MAHATMA GANDHI UNIVERSITY

PRIYADARSHINI HILLS, KOTTAYAM-686560

CHOICE BASED CREDIT AND SEMESTER SYSTEM

SCHEME & SYLLABI

FOR

UNDER GRADUATE PROGRAMMES IN

CHEMISTRY

2009

MAHATMA GANDHI UNIVERSITY, KOTTAYAM

Under Graduate Programmes in Chemistry

Scheme and Syllabi

Preface

Science is pivotal to the development of any modern society. However, the creation of a scientific temper in society necessitates proper education and guidance. 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 restructured, giving 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, and the skills essential for handling equipment and instruments in laboratories and industries.

The Higher Education Council has taken the initiative to reformulate the undergraduate syllabi by introducing choice based credit and semester system. This is to cope with the internationally followed curricula and mode of evaluation. This approach has necessitated the revision of the present curriculum.

This curriculum is prepared to give sound knowledge and understanding of chemistry to undergraduate students. The goal of the syllabus is to make the study of chemistry stimulating, relevant and interesting. The syllabus is prepared with a view to equipping the students with the potential to contribute to academic and industrial environments. This curriculum will expose students to various fields in chemistry and develop interest in related disciplines. Chemistry, being a border science to biology, physics and engineering, has a key role to play in learning these disciplines. The new and updated syllabus is based on an interdisciplinary approach with vigour and depth. Care has been given to ensure that the syllabus is not very heavy while remaining compatible to the syllabi of other universities at the same level. Chemistry being an experimental science, sufficient emphasis is given in the syllabus for training in laboratory skills and instrumentation.

The syllabus has been prepared in a participatory manner, after discussions with a number of faculty members in the subject and also after evaluating the existing syllabi of B.Sc. Part- III, the new syllabi of XI^{th} & XII^{th} standards and U.G.C. model curriculum and the syllabi of other Universities. The units of the syllabus are well defined and the scope of each is given in detail. The number of contact hours required for each unit is also given. A list of reference books is provided at the end of each course.

Broad objectives

To enable the students

- To understand basic facts and concepts in Chemistry while retaining the exciting aspects of Chemistry so as to develop interest in the study of chemistry as a discipline.
- To acquire the knowledge of terms, facts, concepts, processes techniques and principles of the subject.
- To develop the ability to apply the of principles of Chemistry.
- To be inquisitive towards advanced chemistry and developments therein.
- To appreciate the achievements in Chemistry and to know the role of Chemistry in nature and in society.
- To develop problem solving skills.
- To be familiarised with the emerging areas of Chemistry and their applications in various spheres of Chemical sciences and to apprise the students of its relevance in future studies.
- To develop skills in the proper handling of apparatus and chemicals.
- To be exposed to the different processes used in industries and their applications.

At present there are three undergraduate programmes in Chemistry, viz. B.Sc Chemistry, B.Sc Chemistry(Vocational) – Model II, and B.Sc. Petrochemicals. These programmes are restructured in such a manner that for each of these programmes there are 4 types of courses, viz. **A. Common** courses, **B. Core** courses, **C. Complementary** courses, and **D. Open** courses. **The *core courses* are in the discipline of chemistry**. **These core courses and the pattern of examinations are the same for all the three programmes**. In addition to the courses in chemistry there are courses in *industrial chemistry* for the vocational programme and courses in *petrochemicals* for B.Sc petrochemicals. *Open course* is offered by a department to students of other disciplines.

I. B Sc CHEMISTRY

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

Type of course	Number of courses	Credits
A. Common courses	10	38
B. Core courses (Chemistry)	15	50
C. Complementary courses		
i. Mathematics	4	14
ii. Physics	4	14
D. Open course	1	4
Total	**34**	**120**

B.Sc Chemistry- Detailed Scheme

Sl. No.	Study components	No. of Courses	Credit per Course	Total Credits	Total Instructional hours/ week/ For the program	Contact hours/ week SEMESTER					
						1	2	3	4	5	6
A	**Languages and Common Courses**										
	Language: English	**4**	4	**16**	20	5	5	5	5		
	Common Courses	**2**	3	**6**	8	4	4				
	Language: Second Language	**2**	4	**8**	8	4	4				
	Common Courses	**2**	4	**8**	10			5	5		
	Total			**38**							
B	**Core Courses (Chemistry)**										
	1. Theory and Practical	**2**	3	**6**	2 × 4 = 8	4	4				
	2. Theory	**2**	3	**6**	2 × 3 = 6					3	3
	3. Theory and Practical	**5**	4	**20**	5 × 5 = 25			5	5	10	5
	4. Theory and Practical	**3**	4	**12**	3 × 6 = 18					6	12
	5. Practical	**1**	1	**1**	1 × 2= 2						2
	6. Choice Based Course	**1**	3	**3**	1 × 3= 3						3
	7. Project/ Dissertation	**1**	2	**2**	1 × 2= 2					2	
	Total			**50**							
C	**Complementary Courses**										
	1. Mathematics	**2** **2**	3 4	**6** **8**	8 10	4	**4**	 5	 5		
	2. Physics	**2** **2**	3 4	**6** **8**	8 10	4	**4**	 5	 5		
	Total			**28**							
D	**Open Course**	**1**	4	**4**	4					4	
	TOTAL	**34**		**120**	**150**	**25**	**25**	**25**	**25**	**25**	**25**

Detailed Scheme of Instruction of the Core Courses

Sl No.	Course Code	Title of the course	Exam. Duration Hrs	Credit per Course	Total Contact Hours for the course	Contact Hours/ week
		First Semester				
1.	CH1B01	Theory : Methodology of Chemistry As a discipline of Science	3	**2**	36	2
		Practical : Volumetric Analysis	3	**1**	36	2
		Second Semester				
2.	CH2B01	Theory : Theoretical and Inorganic Chemistry	3	**2**	36	2
		Practical : Volumetric analysis	3	**1**	36	2
		Third Semester				
3.	CH3B01	Theory : Fundamentals of Organic Chemistry	3	**3**	54	3
		Practical : Qualitative organic analysis	3	**1**	36	2
		Fourth Semester				
4.	CH4B01	Theory : Basic Organic Chemistry I	3	**3**	54	3
		Practical : Qualitative organic analysis	3	**1**	36	2
		Fifth Semester				
5.	CH5B01	Theory : Chemistry of d and f block elements	3	**3**	54	3
		Practical : Qualitative Inorganic Analysis	3	**1**	54	3
6.	CH5B02	Theory : Basic Organic Chemistry II	3	**3**	54	3
		Practical : Preparation and basic Lab Skills	3	**1**	36	2
7.	CH5B03	Theory : States of matter	3	**2**	36	2
		Practical : Physical chemistry Practical	3	**2**	54	3
8.	CH5B04	Theory : Quantum mechanics and Spectroscopy	3	**3**	54	3
9.	-	Project/ Dissertation	No evaluation	-	36	2
10.	CH5D01	Open course	3	**4**	72	4

Sl. No	Course Code	Title of the course	Exam. Duration Hrs	Credit per Course	Total Contact hours for the course	Contact Hours/ week
		Sixth Semester				
11.	CH6B01	Theory : Applied Inorganic Chemistry	3	**3**	54	3
		Practical : Qualitative Inorganic Analysis	3	**1**	54	3
12.	CH6B02	Theory : Chemistry of Natural Products and Biomolecules	3	**3**	54	3
		Practical : Preparation and basic Lab Skills	3	**1**	36	2
13.	CH6B03	Theory : Equilibrium and kinetics	3	**3**	54	3
		Practical : Physical Chemistry Practicals	3	**1**	54	3
14.	CH6B04	Theory : Solution chemistry	3	**3**	54	3
15.	CH6B05	Practical : Gravimetric Analysis	3	**1**	36	2
16.	CH6B06	Theory :Choice Based Course	3	**3**	54	3
17.	CH6B07	Project/ Dissertation	Evaluation	**2**		-

Evaluation

There shall be two parts for evaluation:

i. Internal or In- Semester Examination or Continuous Assessment
ii. External or End- Semester Examination

For the core courses end-semester practical examinations should be conducted in all semesters. One of the examiners can be appointed from the college and the other one should be external.

The weightages for the Internal and External examinations shall be in the ratio 1:3. Both evaluations shall be done using Direct Grading system based on a 5- point scale as given below

Letter Grade	Performance	Grade point (G)	Grade Range
A	Excellent	4	3.5 to 4.00
B	Very Good	3	2.5 to 3.49
C	Good	2	1.5 to 2.49
D	Average	1	0.5 to 1.49
E	Poor	0	0.00 to 0.49

The overall grade for a programme for certification shall be based on Cumulative Grade Point Average(CGPA) with a 7-point scale given below.

CGPA	Grade
3.80 to 4.00	A+
3.50 to 3.79	A
3.00 to 3.49	B+
2.50 to 2.99	B
2.00 to 2.49	C+
1.50 to 1.99	C
1.00 to 1.49	D

A separate minimum of D grade for both internal and external evaluations are required for a pass for a course.

For the successful completion of a programme and award of the degree, a student must pass all courses satisfying the minimum credit requirements and must score a minimum CGPA of 2.00 or an overall grade of C+ or above.

