to give the knowledge of different theories of drug actions at molecular level.

Course Description:

The Special Topics in Medicinal Chemistry will explore the role of organic chemistry in the design and action of drugs. Concepts presented in this elective course will be applied in discussing principles of drug discovery, drug development, drug/receptor interactions and structure/activity relationships

1. Drug Discovery Design and Development (9 hrs)

Drug discovery without a lead, Lead Discovery, Random Screening Non random Screening, Lead Modification, Identification of active part,: The pharmacophore, Functional group modification, Structure activity relationship.

2. Drug Metabolism (18 hrs)

Phase-transformations: Oxidative reactions, Reductive reactions, Carboxylation reactions and Hydrolytic reactions. & Phase-II Metabolic Reactions Conjugation reactions, Introduction to Drug Designing on the Basis of Metabolic Pathways. Prodrugs- Bioprecursor & Carrier Linked Prodrugs, Hard and Soft Drugs.

3. Drug Receptor Interactions (18 hrs)

Drug Receptor Interactions: General considerations, Interactions involved in drug receptor complexes, Covalent bonds, Ionic interactions, Ion dipole and dipole- dipole interactions, Hydrogen bonds, Charge transfer complexes, Hydrophobic interactions, Theories of Drug Receptor Interactions.

4. Classification, Synthesis and SAR of some important Drugs (27 hour)

4.1 General Anaesthetics: General Discussion, classification and synthesis of nitrous oxide, chloroform, halothane and thiopental sodium.

4.2 Local Anaesthetics: General Discussion, classification and synthesis of Procaine Hydrochloride, Benzocaine, Lignocaine Hydrochloride.

4.3 Hypnotics and Sedatives: Classification, Structural Activity Relationship (SAR) and synthesis of Barbiturates, Allobarbitol, hexobarbitol.

4.4 Tranquilizers: Classification, Mode of action and synthesis of Reserpine, chloropromazine Hydrochloride, and Diazepam.

4.5 Anticonvulsants: Classification and Synthesis of Phenobarbitol, Phenytoin Sodium

4.6 Analgesics and Antipyretics: General Discussion and classification of Analgesics & Antipyretics, Mode of action and SAR of Morphine & its analogues, mefenemic acid, ibuprofen, paracetomol and aspirin.

4.7 Antihistamines: General Discussion, mode of action, SAR of ethanol amine derivatives and synthesis of Diphenhydramine hydrochloride, mepyramine, Promethazine Hydrochloride.

References:

1. Smith HJ, Williams H, eds, "Introduction to the principles of Drug Design" Wright Boston.
2. Silverman R.B. "The Organic Chemistry of Drug Design and Drug Action" Academic Press New York.
3. Robert GCK,ed., " Drug Action at the Molecular Level" University Prak Press Baltimore.
4. Martin YC. "Quantitative Drug Design" Dekker, New York.
5. Lien EJ. SAR " Side effects and Drug Design" Dekker, New York.
6. William H, Malick JB "Drug Discovery and Development" Humana Press Clifton.
7. Foye W O "Principles of Medicinal Chemistry" Lea & Febiger
8. Medicinal Chemistry – Ashutosh Kar, New Age Publication.
9. Medicinal Chemistry – D. Sriram and P. Yogeeswari, Pearson Publication.

PRACTICAL 1
Semester I & II
15U2PRCHE1 – Volumetric Analysis

Credit- 2 **(72 hrs)**

A. Acidimetry and Alkalimetry

1. Strong acid – Weak base
2. Strong base – Weak acid
3. Estimation of Na_2CO_3 and $NaHCO_3$ in a mixture
4. Estimation of NaOH and Na_2CO_3 in a mixture

B. Complexometry

1. Estimation of Zn using EDTA
2. Estimation of Mg using EDTA
3. Estimation of Mg and Ca in a mixture
4. Determination of hardness of water

C. Permanganometry

1. Estimation of Ferrous iron
2. Estimation of Oxalic acid
3. Estimation of Calcium

D. Dichrometry

1. Estimation of Ferrous iron using internal indicator
2. Estimation of Ferrous iron using external indicator
3. Estimation of Ferric iron – reduction with $SnCl_2$

E. Iodometry and Iodimetry

1. Standardisation of thiosulphate using KI, electrolytic copper and potassium dichromate.
2. Estimation of As_2O_3 and arsenite.
3. Estimation of Cu in a copper salt.

References

1. Vogel's Textbook of Quantitative Chemical Analysis 6th edn, Pearsons Education Ltd.
2. D. A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry 8th edn, Brooks/Cole Nelson .
3. G. D. Christian, Analytical Chemistry, John Wiley and Sons

PRACTICAL 2
Semester III & IV
15U4PRCHE2 – Organic Chemistry Practicals – I
Qualitative Organic Analysis

Credit-2 **(72 hrs)**

1. Tests for elements: Nitrogen, Halogens and Sulphur
2. Tests for unsaturation.
3. Tests for aromatic character.
4. Determination of Physical constants of solids and liquids
5. Study of the reactions and systematic analysis of the following organic compounds containing one functional group and characterization with a derivative - alcohol, aldehyde, ketone, carboxylic acid, 1, 2 - dicarboxylic acid, ester, primary, secondary amines and tertiary amines, nitro compounds, amides, diamide, anilide reducing and non-reducing sugars, phenols, and halogen compounds, polynuclear hydrocarbons.