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

1. Theory

Component	Weight
Attendance	1
Assignment	1
Seminar/Viva voce	1
Best two test papers	2

Assignment: best two assignments per course
Seminar / **Viva voce** in alternate semesters

2. Practical

Component	Weight
Attendance	1
Lab involvement	2
Record	2
Best two test papers	2
Viva-voce	1

3. Project

Component	Weight
Project Report/Dissertation	2
Presentation	2
Viva-voce	1

Grades for attendance will be awarded as shown below

% of Attendance	Grade
> 90%	A
Between 85 and 90	B
Between 80 and 85	C
Between 75 and 80	D
< 75	E

Project: All students have to undertake a project/dissertation. The project can be done individually or as a group of three students. The reports shall be prepared and submitted individually. The reports of the projects/dissertation are to be submitted in duplicate to the department at the end of the sixth semester and are to be produced before the examiners appointed by the University.

Pattern of questions

The pattern of questions for theory is shown below

	Type of questions	Weight	Number of questions to be answered
1	A bunch of 4 objective type	1	4 bunches (no choice)
2	Short answer type	1	5 out of 8
3	Short essay/problem solving type	2	4 out of 6
4	Essay type	4	2 out of 3

SYLLABUS FOR CORE (CHEMISTRY) COURSES

(Semester – I)

CH1BO1 - Methodology of Chemistry as a discipline of Science

Credits- 2 (36 hrs)

Aim: To illustrate the methodology of science in chemistry

Objectives:

- To have a broad outline of the methodology of science in general and Chemistry in particular
- To understand the important analytical and instrumental tools used for practicing chemistry
- To learn computer based presentation and statistical analysis of data using spreadsheet software
- To apply these skills in the analysis of experimental data in chemistry practical

1. Chemistry as a discipline of science (9 hrs)

What is science? Scientific statements, Scientific methods–observation-posing a question-formulation of hypothesis-experiment-theory-law. Falsification (disproving) of hypothesis, inductive and deductive reasoning, revision of scientific theories and laws.

Methods of science as illustrated through the following

i) Laws of chemical combination- Faradays laws of electrolysis- Daltons atomic theory-atom models- J.J.Thomson, Rutherford, Bohr model and quantum mechanical model of atom.

ii) n-P-V-T relation of gases-gas laws-kinetic molecular theory

Role of concepts and models in science.

Evolution of Chemistry- ancient speculations on the nature of matter, early form of chemistry-alchemy, origin of modern chemistry.Structure of chemical science: scope of chemical science,theory and experiment, branches of chemistry. Role of Chemistry as a central science connecting Physics, Biology and other branches of science. Interdisciplinary areas involving Chemistry- Nanotechnology, Biotechnology.

Chemical science in the service of man: Drugs, food, flavouring agents, sweeteners, cosmetics, soaps and detergents, paints, varnishes, textiles, dyes, fertilizers, insecticides, fuels etc - examples in each.

Methodology of chemistry: Symbols, formulae, Chemical equations, classification (periodic classification of elements, classification of organic compounds into homologous series), Analysis (qualitative and quantitative), preparation, synthesis, manufacture.

References

1. J. A. Lee, Scientific Endeavor, Addison Wesley Longman (chapters1and 2)
2. C. N. R. Rao, University General Chemistry, MacMillan (India) Ltd (Chapters 1 and 2)

2. Research in Science (9 hours)

Selecting a topic – hypothesis-design of experiment: variables, correlation and causality, sampling, use of controls, experimental bias, analysis, results, discussion of results, models.

Summary of the scientific methods. Writing Science

Reference

J.A Lee, Scientific Endeavor, Addison Wesley Longman (chapters3, 9 and Appendix 3)

3. Analytical and synthetic methodologies in Chemistry (9 hours)

Titrimetric analysis: fundamental concepts - mole, molarity, molality, ppm and ppb primary standard-secondary standard, quantitative dilution – problems. Acid base titrations- titration curves –pH indicators. Redox titrations – titration curve –titrations involving MnO_4^- and $Cr_2O_7^{2-}$ - redox indicators. Complexometric titrations – EDTA titrations - titration curves - indicators- **Gravimetric analysis**: Unit operations in gravimetric analysis Illustrations using iron and barium estimation. **Synthetic methodologies** – condensation – addition- examples. Separation and purification techniques – Filtration, Crystallization and precipitation – concept of solubility product as applied in group separation of cations – problems. Fractional distillation, Solvent extraction.

References

1. B. R. Puri, L. R. Sharma, Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi(Chapter40)
2. D. A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry 8th edn, Brooks/Cole Nelson (Chapters 12-17)
3. Vogel's Textbook of Quantitative Chemical Analysis 6th edn, Pearsons Education Ltd(Chapters 10,11)
4. G. D. Christian, Analytical Chemistry, JohnWiley and Sons(Chapters 5,7,8,16,17)

4. Data Analysis (9 hours)

Units, significant digits, rounding, scientific and prefix notation, graphing of data - Precision and accuracy – Types of errors – Ways of expressing precision – Ways to reduce systematic errors - reporting analytical data ,Statistical treatment of analytical data – population and samples –Mean and standard deviation – distribution of random errors– confidence limits – tests of significance – Correlation and regression – linear regression analysis, calculation of regression coefficients (slope, Intercept) using scientific calculator - methods of least squares.

The following section is non-evaluative for theory examination

Familiarization of software packages for analysis and graphical representation of data - MS Excel, Origin, Openoffice calc (Physical Chemistry experiments using software packages are included in the 5^{th} and 6^{th} semesters), simulations, virtual experiments, drawing molecular structures using Chemsketch, ISIS Draw.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi(Chapter40)
2. J. A. Lee, Scientific Endeavor, Addison Wesley Longman (Appendices 1,2 and 4)
3. D. A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry 8^{th} edn, Brooks/Cole Nelson (Chapters 5-8)
4. Vogel's Textbook of Quantitative Chemical Analysis 6^{th} edn, Pearsons Education Ltd.(Chapter 4)
5. G. D. Christian, Analytical Chemistry, JohnWiley and Sons(Chapter 2)
6. R. Crouch and F. J. Holler, Applications of Microsoft Excel in Analytical S.Chemistry, Brooks/Cole

Further Reading

1. J. Mills and P. Evans, Core Chemistry, Foundation books Pvt Ltd, New Delhi (2004)
2. T. F. Gieryn, Cultural boundaries of science, University Chicago Press, 1999
3. H. Collins and T. Pinch, The Golem, What everyone should know about science, Cambridge University Press, 1993
4. Hewitt, Paul G, S. Lyons, J. A. Suchocki and J. Yeh, Conceptual Integrated Science, Addison Wesley, 2007
5. Methods for Teaching Science As Inquiry, Allyn and Bacon, 2009
6. K. V. S. Sarma, Statistics made simple, Prentice-Hall of India, New Delhi.
7. R. Crouch and F. J. Holler, Applications of Microsoft Excel in Analytical S.Chemistry, Brooks/Cole.
8. R. D. Jarrard, Scientific Methods,jarrard@mines.utah.edu,2001

9. R. Sangenburg, D. K. Moser, History of Science (5 volumes), Universities Press (India) Ltd.

Practical: CH1B01 Volumetric Analysis

Credit- 1 **(36 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
5. Estimation of ammonia in ammonium salts by direct and indirect methods

B. Complexometry

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

References

1. D. A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry 8th edn, Brooks/Cole Nelson (Chapters 13,14)
2. Vogel's Textbook of Quantitative Chemical Analysis 6th edn, Pearsons Education Ltd.(Chapter 10)
3. G. D. Christian, Analytical Chemistry, JohnWiley and Sons(Chapters 7,8)
4. R. D. Day, A. L. Uderwood, Quantitative analysis,6th Edn.,Prentice Hallof India Pvt. Ltd (Chapters 6,8)

(Semester – II)

CH2B01: Theoretical and Inorganic Chemistry

Credits- 2 **(36 Hrs)**

Aim

To impart essential theoretical knowledge on atomic structure, periodic properties, chemical bonding, and nuclear chemistry.

Objectives:

- To study the various atom models
- To understand the important features of the quantum mechanical model of the atom.
- To study the periodic properties of elements
- To explain the formation of different types of bonds
- To predict the geometry of simple molecules
- To explain the different types of hybridisation and draw shapes of simple covalent molecules
- To understand the molecular orbital theory of diatomic molecules
- To develop interest in various branches of inorganic chemistry.
- To study nuclear models and nuclear reactions.

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

Bohr model of hydrogen atom, Bohr's equation for the energy of electron in hydrogen atom, the hydrogen spectrum, limitations of Bohr theory, photoelectric effect, idea of de Broglie matter waves, Heisenberg's uncertainity principle and its significance, Schrodinger wave equation (derivation not expected), wave functions, significance of ψ (psi) and ψ^2, atomic orbitals, Nodal planes in atomic orbitals, quantum numbers (n, l, m), Zeeman effect, Stern-Gerlac experiment, spin quantum number (s), shapes of s, p and d orbitals. Aufbau and Pauli's exclusion principles, Hund's rule, energy level diagram of a multielectron atom, concept of effective nuclear charge, Slater's rules and applications, Electronic configuration of atoms.

References

1. J. D. Lee, Concise Inorganic Chemistry, 5^{th} edn., Blackwell Science, London (Chapter 1)
2. B. R. Puri, L. R. Sharma, Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi(Chapter 1)
3. C. N. R. Rao, University General Chemistry, Macmillan,India (Chapter 1)

4. F. A. Cotton, G. Wilkinson and P.L. Gaus, Basic Inorganic Chemistry, 3rd edn., John Wiley(Chapter 2).
5. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd edn., Oxford University Press(Chapter 1)
6. B. Douglas, D. Mc Daniel, J. Alexander, Concepts and models in Inorganic Chemistry(Chapter 1)

2. Periodic properties (3 hrs)

Periodic trends in atomic volume, atomic and ionic radii, ionisation enthalpy, electron affinity(electron gain enthalpy), electronegativity and metallic character, Pauling's electronegativity scale, Classification of elements as s,p,d & f block.

References

1. J. D. Lee, Concise Inorganic Chemistry, 5th edn., Blackwell Science, London(Chapter 1,6)
2. B. R. Puri, L. R. Sharma, Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi(Chapter 2)
3. C. N. R. Rao, University General Chemistry, Macmillan India (Chapter 3)
4. F. A. Cotton, G. Wilkinson and P. L. Gaus, Basic Inorganic Chemistry, 3rd edn., John Wiley(Chapter 2).
5. B. Douglas, D. Mc Daniel, J. Alexander, Concepts and models in Inorganic Chemistry(Chapter 1).

3 Chemical Bonding (15 hrs)

Ionic bond – nature of ionic bond, properties of ionic compounds, radius ratio and coordination number, factors favouring the formation of ionic compounds. Lattice energy, Born-Lande equation with derivation, factors affecting lattice enthalpy, Born-Haber cycle and its applications, solvation enthalpy and solubility of ionic compounds.

Covalent bond- valence bond theory and its limitations, concept of resonance, resonance energy, hybridisation and shapes of simple molecules (BeF_2, PCI_3, PCI_5, SF_6 , CH_4, Ethane, ethane and ethyne) VSEPR theory, shapes of molecules and ions (NH_3, XeF_6, CIF_3, NH_4^+, H_3O^+). Molecular orbital theory – LCAO method, molecular orbital energy diagram and properties of homo and hetero diatomic molecules (N_2, O_2, CO and NO), bond strength and bond energy. Polarisation of covalent bond, polarising power and polarisability of ions, Fajan's rule.

Dipole moment and molecular structure – percentage ionic character from dipole moment.

Metallic bonding – free electron theory, valence bond theory and band theory, explanation of metallic properties based on these theories.

Weak chemical forces – hydrogen bond, inter and intra molecular hydrogen bonds, effects of hydrogen bonding, van der Waals forces

References

1. J. D. Lee, Concise Inorganic Chemistry, 5th edn., Blackwell Science, London(Chapter 2-5)
2. B. R. Puri, L. R. Sharma, Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi(Chapter 4,5)
3. C. N. R. Rao, University General Chemistry, Macmillan India (Chapter 3)
4. F. A. Cotton, G. Wilkinson and P. L. Gaus, Basic Inorganic Chemistry, 3rd edn., John Wiley(Chapter 3,4).
5. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd edn., Oxford University Press(Chapter 2,3)

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.

References

1. B. R. Puri, L. R. Sharma, Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi(Chapter 38)
2. H. J. Arnikar, Essentials of Nuclear Chemistry,New Age (Chapter3- 5)
3. R. Gopalan, Elements of Nuclear Chemistry, Vikas Publ. House.

Further Reading

1 J. E. Huheey, E. A. Keiter, R. L. Keiter, Inorganic Chemistry, 4th edn., Harper Collins, 1993.
2 G. Wulfsberg, Inorganic Chemistry, Viva Books
3 W. L Jolly, Inorganic Chemistry, Ttata Mc Graw Hill
4 J. D. Lee, New concise inorganic chemistry,

5 M. N. Greenwood and A. Earnshaw, Chemistry of the elements 2nd edn, Butterworth
6 Manas Chanda, Atomic structure and chemical bonding
7 H. J. Emeleus, A. G. Sharpe, Modern Aspects of Inorganic Chemistry, Universal Book Stall
8 J David Brown, The Chemical Bond in Inorganic Chemistry,Oxford Science Publication

Practical: CH2B01 Volumetric Analysis

Credit- 1 (36 hrs)

A. Permanganometry

1. Estimation of Ferrous iron
2. Estimation of Oxalic acid
3. Estimation of Hydrogen Peroxide
4. Estimation of Calcium

B. Dichrometry

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

C. Iodometry and Iodimetry

1. Standardisation of thiosulphate using KIO_3, electrolytic copper and potassium dichromate.
2. Estimation of As_2O_3 and arsenite.
3. Estimation of Cu in a copper salt.

References

1. D. A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry 8th edn, Brooks/Cole Nelson (Chapters 13,14)
2. Vogel's Textbook of Quantitative Chemical Analysis 6th edn, Pearsons Education Ltd.(Chapter 10)
3. G. D. Christian, Analytical Chemistry, JohnWiley and Sons(Chapter12)
4. R. D. Day, A. L. Underwood, Quantitative analysis,6th Edn.,Prentice Hallof India Pvt. Ltd(Chapter 11)

(Semester – III)

CH3 B01 – Fundamentals of Organic chemistry

Credits - 3 **(54 hours)**

Aim

To promote understanding of basic facts and concepts and to inculcate 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 new areas of organic chemistry
- To develop skills required for the qualitative analysis of organic compounds

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

Classification of organic compounds
Rules of IUPAC system of nomenclature of common organic compounds –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. Fundamentals of organic reaction mechanism (15 Hrs)

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.
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, Elimination and Rearrangement.
Reactive intermediates with examples – Carbocations, Carbanions and Free radicals.
Electron displacement effects - Inductive, inductomeric, electromeric, mesomeric, resonance, hyper conjugation and steric effects.
Aliphatic nucleophilic substitutions, mechanism of S_N1,S_N2- effects of structure-substrate, solvent, nucleophile and leaving groups - Stereochemistry- Walden inversion
Elimination Reactions:-Hoffmann and Saytzeff rules- cis and trans eliminations – mechanisms of E1 and E2 reactions. Elimination versus substitution.
Addition reactions- mechanisms of addition of Bromine and hydrogen halides to double bonds-Markownikoff's rule and peroxide effect
Polymerisation reactions-Types of polymerisation - free radical, cationic and anionic – polymerisations –including mechanism .

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. Mukhergi 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 (15 hrs)

Stereoisomerism - definition - classification into optical and geometrical isomerism

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.

Optical isomerism - optical activity - optical and specific rotations - conditions for optical activity - asymmetric centre -- chirality - achiral molecules - meaning of (+) and (-) Elements of symmetry -. Racemisation - methods of racemisation (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 not containing asymmetric carbon atoms- Biphenyls.

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

Conformational analysis - introduction of terms - conformers, configuration, dihedral angle, torsional strain - Conformational analysis of ethane and n-butane including energy diagrams - conformers of cyclohexane (chair, boat and skew boat forms) - axial and equatorial, Bonds-ring flipping showing axial equatorial interconversions, 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 (15 Hrs)

Concept of resonance- resonance energy. 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 diagram and resonance energy)

Concept of aromaticity – aromaticity (definition), Huckel's rule – application to Benzenoid -Benzene, Naphthalene- and Non – Benzenoid compounds -cyclopropenyl cation, cyclopentadienyl anion and tropylium cation.

Reactions – General mechanism of electrophilic substitution, mechanism of halogenation, nitration, Friedel Craft's alkylation and acylation. 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 Phenolic-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).

Reactivity of naphthalene towards electrophilic substitution. Nitration and sulfonation

Aromatic Nucleophilic substitutions- bimolecular displacement mechanism- Elimination –addition mechanism-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 :, 6th Edition, 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. Pericyclic Reactions (5 hrs)

Classification- electrocyclic, sigmatropic, cycloaddition reactions.

Claisen rearrangement -Diels_Alder reation- . Stereochemical aspects.

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

Practical: CH3B01- Qualitative Organic Analysis

Credit -1 **(36 hrs)**

1. Tests for elements: Nitrogen, Halogens and Sulphur
2. Tests for unsaturation.
3. Tests for aromatic character.
4. Study of the reactions of the following functional groups: alcohol, aldehyde, ketone, carboxylic acid, 1,2 dicarboxylic acid, ester, primary and secondary amines
5. 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 and secondary amines.

(Minimum eight 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.

(Semester – IV)

CH4B01 - Basic Organic Chemistry -I

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)

Monohydric alcohols: Classification, physical properties–hydrogen bonding-distinction between primary ,secondary and tertiary alcohols- Ascent and decent in alcohol series
Dihydric alcohols: Oxidative cleavage – Lead tetra acetate, Periodic acid- Pinacol - Pinacolone rearrangement –mechanism
Phenols – Acidity of phenols- effects of substituents – comparison of acidity with alcohols
Preparation and uses of nitrophenols, picric acid, catechol, resorcinol and quinol
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 Mc Murry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
3. C. N. Pillai 'Organic Chemistry' Universities Press.