(Minimum Nine mono functional and three bifunctional compounds to be analysed)

References

1. 'Vogel's Textbook of Practical Organic Chemistry' Pearson Education.
2. F. G. Mann and B. C. Saunders, 'Practical Organic Chemistry' *Fourth Edition,* Pearson Education.
3. V. K. Ahluwalia and S. Dhingra 'Comprehensive Practical Organic Chemistry' Universities Press.

PRACTICAL – 3
Semester V & VI
15U6PRCHE3 – Qualitative Inorganic Analysis

Credit-2 **(72 hrs)**

1. Study of the reactions of the following radicals with a view to their identification and

confirmation.
Ag^{+}, Hg^{2+}, Pb^{2+}, Cu^{2+}, Bi^{2+}, Cd^{2+}, As^{3+}, Sn^{2+}, Sb^{3+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, Li^{+}, Na^{+}, K^{+}, NH_4^{+}.
CO_3^{2-}, S^{2-}, SO_4^{2-}, NO^{3-}, F^{-}, Cl^{-}, Br^{-}, BO^{2-}, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, CH_3COO^{-}, PO_4^{3-} , AsO_3^{3-}, AsO_4^{3-} and CrO_4^{2-}

2. Elimination of interfering anions such as F^{-}, BO^{2-}, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, PO_4^{3-} , AsO_3^{3-}, AsO_4^{3-} and CrO_4^{2-}

3. Systematic qualitative analysis of mixtures containing two acid and two basic radicals from the following with one interfering radical by semi-micro method only
Ag^{+}, Hg^{2+}, Pb^{2+}, Cu^{2+}, Bi^{2+}, Cd^{2+}, As^{3+}, Sn^{2+}, Sb^{3+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, Li^{+}, Na^{+}, K^{+}, NH_4^{+}.
CO_3^{2-}, S^{2-}, SO_4^{2-}, NO^{3-}, F^{-}, Cl^{-}, Br^{-}, BO^{2-}, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, CH_3COO^{-}, PO_4^{3-} , AsO_3^{3-}, AsO_4^{3-} and CrO_4^{2-}

(Minimum of seven mixtures to be analyzed)

References

1. Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)
2. G. Svehla, Text Book of Vogel's Macro and Semi-micro Inorganic Analysis, revised, Orient Longman.
3. V. V. Ramanujam, 'Inorganic Semi micro Qualitative Analysis', The National Publishing Co., Chennai.
4. W. G. Palmer 'Experimental Inorganic Chemistry', Cambridge.

PRACTICAL – 4
Semester V & VI
15U6PRCHE4 – Organic Chemistry Practicals – II
Preparation and Basic Laboratory Skills

Credit-2 **(72 hrs)**

A. Basic Laboratory Skills

a. Solvent extraction: o-toludine from water, phenol from water, methyl benzoate from water using ether, Record the yield recovery- (*Any two experiments shall be done*).
b. Crystallisation: Any four compounds using ethyl acetate, ethanol, and water - Record the yield recovery.
c. Distillation- Purification of water and ethyl acetate-Record the yield recovery.
d. TLC - Separation and identification- Determination of Rf value of *o*-and *p*- nitroanilines - benzil and *o*-nitroaniline or any two amino acids.

B. Preparations

I. *Organic preparations involving.-*

1. Oxidation (benzaldehyde or benzyl alcohol to benzoic acid).
2. Hydrolysis (methyl salicylate or ethyl benzoate to the acid).
3. Nitration (*m*-dinitrobenzene or picric acid).
4. Halogenation (*p*-bromoacetanilide from acetanilide).
5. Diazocoupling (methyl orange or benzene azo –β-naphthol).

(*Minimum eight preparations expected*)

References

1. F. G Mann and B.C. Saunders, 'Practical Organic Chemistry' Fourth Edition, Pearson Education.
2. A. I. Vogel, 'Vogel's Textbook of Practical Organic Chemistry' Pearson Education
3. Brauer 'Handbook of Preparative Inorganic chemistry', Vol - I & II, Academic Press.

PRACTICAL – 5
Semester V & VI
15U6PRCHE5 – Gravimetric Analysis

Credit-2 **(36 hrs)**

1. Estimation of Barium as $BaSO_4$
2. Estimation of sulphate as $BaSO_4$
3. Estimation of magnesium as oxinate

4. Estimation of iron as Fe_2O_3
5. Estimation of Nickel as dimethyl glyoxime complex
6. Estimation of copper as CuCNS

References

1. A.I. Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)
2. J. Bassett, R.C. Denney, G. H. Heffery and J Mendham, 'Vogel's Textbook of quantitative Inorganic Analysis' (revised), ELBS

PRACTICAL – 6
Semester V & VI
15U6PRCHE6 – Physical Chemistry Practicals

Credit-2 **(72 hrs)**

1. Viscosity – percentage composition of a mixture.
2. Heat of solution – KNO_3, NH_4Cl

3. Heat of neutralization
4. Determination of equivalent conductance of an electrolyte
5. Conductometric titration – strong acid *vs.* strong base, weak acid-strong base
6. Determination of partition coefficient of non-volatile solute between two immiscible solvents. E.g. I_2 between CCl_4 and water.
7. Transition temperature of salt hydrates. (Sodium thiosulphate, sodium acetate)
8. Critical solution temperature. Phenol-water system
9. Determination of molecular weight by Rast's Method (using naphthalene, camphor or biphenyl as solvent and acetanilide, p-dichlorobenzene etc. as solute.)
10. Kinetics of simple reactions eg. Acid hydrolysis of methyl acetate.
11. Potentiometric titration – Fe^{2+} *vs.* $Cr_2O_7^{2-}$, I^- *vs.* MnO_4^-, strong acid - strong base, weak acid-strong base.
12. Data analysis of kinetic experiments using spreadsheet program (determination of rate constant)
13. Determination of equivalence point of potentiometric and conductometric titrations using spreadsheet program.

References

1. W. G. Palmer: 'Experimental physical chemistry', Cambridge University Press.
2. J. B. Yadav: Advanced Practical Physical Chemistry, Goel Publishing House.
3. R.C. Das and B. Behra; 'Experiments in Physical Chemistry', Tata McGraw hill.
4. K. K. Sharma : 'An Introduction of Practical Chemistry': Vikas Publishing House, New Delhi.

SACRED HEART COLLEGE, THEVARA
(AUTONOMOUS)

DEPARTMENT OF CHEMISTRY

CHOICE BASED COURSE CREDIT SEMESTER SYSTEM

SCHEME AND SYLLABI FOR

UNDERGRADUATE PROGRAMME IN

COMPLEMENTARY CHEMISTRY

2015

SYLLABUS FOR COMPLEMENTARY CHEMISTRY COURSES

SEMESTER - I

15U1CPCHE1: GENERAL CHEMISTRY

(Common to Physical sciences and Life sciences)

Credit - 2 **(36 Hrs)**

Aim: The aim of the course is to provide an insight into some of the fundamental concepts and principles that are very essential in the study of chemistry

Objectives

i) To study atomic structure, basics of Nuclear Chemistry and the concept of equilibrium

ii) To understand principles of analytical chemistry and Environmental Chemistry.

1. Atomic Structure (9 hrs)

Introduction:-Atoms, Planck's quantum Theory, Photoelectric effect, Postulates of bohr's theory, Energy levels in atom and origin of hydrogen spectrum(qualitative treatment only) Sommerfeld's extention of Bohr's Theory, Shortcomings of Bohr Theory, Dual nature of matter and radiation. Derivation of de Broglie equation, Wave nature of electron and quantisation of angular momentum, Heisenberg's uncertainty principle, Concept of orbital, Quantum numbers, shapes of orbitals (s-, p-, d-), Electronic configuration of atoms-Aufbau principle, Hund's rule of maximum multiplicity, Pauli's exclusion principle. ,

References:

1. B. R. Puri, L. R. Sharma, Kalia, Principles of Inorganic Chemistry 31st edn. Milstone Pub.2010
2. Manas Chanda, Atomic Structure and Molecular Spectroscopy.
3. P. L. Soni, Inorganic Chemistry.
4. C. N. R. Rao, University General Chemistry, Macmillan.

2. Concept of Equilibrium (8 hrs)

Acids and bases –Arrhenius, Lowry-Bronsted and Lewis Concepts, ionic product of water, introductory idea of pH, pOH. Strengths of acids and bases, Ka and Kb, pKa and pKb, buffer solution Henderson equation (elementary idea only), hydrolysis of salt, solubility, solubility product, application. Common ion effect, application.

1. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical Chemistry, 3rd edn. Vishal Pub. CO., 2008 2. C. N. R. Rao, University General Chemistry, Macmillan

3. Nuclear Chemistry (6 hrs)

Stability of Nucleus:- binding energy, magic number, packing fraction, n/p ratio.

Radioactivity: natural radioactivity, induced radioactivity, fertile and fissile isotopes, units of radioactivity.

Nuclear Reactions: fission and fusion, chain reactions, disposal of nuclear wastes.

Applications: Reactors – conventional and breeder, energy generation, radiocarbon dating, medical, agricultural and industrial applications.

4. Analytical Chemistry- Basic principles (5 hrs)

Concentration terms- molality, molarity, normality, weight percentage, ppm, and millimoles. Titrimetric method of analysis: General principle, types of titrations, requirements for titrimeric analysis. Primary and secondary standards, criteria for primary standards, preparation of standard solutions, standardization of solutions.

Evaluation of analytical data: Accuracy, precision, absolute error, relative error, types of error. Methods of elimination or minimization of errors.

References

1. R. A. Day Junior, A.L. Underwood, Quantitative Analysis, 5th edn. Prentice Hall of India Pvt. Ltd. New Delhi, 1988(Chapters 2,3,4,6,8,11)
2. Vogel's Text Book of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, 6th edn. Pearson Education (2003)(Chapters 3,4,10)
3. R. Gopalan, Analytical Chemistry, S. Chand and Co., New Delhi.