2. Ethers and Epoxides (3 Hrs)

Synthesis and Reactions of Epoxides
Cleavage of ether linkages by HI- Ziesels method of estimation of alkoxy groups- Claisen rearrangement –mechanism.

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, Visal 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 Mc Murry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
3. C. N. Pillai 'Organic Chemistry' Universities Press.

3. Aldehydes and Ketones (12 hrs)

Structure and reactivity of the carbonyl group - acidity of alpha hydrogen. Comparative studies of -aldehydes and ketones - aliphatic and aromatic aldehydes - formaldehyde and acetaldehyde-Mechanism of nucleophilic additions to carbonyl groups with special emphasis on Claisen , Claisen-Schmidt, Benzoin, Aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction.-Addition of Grignard reagents. 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) .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, Visal Publishing Company Co. (Chapter-22)
4. K.S Tewari and NK 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 Mc Murry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
3. C.N.Pillai'OrganicChemistry'UniversitiesPress.

4. Carboxylic and Sulphonic acids (18 hours)

Structure of carboxylate ion- effects of substituents on acid strength of aliphatic and aromatic carboxylic acids- ascent and descent in fatty acid series- Hell-Volhard-Zelinsky reaction -Mechanism of decarboxylation

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

Methods of formation and chemical reactions of anthranilic acid,cnnamic acid, acrylic acid, oxalic acid, malonic acid, citric acid, adipic acid, maleic acid, fumaric acid and coumarin.

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. (Chapter-)
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, Visal Publishing Company Co. (Chapter-22)
3. K.S Tewari and NK Vishnoi 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-20,21,28)
4. B.S. Bahl 'Advanced organic Chemistry', S. Chand

Further reading

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

5. Carbonic acid derivatives (3 Hrs)

Preparation- reactions and structure of urea, thiourea and semi carbazide manufacture of uea- 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, Visal 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 Mc Murry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
3. C. N. Pillai 'OrganicChemistry' Universities Press.

6. Grignard and related compounds (3 Hrs)

Grignard reagents-formation, structure and synthetic applications, alkyl lithium, Reformatsky reaction

References

1. R. T. Morrison and R.N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India. (Chapter-)
2. I. L. Finar Organic Chemistry -, 6th Edition. Vol.- I, Pearson. (Chapter-15)
3. M.K.Jain and S.C. Sharma 'Modern Organic Chemistry', 3rd Edition, Visal Publishing Company Co. (Chapter-)
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' - 3rd Edn. Pearson Education Asia.
2. John Mc Murry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
3. C. N. Pillai 'OrganicChemistry' UniversitiesPress.

7. Compounds containing active methylene groups (4 Hrs)

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

References

1. R. T. Morrison and R. N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India. (Chapter-)
2. I. L .Finar Organic Chemistry -, 6th Edition. Vol.- I, Pearson. (Chapter-10,13)
3. M. K. Jain and S.C. Sharma 'Modern Organic Chemistry', 3rd Edition, Visal 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 Mc Murry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
2. C. N. Pillai, 'OrganicChemistry", UniversitiesPress.

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

Classification –reactions and structure of naphthalene, anthracene and phenanthrene. 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, Visal Publishing Company Co. (Chapter- 16)
3. K.S Tewari and NK 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 Mc Murry, '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

Practical CH4 B01 -Qualitative Organic Analysis

Credit 1 **(36 hrs)**

1. Determination of Physical constants of solids and liquids
2. Study of the reactions of the following functional groups: reducing and non-reducing sugars, phenol, tertiary amines, amide, nitro and halogen compounds diamide , anilide, polynuclear hydrocarbons
3. Systematic analysis of the following organic compounds containing one functional group and characterization with its physical constant and a derivative :- reducing and non reducing sugars, phenol, tertiary amines, amides, diamide, nitro and halogen compounds, anilides and polynuclear hydrocarbons.

(Minimum ten compounds to be analysed)

References

1. A. I. Vogel, 'A Text Book of Practical Organic Chemistry', Longman. 'Vogel's Textbook of Practical Organic Chemistry' Pearson Education
2. F. G.Mann and B. C. Saunders, 'Practical Organic Chemistry' 4th edn, Pearson Education.
3. V. K. Ahluwalia and S. Dhingra ' Comprehensive Practical Organic Chemistry' Universities Press.

(Semester – V)

CH5B01 –Chemistry of d and f block elements

Credits - 3 **(54 hours)**

Aim

To improve the level of understanding of the chemistry of transition and inner transition metals, coordination compounds, organometallic compounds, metal carbonyls 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 Werner's theory of coordination compounds
- To study isomerism in metal complexes
- To study the bonding in coordination compounds
- To understand the applications of coordination compounds
- To understand the classification, properties and applications of organometallic compounds
- To study the methods of preparation, properties, structure and bonding of metal carbonyls and metal clusters
- To understand the role of metals in biological systems.

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

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., Blackwell Science, London.(Chapter 18, 29 and 30).
2. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi (Chapter 21 and 25)

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 5th edn., John Wiley, New York.
3. D. F. Shriver and P.W. Atkins, Inorganic Chemistry 3rd edn., Oxford University Press.

2. Coordination Chemistry (18hrs)

IUPAC nomenclature, coordination number, geometry of complexes with coordination numbers 4 and 6. Stability of complexes - factors affecting the stability of metal complexes. Chelates, chelate effect, stepwise stability constant and overall stability constant. Isomerism in coordination compounds – structural isomerism and stereo isomerism, stereochemistry of complexes with 4 and 6 coordination numbers.

Bonding theories –Werner's theory of coordination, EAN, Valence bond theory, geometries of coordination numbers 4-tetrahedral and square planar and 6-octahedral and its limitations, high spin and low spin complexes, inner orbital and outer orbital complexes. Crystal filed theory, splitting of d-orbitals in octahedral, tetrahedral and square-planar complexes – low spin and high spin complexes, strong and weak field ligands, pairing energy, Jahn-Teller distortion, Jahn-Teller distortion in Cu (II) complexes. MO theory, evidence for metal ligand covalency, MO diagram of complexes of octahedral symmetry (sigma bonding only).

Spectral and magnetic properties of metal complexes-Electronic absorption spectrum of $[Ti(H_2O)_6]^{3+}$ ion. Types of magnetic behavior, spin-only formula, calculation of magnetic moments.

Reactivity of metal complexes-Labile and inert complexes, ligand substitution reactions – $S_N1$and,S_N2 substitution reactions of square planar complexes – Trans effect and applications of trans effect.

References

1. J. D. Lee, Concise Inorganic Chemistry 5th edn., Blackwell Science, London (Chapter 7)
2. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi (Chapter 26, 27, 28, 29 and 30)
3. G.L. Meissler, D.A Tarr, Inorganic Chemistry, Pearson Education (Chapter 9, 10, 11 and 12)
4. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, Pearson 2006(Chapter 14, 15, 16, 17)
5. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry 5th edn., John Wiley, New York (Chapter 2)

Further Reading

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

3. Organometallic Compounds (9hrs)

Definition, classification of organometallic compounds, Ylides, classification on the basis of hapticity, naming of organometallic compounds. Catalytic properties of organometallic compounds - alkene hydrogenation, synthesis of water gas – shift reaction, Zeigler-Natta polymerisation, 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.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi (Chapter 33)
2. G. L. Meissler, D. A Tarr, Inorganic Chemistry, Pearson Education (Chapter 13 and 14)
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, Pearson 2006(Chapter 18, 19)

Further Reading

1. R. C. Mehrothra and A. Singh, Organometallic chemistry, New age publishers.
2. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry 5th edn., John Wiley, New York.
3. A G Sharpe, Inorganic Chemistry, 3rd Edn. Pearson

4. 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 $Re_2CI_8^{2-}$.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi (Chapter 31 and 32)
2. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, Pearson 2006(Chapter 15)
3. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry 5th edn., John Wiley, New York (Chapter 22 and 23)

Further Reading

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

5. Bioinorganic Chemistry (9hrs)

Essential and trace elements in biological systems, myoglobin and haemoglobin, role of myoglobin and haemoglobin in biological systems, mechanism of oxygen transport, cooperativity, Bohr effect. Vitamin B_{12} (structure not expected) Metalloenzymes of zinc, inhibition and poisoning of enzymes. Electron carriers – cytochromes. Role of alkali and alkaline earth metals in biological systems, Na/K pump. Biological function and toxicity of metals – Fe, Cu, Zn, Cr, Mn, Ni, Co, Cd, Hg and Pb, treatment of metal toxicity. Anti cancer drugs – cisplatin and carboplatin

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi (Chapter 36)
2. G. L. Meissler, D. A Tarr, Inorganic Chemistry, Pearson Education (Chapter 16)
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, Pearson 2006(Chapter 20)
4. F.A.Cotton,G.Wilkinson,P.L.Gaus,Basic Inorganic Chemistry,3rd Edn,John – Wiley,1995
5. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry 5th edn., John Wiley, New York(Chapter 30)

Further Reading

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

Practical: CH5 B01-Qualitative Inorganic Analysis

Credit 1 **(54 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. Systematic qualitative analysis of mixtures containing two acid and two basic radicals from the above list without interfering radical by Semi-micro method only.