5. Laws of Thermodynamics (8 hrs)

System and Surrounding. First law of Thermodynamics: Internal energy, Significance of internal energy change, enthalpy, Second law of Thermodynamics: free energy, Entropy and Spontaneity, Statement of second law based on entropy, Entropy change in Phase transitions (No derivation required)-entropy of fusion, entropy of vaporization, entropy of sublimation.

The concept of Gibbs's free energy- Physical significance of free energy, conditions for equilibrium & spontaneity based on ΔG values. Effect of temperature on spontaneity of Reaction. Third law of thermodynamics.

References

1. B. R. Puri, L. R. Sharma, M.S. Pathania, Elements of Physical Chemistry, 3rd edn. Vishal Pub. CO., 2008.
2. C. N. R. Rao, University General Chemistry, Macmillan.

SEMESTER - II

15U2CPCHE2: BASIC ORGANIC CHEMISTRY

(Common to Physical sciences and Life sciences)

Credits-2 **(36Hrs)**

Aim: The aim of the course is to understand some fundamental aspects of organic chemistry.

Objectives:

i) To study The Purification techniques.

ii) Stereochemistry of organic compounds

iii) Mechanisms of some basic organic reactions

iv) Classification of polymers, polymerization reactions, and the structure and uses of some commercial and natural polymers

1. Purification of organic compounds (3 Hrs)

Purification techniques: Recrystallisation, sublimation. General principles of distillation, fractional distillation, distillation under reduced pressure. Solvent extraction.

2. Stereochemistry of Organic Compounds (11 Hrs)

Geometrical isomerism- cis and trans configuration, 2-butene, maleic and fumaric acid, determination of configuration of cis-trans isomers, E and Z configuration.

Optical isomerism- D and L configuration. Optical activity, Chirality, Stereogenic Centre, Enantiomers and diastereomers – optical isomerism in lactic acid and tartaric acid, Racemisation.

Conformation- Newman projection, Saw-horse projection, Conformations of Ethane, n - butane and Cyclohexane.

References

1. I. L. Finar, Organic Chemistry Vol. I , 6th edn. Pearson(Chapter2-4)
2. S. M. Mukherji, S. P Singh, R. P Kapoor, Organic Chemistry Vol.1, New Age International (P) Ltd, 2006(Chapter 2)
3. P.S Kalsi Stereochemistry Conformation and Mechanism, New Age International Publishers, 2004.

3. Mechanisms of Organic Reactions (15 Hrs)

Hybridization and shape of molecules - sp^3, sp^2 and sp, (ethane, ethene, ethyne).Types of reagents - electrophiles, nucleophiles.

Types of electron displacement in organic molecules- Inductive, electromeric, mesomeric, and hyper conjugative effects. Explanation of the strength of carboxylic and halogen substituted acids, base strength of primary, secondary and tertiary amines.

Types of bond fission- homolytic and heterolytic fission.

Reactive intermediates- carbocations, carbanions and free radicals. Their formation and stability.

Types of organic reactions – Substitution reactions: Nucleophilic substitution of alkyl halides- S_N1 and S_N2 mechanisms. Factors affecting rate of Substitution reaction of alkyl halide. Nature of alkyl halide, Effect of solvent. Stereochemistry of S_N1 and S_N2 reactions.

Electrophilic substitution in benzene-reaction mechanism. Halogenation, Nitration and Sulphonation.

Addition reactions: electrophilic addition. Addition of Bromine and Hydrogen halides to ethane, propene and ethyne-the Markwonikoff's rule, Peroxide effect.

Elimination reactions: E1 and E2 mechanisms. Saytzeff and Hofmann elimination.(Detailed mechanism is not expected.)

References

1. I. L. Finar, Organic Chemistry, 6th edn. Vol. I Pearson
2. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th edn. Orient Longman, 1988
3. S. M. Mukherji, S.P Singh, Reaction Mechanism in Organic Chemistry, Macmillan, Third Edn., 2003.

4. Natural and Synthetic Polymers (7 Hrs)

Classification of polymers: Natural, synthetic; linear, cross-linked and network; plastics, elastomers, fibres; homopolymers and copolymers. Polymerization reactions, Addition Polymerization, Condensation polymerization, typical examples- polyethene, polypropylene, PVC, phenol-formaldehyde resins, polyamides (nylons) and polyester. Natural rubber: structure, vulcanization. Synthetic rubbers- SBR, nitrile rubber, neoprene. Biodegradable polymers, environmental hazards caused by polymers, Health problem due to burning plastics.

Reference

1. V. R. Gowariker, Polymer Science, Wiley Eastern
2. K.S Tewari,N K Vishnoi, Text book of Organic Chemistry, Vikas Publishing House Pvt. Ltd.2007.

SEMESTER-III

15U3CPCHE3.1: ADVANCED PHYSICAL CHEMISTRY – I

(For students who have opted Physics main)

Credits-3 (54 Hrs)

Aim: To give the students a thorough knowledge and create an aptitude to know about molecular structure properties of solid and liquid states, Thermodynamics and surface chemistry.