   (Minimum of five mixtures to be analysed)

References

1. A. I. 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.

CH5B02- Basic Organic Chemistry-II

Credits - 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
- To develop basic skills required for crystallisation, distillation, solvent extraction, TLC and column chromatography.

1. Organic compounds containing Nitrogen (20 Hrs)

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.

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.

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

Diazonium salts-preparation, synthetic transformations of aryl diazonium salts, azo coupling-. Mechanisms of Sandmeyer's and Gatterman reactions- Schiemann and Gomberg reactions

Preparation and uses of Phenyl hydrazine.

Diazomethane and diazoacetic ester - preparation, structure and synthetic uses.-Arndt Eistert synthesis- mechanism –Wolff rearrangement

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, (Chapter- 22,23,)
3. M. K.J ain and S.C. Sharma 'Modern Organic Chemistry', 3rd Edition, Visal 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 Mc Murry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
3. C. N. Pillai 'OrganicChemistry' Universities Press.
4. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press

2. Dyes (5 Hrs)

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

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.J ain 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-38).
4. B. S. Bahl, 'Advanced organic Chemistry', S. Chand.

Further Reading

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

3. Organic photochemical reactions (3 Hrs)

Introduction- Photochemical versus Thermal reactions

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

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 'OrganicChemistry' Universities Press
3. John Mc Murry, 'Organic Chemistry', Vth Edition, Thompson Asia Pvt Ltd

4. Organic Polymers (4 hrs)

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. Synthetic rubbers –SBR and Nitrile rubber.

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 Jayader Sreedhar, 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)

Cycloalakanes- relative stabilities

Butadiene – structure and stability, 1,4 addition,

References

1. I. L. Finar Organic Chemistry , 6th Edition. Vol.- I, Pearson. (Chapter-19 and p-127-129)
2. M. K.J ain 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

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

6. Soaps and Detergents (3 hrs)

Composition of soaps- detergent action of soap-Synthetic detergents- - their functions – comparison between soaps and detergents- 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 Mc Murry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd

7. Chemotherapy (5 Hrs)

Drugs- introduction –classification –mode of action
Elementary idea of the structure and mode of action of the following drugs
Sulphanilamide, Amphicillin and Chloramphenicol,
Elementary idea of the structure and application of Chloroquine, Paracetamol and Analgin.
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 Mc Murry, 'Organic Chemistry', Vth Edition, Thompson Asia Pvt Ltd.

8. Chemistry of Organic Reagents (4Hrs)

Analytical reagents – Tollens reagent, Fehling solution, Schiff's reagents, Borsche's reagent, Benedict solution, Barford's reagent
Synthetic reagents –NBS, Lead tetra acetate, Periodic acid, OsO_4 , Ozone, LDA, Raney Nickel, Ziegler –Natta Catalyst, 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, Visal Publishing Company Co. (Chapter-22)

Further Reading

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

9. Structure elucidation (8 Hrs)

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

Problems pertaining to the structure elucidation of simple organic compounds using IR and PMR spectroscopic techniques
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 Spectrosopy' Thomson Brooks Cole.
3. Paula Y. Bruice, 'Organic Chemistry', 3rd Edn. Pearson Education Asia

Practical CH5 B02: Preparation and Basic Laboratory skills

Credit 1 **(36 hrs)**

A. Basic Laboratory Skills

a. Solvent extraction – aniline 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.

B. Preparations

I. *Organic preparations involving.-*

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

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.

CH5B03-States of matter

Credits - 2 (36 hours)

Aim

To understand the general characteristics of different states of matter

Objectives

- To study the intermolecular forces in gases and liquids
- To understand the dynamics of the molecules in the gases and liquids
- To study liquefaction of gases
- To learn the structure of solids
- To study defects in crystals
- To study adsorption.

1. Gases (12 hours)

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 behaviour. 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. Liquids (3hrs)

Intermolecular forces in liquids (qualitative idea only)- viscosity, the viscometer method- surface tension - structure of liquids. Unusual behaviour of water.

References

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

3. Symmetry and Solid state (21 hours)

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 symbol, crystallographic point groups

The nature of the solid state- anisotropy- the law of constancy of interfacial angles, law of rational indices - Miller indices. Seven crystal systems and fourteen Bravais lattices. X-ray diffraction, Bragg's law, detailed study of simple, face centred and body centred cubic systems – Bragg's x-ray diffractometer method and powder pattern method. Analysis of powder diffraction patterns of NaCl and KCl, density of cubic crystals, identification of cubic crystal from crystallographic data

Close packing of spheres, ccp and hcp arrangements .Structure of ionic compounds of the type AX (NaCl, CsCl, ZnS) and AX_2 (CaF_2, Na_2O) .Defects in crystals – stoichiometric and non-stoichiometric defects, extrinsic and intrinsic defects. Electrical conductivity, semiconductors, n-type, p-type, Superconductivity – an introduction.

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

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.

References

1. K. L. Kapoor, A Textbook of Physical chemistry, Volume 1, Macmillan India Ltd Chapers 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

Further reading

1. A. R. West, Solid State Chemistry and its applications, John Wiley.
2. G. W. Castellan, Physical Chemistry, 3rd edn., Narosa Publishing House, New Delhi.
3. P. W. Atkins, The elements of Physical chemistry, 8th edn., Oxford University Press (2006).
4. S. H. Marron and J. B. Lando, Fundamentals of Physical Chemistry, Macmillan Ltd. (1996)
5. D K Chakrabarty, Adsorption and Catalysis by Solids, New Age India.
6. R E Hummel, Understanding materials science 2nd edn, Springer.
7. G. M. Barrow, Physical Chemistry, 5th edn., Tata McGraw Hill.
8. G. K. Vemulapalli, Physical Chemistry, Prentice-Hall India Pvt. Ltd.
9. W. J. Moore, Basic Physical Chemistry, Orient Longman.
10. W. Adamson and A P Gast, Physical Chemistry of surfaces, John Wiley sons.
11. http://www.iupac.org/dhtml_home.html
12. K.J Laidler, John H.Meiser, Physical Chemistry,2nd edn.

Practical: CH5 B03-Physical Chemistry Practicals

Credits 2 **(54hrs)**

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)

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.

CH5B04-Quantum Mechanics and Spectroscopy

Credits - 3 **(54hours)**

Aim

To understand the fundamentals of quantum mechanics and its applications in the study of structure of atoms, bonding in molecules and molecular spectroscopy

Objectives

- To differentiate between classical and quantum mechanics
- To study the postulates of quantum mechanics and the quantum mechanical model of the hydrogen atom
- To study valence bond and molecular orbital theory
- To study the principle and applications of microwave, infra red, Raman, electronic and magnetic resonance spectroscopy.
- To study the fundamentals of mass spectrometry
- To study the fundamentals of photochemistry

1. Quantum mechanics **(18hrs)**

Classical mechanics: concepts, failure of classical mechanics, qualitative idea about the energy distribution in black body radiation. Plank's radiation law, Compton effect.

Binding energy of an electron in hydrogen atom, radius of the hydrogen atom, de Broglie hypothesis, dual nature of electrons – Davisson and Germer's experiment. Heisensberg's uncertainty principle and its significance. Sinusoidal wave equation (no derivation needed). Wave function – physical interpretation, concept of operators, eigen functions, eigen values.

Postulates of quantum mechanics, Particle in one-dimensional box – derivation for energy, application to linear conjugated polyene (butadiene). Introductory treatment of Schrödinger equation for hydrogen atom. Quantum numbers and their importance, hydrogen like wave functions – radial and angular wave functions, radial distribution curves.

Molecular orbital theory: basic ideas – criteria for forming MO from AOs, construction of molecular orbital by LCAO method, H_2^+ ion (elementary idea only), physical picture of bonding and anti bonding wave functions, concept of σ, σ^*, π, π^* orbitals and their characteristics. Introduction to valence bond model of hydrogen molecule, comparison of MO and VB methods.

References

1. K. L. Kapoor, A Textbook of Physical chemistry, Volume 4, Macmillan India Ltd Chaper 1,2
2. Mc Quarrie, J. D. Simon, Physical Chemistry – A molecular Approach, Viva Books Pvt. Ltd, Chapters 1,2,3,4,6
3. I. N. Levine, Physical Chemistry, Tata Mc Graw Hill, Chapter18
4. A. Bahl, B. S. Bahl, G. D. Tuli, Essentials of Physical Chemistry, S. Chand and Company, chapter 1,2
5. K. J. Laidler, John H.Meiser, Physical Chemistry,2nd edn, Chapters 11,12

Further reading

1. P Atkins, J Poula, Physicl Chemistry, 8 th edn,OUP
2. Mc Quarrie, Quantum Chemistry, Viva Books
3. I. N. Levine, Quantum Chemistry 5th edn, Pearson.
4. R. K. Prasad, Quantum Chemistry, New Age.

2. Molecular spectroscopy I **(15hrs)**

Introduction: electromagnetic radiation, regions of the spectrum, interaction of electromagnetic radiation with molecules, various types of molecular spectroscopic techniques, Born-Oppenheimer approximation.
Rotational spectrum: diatomic molecules, energy levels of a rigid rotator, selection rules, determination of bond length.

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.

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.

References

1. Mc Quarrie, J. D. Simon, Physical Chemistry – A molecular Approach, Viva Books Pvt. Ltd,
2. C. N. Baanwell and E M Mc Cash, Fundamentals of molecular spectroscopy 4thedn, TataMc Graw Hill,Chapters I- 4.
3. K. L. Kapoor, A Textbook of Physical chemistry, Volumes 4, Macmillan India Ltd Chaper 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, J. H.Meiser, Physical Chemistry,2nd edn, Chapter 13

Further reading

1. D. L. Pavia, G. M. Lampman, G. S. Kriz, Introduction to spectroscopy 3rd edn, Thomson Brooks/Cole, 2001.
2. D. N .Satyanarayana, Electronic absorption spectroscopy and related techniques, Universities Press.

3. Molecular spectroscopy II (15 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.

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.

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

References

1. Mc Quarrie, J. D. Simon, Physical Chemistry – A molecular Approach, Viva Books Pvt. Ltd,
2. C. N. Baanwell and E M Mc Cash, Fundamentals of molecular spectroscopy 4thedn, TataMc Graw Hill,Chapters 6,7
3. K. L. Kapoor, A Textbook of Physical chemistry, Volumes 4, Macmillan India Ltd Chaper 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

Further reading

1. P Atkins, J Poula, Physicl Chemistry, 8 th edn , OUP
2. D. L. Pavia, G. M. Lampman, G. S. Kriz, Introduction to spectroscopy 3rd edn, Thomson Brooks/Cole, 2001.
3. D. N. Satyanarayana, Electronic absorption spectroscopy and related techniques, Universities Press.
4. G. K. Vemulapalli, Physical Chemistry, Prentice-Hall of India Pvt. Ltd.

4. 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, non-radiative 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. 6 hrs

References

1. K. L. Kapoor, A Textbook of Physical chemistry, Volumes 4, Macmillan India Ltd, Chaper 7
2. I. N. Levine, Physical Chemistry, Tata Mc Graw Hill, Chapter 21
3. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co., Chapter 22
4. K. K. Sharma, L R Sharma, A text book of Physical Chemistry, Vikas Publishing house Chapter 24

Further reading

1. K. K. Rohatgi-Mukherjee , Fundamentals of Photochemistry, New Age.
2. K. K. Sharma, L. R. Sharma, A text book of Physical Chemistry, Vikas Publishing house

(Semester –VI)

CH6B01-APPLIED INORGANIC CHEMISTRY

Credits - 3 (54 hours)

Aim

The aim of the course is to sensitise the students to the spectrum of applications of chemical methods and materials.

Objectives

To understand

- the principle of inorganic qualitative analysis
- thermodynamic concepts in the extraction of metals
- the applications of radioactivity and radioisotopes
- the preparation and uses of inorganic polymers
- preparation and application of nanomaterials
- the chemistry of refractory and ceramic materials
- the chemistry of the compounds of p block elements
- thermal and chromatographic techniques

1. Principles of Inorganic Qualitative Analysis (3hrs)

Qualitative Analysis - solubility product, principle of elimination of interfering anions, common ion effect, complex formation reactions including spot tests in qualitative analysis, reactions involved in separation and identification of cations and anions in the analysis, semi micro techniques.

References

1. Vogel's qualitative inorganic analysis, Svehla, 7^{th} edn., Pearson Education.
2. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi (Chapter 40)

2. Metallurgy (9hrs)

Occurrence of metals based on standard electrode potential, methods of concentration of ores, reduction to free metal, electrometallurgy, hydrometallurgy. 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 and Ti.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi (Chapter 10)
2. S. Prakash, G. D. Tuli, S. K. Basu and R. D. Madan, Advanced Inorganic Chemistry,Volume I, S Chand,(Chapter 20)
3. A. Cottrel, An introduction to metallurgy, 2^{nd} edn., University press.

3. Applications of Radioactivity (3hrs)

Nuclear reactors – conventional and breeder types. Applications of nuclear fusion. Rock dating, radio carbon dating, activation analysis, study of reaction mechanism (ester hydrolysis) and medical applications of Co^{60}, I^{131} and Na^{24}. Disposal of nuclear wastes.

Reference

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi (Chapter 38)
2. H. J. Arnikar, Essentials of Nuclear Chemistry, New Age International Pub.
3. H. J. Arnikar, Isotopes in the atomic age, Wiley Eastern(Chapter 12)
4. R. Gopalan, Elements of Nuclear Chemistry, Vikas Pub. House.
5. S. Glasstone, Sourcebook on Atomic Energy, East-west Press
6. M. Sharon, M. Sharon, Nuclear Chemistry, 2009, Ane Books

4. 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).

Reference

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi(Chapter 34)
2. S. Prakash, G. D. Tuli, S. K. Basu and R. D. Madan, Advanced Inorganic Chemistry,Volume I, S Chand, (Chapter 36)
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, 4th edn., Pearson 2006

5. Nanomaterials (3hrs)

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 and carbon nanotubes.

References

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

6. Industrially important materials (6hrs)

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.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi(Chapter 14)
2. S Prakash, G D Tuli, S K Basu and R D madan, Advanced Inorganic Chemistry,Volume I, S Chand,(Chapter 26, 27)

7. Non aqueous solvents (3hrs)

Classification of solvents, characteristics of solvents, reactions in liquid ammonia, 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, Milestone Publishers, New Delhi(Chapter 7)
2. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, 4th edn., Pearson 2006 (Chapter 9)

8. Compounds of p block Elements (9hrs)

Boron hydrides – diborane (preparation, properties and bonding), B_5H_9, B_4H_{10} (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 (Chapter 12, 13, 14, 15, 16 and 17)
2. B. R. Puri, L. R. Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi(Chapter 15, 16, 17, 18, 19 and 20)
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. M. N. Greenwood and A. Earnshaw, Chemistry of the elements 2nd edn, Butterworth.

9. Analytical Techniques (12 hrs)

Thermo analytical methods: Principle of thermo gravimetry, differential thermal analysis, differential scanning caloimetry. Applications - TGA of calcium oxalate monohydrate, DTA of calcium acetate monohydrate

Chromatography : Column Chromatography - Principle, types of adsorbents, preparation of the column, elution, recovery of substances and applications.

Thin Layer Chromatography - Principle, choice of adsorbent and solvent, Preparation of Chromatoplates, R_f-Values, significance of R_f values.

Paper Chromatography - Principle, Solvents used, Development of Chromatogram, ascending, descending and radial paper chromatography.

Ion - Exchange Chromatography – Principle - Experimental techniques.

Gas Chromatography - Principle - Experimental techniques - Instrumentation and applications.

High Performance Liquid Chromatography (HPLC) - Principle- Experimental techniques, instrumentation and advantages.

References

1. Vogel's Textbook of Quantitative Analysis 6th edn., Pearson Education.
2. D. A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry, Brooks/Cole Nelson.

Further reading

1. W. D. Callister Materials Science and Engineering- an introduction, , Wiley(NY).
2. J. M. Martinez-Duart, R. J. Martin-Palma and F. Agullo- Rueda, Nanotechnology for microelectroics and optoelectronics, Elsevier.
3. R. Booker and , E. Boysen, Nanotechnology, Wiley India Pvt Ltd, 2008
4. M. N. Greenwood and A. Earnshaw, Chemistry of the elements 2nd edn, Butterworth.
5. D.F. Shriver and P.W. Atkins, Inorganic Chemistry, , 3rd edn., Oxford University Press.
6. D.A.Skoog, F. J. Holler, and S. R. Crouch, Principles of Instrumental Analysis, Brooks/Cole Nelson.
7. C. P. Poole Jr and F J Owens, Introduction to nanotechnology, Wiley IndiaPvt Ltd 2009.
8. K. J. Klabunde, Nanoscale materials in chemistry, John Wiley and Sons.
9. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press
10. G. L. Meissler, D.A Tarr, Inorganic Chemistry, Pearson Education

Practical CH6 B01 Qualitative Inorganic Analysis

Credit 1 **(54 hrs)**

1. 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-}

2. 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^-, $C_2O_4^{2-}$, $C_4H_4O6^{2-}$, CH_3COO^-, PO_4^{3-}, AsO_3^{3-}, AsO_4^{3-} and CrO_4^{2-}

(Minimum of seven mixtures to be analysed)

References

1. G. Svehla ‘Vogel's Qualitative Inorganic Analysis’ Pearson Education
2. V. V. Ramanujam, ‘Inorganic Semi micro Qualitative Analysis’ ,The National Publishing Co., Chennai,

CH 6B02 – Chemistry of Natural products and Biomolecules

Credits - 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 (12Hrs)

Natural Products - Terpenoids - isoprene rule. Structure elucidation of citral and geraniol. Natural rubber –structure, latex collection and treatment –vulcanisation

Alkaloids - general methods of isolation –classification – structure elucidation of conine, piperine and nicotine.