Objectives:

- To enable the students to get a clear idea about the molecular structure

- To make students capable of understanding and studying electrical and nuclear properties of molecules.

1. Nanomaterials and Nanotechnology (8 hrs)

Introduction to nanoscience-Moore's law-properties of nanomaterials–Synthesis of nanomaterials-reduction method-precipitation method-sol gel method-Green synthesis of nanosilver and nanogold-surface plasmon resonance (SPR)-SEM and TEM (principle only)-Elementary idea about carbon nanotubes, fullerenes and quantum dots- Properties and applications of nanomaterials - nanocomposites-nanomedicine.

References:

1. V. S. Muraleedharan and A. Subramanian, Nanoscience and nanotechnology, Ane Books Pvt. Ltd. New Delhi, 2009
2. T. Pradeep, Nano; The Essentials, McGraw-Hill education, New Delhi, 2006.

2. Symmetry and Molecular Structure (9 hrs)

Symmetry elements and symmetry operation – Centre of symmetry, plane of symmetry, proper and improper axes of symmetry, identity, molecular point groups, Schoeniflies symbol (determination of point groups of simple molecules like H_2O, NH_3, BF_3, C_2H_2, CO_2, CO, HCl, Benzene, NO_3^-, PCl_5).

3. Solid State (18 hrs)

Classification: amorphous, crystalline – differences. Lattice ,lattice energy (general idea), unit cell, examples of simple cubic, bcc and fcc lattices, calculation of number of molecules in a unit cell, calculation of lattice parameters of cubic unit cell.

Weiss and Miller indices, crystal systems, Bravais lattices, X-ray diffraction – Bragg's equation, structure determination of NaCl by X-ray diffraction.

Theories of Solid: metallic bond, band theory, conductors, semiconductors and insulators, mention of super conductors.

Defects in solids-stoichiometric and Non-stoichiometric defects and consequences.

Magnetic Properties: classification - diamagnetic, paramagnetic, antiferromagnetic, ferro and ferrimagnetic, permanent and temporary magnets.

4. Liquid State (5 hrs)

Intermolecular forces, liquids compared with gases and solids (qualitative idea only), viscosity, surface tension (method of determination not expected.

Liquid crystals – the intermediate phase between solid and normal liquid phases, thermographic behavior, classification, structure of nematic and cholesteric phases.

5. Surface Chemistry and Colloids (5 hrs)

Adsorption – types of adsorption of gases by solids, factors influencing adsorption, Freundlich adsorption isotherm – Langmuir adsorption isotherm (derivation not required). Colloids: preparation, properties – optical and electrical, electric double layer, coagulation, electrophoresis, electro osmosis, surfactants, micelle, applications of colloids.

6. Phase Equilibrium (9 hrs)

The phase rule, definition, equilibrium between phases, one component system – water system, Sulphur system. Two component systems: simple eutectic, lead-silver system, Distribution law, partition coefficient, applications- Study of association or dissociation, Principle of extraction. Distribution indicators.

References:

1. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical Chemistry, 40th edn. Vishal Pub. Co. Jalandhar (2003)
2. Ashcroft / Mermin, Solid State Physics, Thomson Publishers
3. J. Tareen and T. Kutty, A basic course in Crystallography, University Press.

SEMESTER-III

15U3CPCHE3.2: INORGANIC AND BIO-INORGANIC CHEMISTRY

(For students who have opted Biological Sciences as Main)

Credits-3 (54 Hrs)

Aim:

- The aim of the course is to promote understanding facts and concepts in inorganic and organic chemistry.
- Objectives:
- To give the students a basic understanding of nuclear chemistry and heterocyclic compounds.

- To learn about various types of food additives.

1. Chemistry and Agriculture (12 Hrs)

Plant nutrients- Non Mineral nutrients. Mineral nutrients-Macro nutrients- Primary and Secondary macro nutrients. Micronutrients. Their role in plant growth.

Fertilizers- NPK value, superphosphates, triple super phosphate, uses of mixed fertilizers, Bio-fertilizers. Plant growth hormones.

Pesticides-classifications with simple examples, mention of bio pesticides. Insecticides – stomach poisons, contact insecticides, fumigants. Examples. Method of preparation of DDT, BHC, pyrethrin. Herbicides- structure and function of 2,4-D and 2,4,5 –T
Fungicides- inorganic and organic- Bordeaux mixture, dithiocarbamates, Excessive use of pesticides – environmental hazards.

References

1. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry,31st Milestone Publishers, New Delhi, 2010.
2. http://en.wikipedia.org/wiki/Plant_nutrition.

2. Oxygen carriers in biological system (12 hrs)

Oxygen transport in biological system-Hemoglobin and myoglobin, Structure and function. Oxygen transport mechanism, cooperativity of hemoglobin, Perutz mechanism, Bohr effect.
Hemocyanin, Hemerythrin (Structure and function only.)

2.1 Photosynthesis: Photosynthetic pigments, Chlorophyll, Structure, Different types of chlorophyll. Photosystem-I, photosystem-II, Z- Scheme, photophosphorylation (Elementary idea only).