Vitamins – classification- structure (elementary idea) of vitamin A, C and B_1.B_2 ,B_6

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, Visal 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 (12 hrs)

Classification - constitution of glucose and fructose. Reactions of glucose and fructose - osazone formation. Mutarotation and its mechanism. Cyclic structure. Pyranose and furanose forms. Determination of ring size. Haworth projection formula, configuration of monosaccharides ,epimerisation, chain lengthening and chain shortening of aldoses. Inter conversion of aldoses and ketoses.
Disaccharides - reactions and structure of sucrose. Ring structure
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, Visal 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. (12Hrs)

Aromaticity of heterocyclic compounds.

Preparation, properties and uses of furan, pyrrole and thiophene.

Synthesis and reactions of pyridine and piperidine - comparative study of basicity of pyrrole, pyridine and piperidine with amines.

Synthesis and reactions of quinoline, isoquinoline and indole with special reference to Skraup. Bischler and 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, Visal 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 Mc Murry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
2. C. N. Pillai 'OrganicChemistry' Universities Press.

4. Amino acids and Proteins (9 hrs)

Amino acids- classification, Zwitter ion. Peptide- solution phase peptide synthesis. Classification of proteins based on physical and chemical properties and on physiological functions.
Primary secondary and tertiary structure of proteins, helical and sheet structures (elementary treatment only). Denaturation of proteins.

Nucleic acids. Types of nucleic acids -RNA and DNA, polynucleotide chain components - biological functions.

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, Visal 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

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

5. Enzymes (3hrs)

Chemical nature and properties of enzymes.

Nomenclature and classification of enzymes.

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, Visal 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 Mc Murry, 'Organic Chemistry' - Vth Edition -Thompson Asia Pvt Ltd
2. C. N. Pillai 'OrganicChemistry' Universities Press
3. S. P. Bhutani, Chemistry of Biomolecules, Ane Books Pvt Ltd

6. Steroids (3 hrs)

Introduction – Diels hydrocarbon- Structure and functions of cholesterol,

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, Visal Publishing Company Co. (Chapter-39)
3. K. S. Tewari and N. K. Vishnoi, 'Organic Chemistry', 3rd Edition, Vikas Publishing House (Chapter-41)

Further reading

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

7. Supramolecular Chemistry (3 Hrs)

Introduction-Molecular recognition-Host-guest interactions- types of non-covalent interactions

References

Helena Dodzuik, Introduction to supramolecular chemistry Springer(chapter1,2**)**

Further reading

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

CH6B02: Preparation and Basic Laboratory Skills

Credit 1 **(36 hrs)**

a. Distillation- Purification of water and ethyl acetate-Record the yield recovery.

b**.** Chromatography -

1. TLC - Separation and identification- Determination of Rf value of

o-and *p*- nitroanilines - benzil and *o*-nitroaniline *ortho* and *para* chloroanilines or any two amino acids

2. Column Chromatography – purification of *o*-nitro aniline, m- dinitro benzene, benzene azo –β-naphthol. (*non –evaluative*)

c**.** Organic preparations involving.-

1. Acylation (Benzoylation of aniline, phenol, β -naphthol).
2. Esterification (benzoic acid).
3. Iodoform from acetone or ethyl methyl ketone.
4. Side chain oxidation (benzyl chloride to benzoic acid).
5. Claisen – Schmidt: Dibenzal acetone from benzaldyde.

d. Technique of quantitative dilution.

1. Preparation of 100 mL 0.2 M H_2SO_4 from commercial acid
2. Preparation of 250 mL 0.025 M thiosulphate from .1 M thiosulphate
3. Preparation of sucrose solutions of different concentrations by dilution

(Any such five experiments)

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. V. K . Ahluwalia and S. Dhingra ' Comprehensive Practical Organic Chemistry',Universities Press.
4. A. I. Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)

CH6B03-Equilibrium and Kinetics

Credits - 3 (54 hours)

Aim

To provide an insight into the thermodynamic and kinetic aspects of chemical reactions and phase equilibria

Objectives

- To study the laws of thermodynamics
- To derive Gibbs-Helmholtz, Clausius-Clapeyron, Gibbs-Duhem equations
- To derive the relation between K_p, K_c and K_x
- To derive the phase rule
- To derive the rate equations for zero, first and second order reactions
- To study the phase diagrams of one and two component systems
- To understand the theories of chemical kinetics
- To get an elementary idea of catalysis including enzyme catalsis.

Thermodynamics

1. Introduction, definition of thermodynamic terms, intensive and extensive properties, path and state functions, exact and inexact differentials, zeroth law of thermodynamics First law of thermodynamics, reversible and irreversible processes, internal energy and enthalpy, heat capacity, C_p and C_v 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.

2. Second law: 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, spontaneous and non spontaneous processes .Change in entropy of an ideal gas with pressure, volume and temperature. Third law of thermodynamics-statement and significance

3. Helmholtz energy and Gibbs energy – variation of Gibbs energy with T and P. Criteria for reversible and irreversible processes. Gibbs-Helmholtz equation. Clasius- 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 K_c and K_x – K_p , van't Hoff reaction isotherm. Temperature dependence of K_p – 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, Shoban Lal 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).

Phase equilibria

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. Three component systems having one partially miscible pair – acetic acid-water-chloroform system.

9hrs

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. Jalandhar, 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

Kinetics

Rate of reaction, rate equation, order and molecularity of reactions, Integrated rate expressions for first and second order reactions. Zero order reactions, pseudoorder 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. 9 hrs

References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry,, Vishal Pub. Co. Jalandhar, Chapters 7,8

2. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A molecular Approach Viva Books Pvt. LtdChapters 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

CH6 B03 :Physical Chemistry Practicals

Credit 1 **(54 hrs)**

1. Critical solution temperature. Phenol-water system
   a. Determination of molecular weight by Rast's Method (using naphthalene, camphor or biphenyl as solvent and acetanilide, p-dichlorobenzene etc. as solute.)
2. Kinetics of simple reactions eg. Acid hydrolysis of methyl acetate.
3. Potentiometric titration – Fe_2^+ *vs.* $Cr_2O_7^{2-}$, I^- *vs.* MnO^{4-},strong acid- strong base, weak acid-strong base.
4. Data analysis of kinetic experiments using spreadsheet program (determination of rate constant)
5. 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

CH6B04-SOLUTION CHEMISTRY

Credits - 3 (54 hours)

Aim: To provide an insight into the characteristics of different types of solutions and electrochemical phenomena

Objectives:

- To study the behaviour of binary liquid mixtures, CST, azeotropes, colligative properties
- To study solubility of gases in liquids,
- To study ionic equilibria and electrical properties of ions in solution.
- To study the concepts of acids and bases, pH and buffer solutions

1. Solutions (12 hrs)

Introduction-- Binary liquid solutions – Raoult's law- ideal and non-ideal solutions- ΔG_{mix}, ΔV_{mix}, and ΔS_{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' 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, chapter 4

2. Ionic Equilibria (12 hours)

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

3. Electrical Conductance (15 Hours)

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, coductometric titrations.

References

1. K. L. Kapoor, A Textbook of Physical chemistry, Volume 1, Macmillan India Ltd,chapter 5
2. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co. Jalandhar, Chapter 17

4. Electromotive force (15 Hours)

Introduction - Galvanic cells, characteristics of reversible cells. Reversible electrodes – different types, electrode potential – electrochemical series. Representation of cells – emf of cell. Thermodynamics of reversible cells and reversible electrodes – Determination of ΔG, ΔH and ΔS of cell reaction. Emf and equilibrium constant of cell reaction, effect of electrolyte concentration on electrode potential and emf (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 emf 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

Further reading

1. F A Alberty and R J Silby, Physical Chemistry, John Wiley
2. P. W. Atkins,The elements of Physical chemistry, 8th edn, Oxford University Press.
3. G. W. Castellan, Physical Chemistry, 3rd edn., Narosa Publishing House, New Delhi, (2004).
4. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A molecular Approach Viva Books Pvt. Ltd. (2005)
5. S. H. Marron and J. B. Lando, Fundamentals of Physical Chemistry, Macmillan Ltd. (1996)
6. G. K. Vemulapalli, Physical Chemistry, Prentice-Hall of India Pvt. Ltd. (1997)
7. H. Kuhn and H. D. Fosterling, Principles of Physical chemistry, John Wiley
8. W. J. Moore, Physical chemistry, Orient Longman.

Practical: CH6B05- Gravimetric Analysis

Credit 1 **(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.

CH6B06: CHOICE BASED COURSES

Credits - 3 **(54 hours)**

(Students may be given the option to choose **any one** of the following courses)

CH6B06.1 : Nanochemistry and Nanotechnology

Aim: The aim of this course is to provide a basic understanding of nanochemistry and nanotechnology.