References

1. J. D. Lee, Concise Inorganic Chemistry 5th edn., Wiley India Pvt. Ltd.2008.
2. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, 31st Milestone Publishers, New Delhi, 2010.
3. G.L. Meissler, D.A Tarr, Inorganic Chemistry, 3rd Edn. Pearson Education, 2004.
4. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry, Pearson 2006.

3. Enzymes and Nucleic acids (15 hrs)

Thermodynamics of Living cell- Exergonic and endergonic reactions, coupled reactions, biological oxidation reactions (general idea).
Enzymes: classification, Metalloenzymes, prosthetic group, coenzyme, cofactors, characteristics of enzyme action, mechanism of enzyme action (elementary idea only).
Structure and function of some important enzymes.

Cytochromes, peroxidase, catalase, Ferridoxine, cytochrome P-450.
Carbonic anhydrase, Carboxy peptidase. Cytochrome oxidase.Vitamin B_{12} and Nitrogenase.
Na+/K+ ATPase-Sodium Potassium pump (Detailed mechanism is not expected).
Energy rich molecules: elementary structure of ATP and ADP.

Nucleic acids- Chemical composition, nucleosides, nucleotides. Structure of DNA & RNA. Biological Functions.

4. Chemistry in medicine **(15 hrs)**

Essential and trace elements in biological system. Metal deficiency and disease- Iron, Zinc Copper. Metal toxicity- Toxicity due to Copper overload, Iron, Plutonium and mercury.

Chelation therapy-Treatment for excess iron, copper, mercury and plutonium. Anti-cancer drugs-Cisplatin. Anti-Arthritis drugs- Gold compounds, Outline study and applications of antibiotics, sulpha drugs, antipyretics, analgesics, tranquillizers, and antidepressants (preparation not needed). Drug addiction abuse and prevention.

References

1. I. L. Finar, Organic Chemistry, Vol. 1 & 2, 6th Edition, Pearson.
2. C. N. R. Rao, University General Chemistry, Macmillion.
3. G. T. Austin, Shreve's Chemical process Industries, 5th edition, McGraw Hill, 1984.
4. Rastogi, Biochemistry, Tata McGraw. Hill Publication, 1996.

SEMESTER - IV

15U4CPCHE4.1: ADVANCED PHYSICAL CHEMISTRY – II

(For students who have opted Physical Sciences as Main)

Credits-3 (54 Hrs)

Aim : To promote understanding of the basic facts and concepts in spectroscopy and to develop interest in students to study the structure and properties of matter.

Objectives :

- To help the students to get a basic idea about spectroscopy
- To enable the students to study the rules governing chemical reactions and factors influencing them.

1. Introduction to Spectroscopy **(12 hrs)**

Interaction of electromagnetic radiation with matter, electromagnetic spectrum, quantization of energy, electronic, vibrational and rotational energy levels, Boltzmann distribution of energy (formula only), population of levels.

UV- Visible Spectroscopy: Beer Lambert's law, molar extinction coefficient and its importance, UV spectrum, max, chromophore, auxochrome, red shift, blue shift, types of transition. Infra-red spectroscopy: vibrational degrees of freedom, types of vibrations – symmetric and asymmetric stretching and bending. Concept of group frequencies-frequencies of common functional groups in organic compounds. Rotational Spectroscopy: diatomic molecules, determination of bond length.

2. Chemical Kinetics (8 hrs)

Rate of reaction, rate law, order of reaction, molecularity of reaction. Integrated rate expression for first order reaction, half life, determination of order of reactions. Influence of temperature on reaction rate – Arrhenius equation, concept of activation energy, importance of activated complex, catalysis, examples.

3. Photochemistry (5 hrs)

Laws of Photochemistry, photochemical process – primary and secondary, quantum yield. Basic Concepts of Photosensitized reactions, flash photolysis and chemiluminescence. Frank-Condon principle – fluorescence and phosphorescence.

4. Electrochemistry (12 hrs)

Conductance of electrolytic solution, electrolytic conductivity (K), and molar conductivity of solutions of electrolytes. Variation of conductivity and molar conductivity with concentration. Kohlrausch's law – application. Faraday's laws of electrolysis, electrochemical equivalent and chemical equivalent, transport number-determination by Hittorf's method. Applications of conductance measurements – Kw, Ksp, conductometric titrations, strong and weak electrolytes. Ostwald's dilution law, hydrolysis of salts.

5. Electromotive Force (11 hrs)

Galvanic cells, characteristics of reversible cells. Reversible electrodes – different types, electrode potential – effect of electrolyte concentration on electrode potential and emf (Nernst equation). Electrochemical series, representation of cell, EMF of cell. EMF and equilibrium constant of cell reaction, concentration cells – general discussion of electrode – concentration cell and electrolyte concentration cells. Liquid junction potential, fuel cells – the hydrogen – oxygen fuel cell.

Application of emf measurement – determination of pH using hydrogen electrode, quinhydrone electrode, glass electrode- potentiometric titrations.

6. Redox Reactions **(6 hrs)**

Oxidation Reduction reactions: explanation with examples, oxidation states, rules to assign oxidation states in polyatomic molecules, determination of oxidation states.
Oxidation reduction titrations: Experimental method, example.

References:

1. C. N. Banwell, E.M. McCash, Fundamentals of Molecular Spectroscopy, 4th edn. Tata McGraw – Hill Pub. C. Ltd. New Delhi.
2. Bruce H. Mahan, University Chemistry 3rd edn.
3. P. Atkins. J. Paula, Atkins Physical Chemistry. 8th edn.Oxford University Press, 2006.
4. B. R. Puri, L.R. Sharma, M. S. Pathania, Elements of Physical Chemistry, 40th edn. Vishal Pub. Co. Jalandhar (2003).

SEMESTER - IV

15U4CPCHE4.2: ADVANCED BIO-ORGANIC CHEMISTRY

(For students who have opted Biological Sciences as Main)

Credits-3 (54 Hrs)

Aim :

The aim of this course is to promote understanding of facts and concepts in bioorganic chemistry and to develop interest in the study of biomolecules.

Objectives:

To study:

- The classification and properties of amino acids
- The structure and functions of proteins, nucleic acids, ADP, ATP and AMP
- Classification, properties and structure of carbohydrates
- Classification and characteristics of enzymes and mechanism of enzyme action.
- Fundamentals of vitamins, hormones, steroids, essential oils, lipids and alkaloids

1. Amino acids and proteins (12 hrs)

Classification of amino acids, zwitter ion, general chemical properties of - amino acids, separation of amino acids, synthesis of glycine, alanine, phenyl alanine (any one method). Peptides – peptide bond, polypeptides. Proteins- amino acids as building block of proteins, classifications, prosthetic group, properties, denaturation. Structure of proteins- primary, secondary and tertiary structure.

2. Carbohydrates (10 hrs)

Classification of carbohydrates, preparation and properties of glucose, fructose and sucrose. Haworth configuration of α-D glucose and β-D glucose, α-D fructose, β-D fructose, maltose and cellobiose (ring size determination not expected). Mutarotation. Conversion of glucose to fructose and vice-versa. Structure of starch and cellulose. Industrial applications of cellulose.

4. Vitamins, Steroids, Hormones and lipids (12 hrs)

Structure and biological activity of vitamin A, B and C.

Steroids- general introduction, cholesterol and bile acids.

Hormones (structure not required) - Introduction, steroid hormones peptide hormones, amine hormones, artificial hormones (general idea).

Simple lipids and complex lipids- isolation- properties. Analysis of oils and fats- acid value, saponification value, iodine value, Role of MUFA and PUFA in preventing heart diseases.

References

1. I. L. Finar, Organic Chemistry Vol 1 & 2, 6th edition, Pearson
2. K. S. Tewari, N. K. Vishnoi, A Text Book of Organic chemistry, 3rd edition, Vikas publishing House Pvt. Ltd ,2006.
3. Rastogi, Biochemistry, Tata McGraw –Hill Publication, 1996.
4. Dr. A.C. Deb, Fundamentals of Biochemistry.

5. Natural Products (5 hrs)

Terpenoids: Essential oils- isolation, isoprene rule. Elementary study of citral, geraniol and natural rubber.

Alkaloids- Isolation, general properties. Structure of coniine, nicotine, piperine.

References

1. I. L. Finar, Organic Chemistry Vol 1 & 2, 6th edition, Pearson
2. K. S. Tewari, N. K. Vishnoi, A Text Book of Organic chemistry, 3rd edition, Vikas publishing House Pvt. Ltd, 2006.

6. Heterocyclic Compounds (9 Hrs)

Aromaticity – Huckel rule, preparation (any one method), properties, structure and aromaticity of furan, pyridine, indole, pyrimidine and purine.

References

1. I. L Finar, Organic Chemistry Vol 1 & 2, 6th Edition, Pearson.
2. K. S. Tewari, N. K. Vishnoi, A Text Book of Organic chemistry, 3rd edition , Vikas publishing House Pvt. Ltd, 2006.

7. Chromatographic Techniques (6 hrs)

Classification of chromatographic methods. Basic principle and uses of Column chromatography, Thin layer chromatography (TLC), Paper chromatography (PC), Rf value, Gas chromatography(GC), High Performance Liquid chromatography (HPLC), Ion Exchange chromatography (IEC).

References

1. R. A. Day Junior, A.L. Underwood, Quantitative Analysis, 5th edn. Prentice Hall of India Pvt. Ltd. New Delhi, 1988(Chapters 17, 18).
2. Vogel's Text Book of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, 6th edn. Pearson Education (2003).
3. R. Gopalan, Analytical Chemistry, S. Chand and Co., New Delhi.

PRACTICAL-I

(Semester I and II)

15U2PCCHE1: VOLUMETRIC ANALYSIS

(Common to Physical Sciences and Life Sciences)

Credits 2 (72 hrs)

Standard solution must be prepared by the student

Laboratory operations (Non-evaluative): Use of different glass wares like pipette, burette, standard measuring flask, distillation apparatus; heating methods, filtration techniques, weighing principle in chemical balance, weighing in electronic balance-general idea.

I. Acidimetry and Alkalimetry

1. Standardization of HCl with standard Na_2CO_3 solution
2. Standardization of NaOH with standard oxalic acid solution

3. Estimation of any acid using standard NaOH

4. Estimation of any alkali using standard HCl.

II. Permanganometry

1. Standardization of $KMnO_4$ using (i) oxalic acid (ii) Mohr's salt

2. Estimation of Fe^{2+} in Mohr's salt and crystalline Ferrous Sulphate using standard $KMnO_4$.

III. Dichrometry

1. Estimation of Ferrous ions (external indicator)

2. Estimation of Ferrous ions (internal indicator)

IV. Iodometry and Iodimetry

1. Standardization of Iodine solution

2. Standardization of Sodium thiosulphate

3. Estimation of $KMnO_4$

4. Estimation of Copper

V. Gravimetric Analysis

1. Determination of percentage of water in Barium chloride crystals

2. Estimation of Barium as Barium Sulphate

VI. Determination of Physical Constants of Organic Compounds

1. Melting Point

2. Boiling Point

References

1. D. A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry 8th edn, Brooks/Cole Nelson.
2. Vogel's Textbook of Quantitative Chemical Analysis 6th edn, Pearsons Education Ltd.
3. G. D. Christian, Analytical Chemistry, JohnWiley and Sons.

4. R. D Day, A.L. Uderwood, Quantitative analysis, 6th Edn., Prentice Hall of India Pvt. Ltd.

PRACTICAL-II

(Semester III and IV)

15U4PCCHE2.1: Physical Chemistry Practical

(For students who have opted Physical Sciences as Main)

Credits-2 **(72Hrs)**

1. Molecular Weight by Victor Meyer's method
2. Determination of Partition coefficient of a non volatile solute
3. Transition temperature of salt hydrates, eg. Sodium thiosulphate Sodium acetate etc.
4. Critical solution temperature of phenol water system
5. Phase diagram of two component systems
6. Heat of Solution KNO_3, NH_4Cl
7. Heat of neutralization
8. Determination of equivalent conductance of an electrolyte
9. Conductometric titration of strong acid Vs. strong base

10. Potentiometric titrations : Fe^{2+} Vs. $Cr_2O_7^{2-}$ and Fe^{2+} Vs. $KMnO_4$
11. Determination of molecular weight by Rast's method. (using Napththalene, camphor or biphenyl as solvent and acetanilide, p–dichlorobenzene etc.as solute)
12. Kinetics of simple reactions, eg. Acid hydrolysis of methyl acetate

References

1. W. G. Palmer: 'Experimental Physical Chemistry', Cambridge University Press.
2. J. B. Yadav: Advanced Practical Physical Chemistry Goel Publishing House.
3. R. C. Das and B. Behra; 'Experiments in Physical Chemistry', Tata McGraw hill.
4. K. K. Sharma : 'An Introduction of Practical Chemistry': Vikas Publishing House, New Delhi

PRACTICAL-II

(Semester III and IV)

15U4PCCHE2.2 : Organic Chemistry Practicals

(For students who have opted Biological Sciences as Main)

Credits-2 **(72Hrs)**

1. Tests for elements: Nitrogen, Halogen and Sulphur.

2. Determination of Physical constants.

3. Study of reactions of common functional groups.

4. Qualitative analysis with a view to characterization of functional groups and identification of the following compounds: Naphathalene, anthracene, chlorobenzene, benzyl chloride, p-dichlorobenzene, benzyl alcohol, phenol, o-, m- and p- cresols, α-naphthol, β-naphthol, resorcinol, benzaldehyde, accetophenone, benzophenone: benzoic acid, phthalic acid, cinnamic acid, salicylic acid, ethyl benzoate, methyl salicylate, benzamide, urea, aniline, o-,

m- and p- toluidines, dimethyl aniline, nitrobenzene, o-nitrotoluene, m-dinitrobenzene and glucose.

5. Organic preparation involving halogenation, nitration, oxidation, reduction, acetylation, benozylation, hydrolysis, diazotization.

6. Isolation of an organic compound from a natural source.

References:

1. A. I. Vogel, A Text Book of Practical Organic Chemistry, Longman.
2. F. G. Mann and B. C. Saunders, 'Practical Organic Chemistry' Fourth Edition, Pearson Education.
3. V. K. Ahluwalia and S. Dhingra , Comprehensive Practical Organic Chemistry, Universities Press.

Syllabus for extra credit course
List of Virtual Lab Experiments in Chemistry
Additional Credit Course in Chemistry

1. Calculation of Thermodynamic Quantities in Physical Chemistry
2. Quantum Chemistry Calculations
3. Practices and Concepts in statistical Thermodynamics
4. EMF measurements in Physical Chemistry
5. Structure and Properties of Organic Compounds
6. Detection of elements : Lassaigne's Test
7. Detection of Functional Groups using spectroscopic Measurements
8. Calculation of λ_{max} of Organic Compounds using Woodward Fieser Rules
9. Acid Base Titrations
10. Calculation in Group Theory.