Objectives: To study

- History,terminology,and scales of nano systems
- Synthesis and characterisation of nano systems
- Electrical and optical properties of nano systems
- Applications of nanomaterials

1 History-terminology- scales of nanosystems- nanoparticles : introduction-atoms to molecules-quantum dots-shrinking of bulk materials to quantum dots. Different types of nanoparticles: metal nanoparticles and monolayer substituted nanoparticles- fullerenes: synthesis and characterization- carbon nanotubes: synthesis and characterization- various approaches in nanoparticle synthesis : self-assembled monolayers, monolayer protected metal nanoparticles. - (12Hrs)

2 Characterization of nanomaterials : Important methods for the characterization of nanomaterials – electron microscopy (SEM), transmission electron microscopy (TEM), scanning tunneling electron microscopy (STEM), environmental transmission electron microscopy (ETEM), scanning probe electron microscopy (SPL), secondary ion mass spectrometry (SIMS)-photoelectron spectroscopy (UPES and XPES).

- (15 Hrs)

3 Electrical and optical properties of nanomaterials: electrical and optical properties of nanoparticles- electrical and optical properties of carbon nanotubes- nanocatalysis- nanolithography- nanochemical devices- optoelectronic devices- photodetectors- LEDs and lasers.

- (15 Hrs)

4 Applications of nanomaterials: nanocrystals- immunogold labeling- applications in medical diagnosis- nanobased drug delivery- applications in biotechnology- nanosensors- self-assebly, nanosensor based on quantum size effects- nanobiosensors- nanomedicines- destructive applications of nanomaterials- nanomaterials in war.

(12 Hrs)

References

1. T. Pradeep, Nano: The Essentials, Mc Graw Hill Publishing Company, New Delhi (2007).
2. V. S. Muraleedharan and A. Subramania, Nanosciece and nanotechnology, Ane Books Pvt. Ltd. New Delhi, 2009
3. C. N. R. Rao and A.Govindraj, Nanotubes and Nanowires, Royal Society of Chemistry (2005).
4. J. M. M. Duart, R. J. M. Palma and F.A. Rueda,Nanotechnology and microelectronics and optoelectronics, Elsevier (2002).
5. R. Booker and , E. Boysen, Nanotechnology, Wiley India Pvt Ltd, 2008
6. K. J. Klabunde, Nanoscale materials in chemistry, John Wiley and Sons.
7. C. P. Poole Jr and F J Owens, Introduction to nanotechnology, Wiley IndiaPvt Ltd 2009.
8. http://www.zyvex.com/nanotech/feynman.html.
9. G.L Hornyak, J.Dutta, H.F Tibbals, A.K Rao, Introduction to Nanoscience, CRC Press

CH6B06.2 : Industrial Chemistry

Aim: The aim of this course is to provide an outline of the application of the principles and techniques of chemistry in the manufacture some industrial products.

Objectives

- To understand the requirements to start an industry - different fuels used and the industrial catalysts used.
- To know about different petrochemical industries
- To understand the manufacture of fertilizers and speciality chemicals.
- To acquire knowledge about oils, soaps, detergents, sugar industry, leather and pesticide industries.
- To understand the important process of metallurgy, extraction of metals and environmental problems caused by chemical industries.

1 Industrial Requirements

Requirements of an industry - location - water - industrial water treatment - safety measures – pilot plants. Fuels - types of fuels with examples - coal - carbonisation of coal - coal tar distillation - liquid fuels - gaseous fuels - selection of fuels - nuclear fuels. Energy - sources of energy - renewable and non-renewable energies - non conventional energies. Industrial catalysts - Types of catalysts - Functions and applications of Raney Nickel, Pd, $CuCrO_4$, TiO_2, Al, V and Pt based catalysts and zeolites. (18 hours)

2 Petrochemical Industries

Crude oil - constitution and distillation - composition of different distillates - pour points, depressants, drag reducers, viscosity reducers, ignition point, flash point, octane number – cracking - catalysts used in petroleum industries - structure, selectivity and applications. Manufacture of synthetic petrol - Bergius and Fischer Tropsh processes - Manufacture of petrochemicals and petrochemical polymers - Manufacture of higher olefins, Acetaldehyde, Acetic acid, Ethylene glycol, Glycerine, Acetone, Phenol, Carbon disulphide, Vinylacetate, Cumene, Chlorophrene, Butane diols, Xylenes, Linear alkyl benzenes and their sulphonates. (18 hours)

3 Fertilizers and Speciality Chemicals

Manufacture - Properties and industrial uses of solvents - DMF, DMSO, THF and Dioxane. Fertilizers - Raw materials, manufacture (flow chart chemical process with equations) of ammonium nitrate, ammonium sulphate, urea, calcium cyanamide, calcium ammonium nitrate, sodium nitrate, ammonium chloride, ammonium phosphate, super phosphate of lime, NPK fertilizers. Manufacture in pure form of the following - Sodium carbonate, Oxalic acid, Potassium dichromate, Perchloric acid. (9 hours)

4 Oils, Soaps and Detergents

Manufacture of Cl_2, NaOH and Chlorates of Na and K - manufacture of perchlorate. Oils - difference between oils and fats - manufacture of cotton seed oil and soybean oil - refining of oil -manufacture of soaps - toilet and transparent soaps - Detergents - synthetic detergents – surface active agents and their classification - manufacture of anionic, cationic and non ionic detergents and shampoo.

Sugar industry - manufacture of sugar from cane sugar and beet root.

Manufacture of leather - hides - Vegetable and chrome tanning finishing.

Manufacture of DDT, dinitrophenols, BHC, gamaxane, malathion, parathion. (9 hours)

References:

1. Sharma B.K, Industrial chemistry, Goel publishing House, 2003, Meerut.
2. Drydens C.E, Outlines of Chemical Technology, Gopala Rao, Eastwest press, NewDelhi.
3. Shreve R.V., Chemical Process Industries, Tata Mc Graw Hill publishing company, Mumbai.
4. Steines H.,Introduction to Petrochemicals, Pergaman Press

CH6B06.3:Polymer Chemistry

Aim: The aim of this course is to provide a basic understanding of classification, preparation, Physical and chemical characteristics and applications of polymers

Objectives

- To know about the types of polymers and the chemistry of polymerisation.
- To understand the physical properties of polymers, their reactions and degradation.
- To acquire knowledge about the polymerisation techniques and polymer processing.
- To know the chemistry of individual polymers, their preparation and properties
- To have an idea about the recent advances in polymer science

1 Introduction to Polymers

Importance of polymers: Basic concept- monomers and polymers - definition. Classification of polymers on the basis of microstructures, macrostructures and applications (thermosetting and thermoplastics) .Distinction among plastics, elastomers and fibers. Homo and heteropolymers. Copolymers. Chemistry of polymerization ,Chain polymerisation, Free radical, ionic, coordination, step Polymerisation ,Polyaddition and polycondensation ,miscellaneous ring-opening & group transfer polymerisations. (9Hrs)

2 Physical Properties and Reactions of Polymers

Properties: Glass transition temperature (Tg)- Definition- Factors affecting Tg- relationships between Tg and molecular weight and melting point. Importance of Tg. Molecular weight of polymers: Number average, weight average, sedimentation and viscosity average molecular weights. Molecular weights and degree of polymerisation. Reactions: hydrolysis-hydrogenation– addition - substitutions-cross-linking vulcanisation and cyclisation reactions. Polymer degradation. Basic idea of thermal, photo and oxidative degradations of polymers. (18Hrs)

3 Polymerisation Techniques and Processing

Polymerisation techniques: Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation polymerisations. Polymer processing: Calendering - die casting, rotational casting - compression. Injection moulding. (9 Hrs)

4 Chemistry of Commercial Polymers

General methods of preparation, properties and uses of the following Polymers: Teflon, polymethylmethacrylate, polyethylene, polystyrene, PAN, polyesters,polycarbonates, polyamides, (Kevlar), polyurethanes, PVC, epoxy resins, rubber-styrene and neoprene rubbers, Phenol - formaldehydes and urea-formaldehyde resins. (9Hrs)

5 Advances in Polymers

Biopolymers - biomaterials. Polymers in medical field. High temperature and fire-resistant polymers. Silicones, Conducting polymers- carbon fibers. (basic idea only). (9Hrs)

References:

1. Billmeyer F.W., Text book of polymer science, Jr.John Wiley and Sons, 1994.
2. Gowariker V.R., Viswanathan N.V. and Jayader Sreedhar, Polymer Science, Wiley Eastern Ltd., New Delhi.
3. Sharma, B.K., Polymer Chemistry, Goel Publishing House, Meerut, 1989.
4. Arora M.G., Singh M. and Yadav M.S., Polymer Chemistry, 2nd Revised edition, Anmol Publications Private Ltd., New Delhi, 1989.

Visit to a polymer processing unit

CH6B06.4:Environmental Chemistry

Aim: To study mainly the chemical aspects of environmental issues

Objectives:

To study:

- Environmental management and impact assessment
- Toxic effects of pollutants
- Air, water, and soil pollution

1 Environmental management and impact assessment (5 hours)

Basic principles, concepts and scope of environmental planning, Conservation of energy – Renewable and non renewable energy sources-nuclear energy, solar energy, hydrogen, non conventional energy sources. Environmental pollution – concepts and definition. Impact assessment- aim, concepts and methods, Environmental management system – ISO-14001.

2 Chemical toxicology (10 hours)

Toxicity -effects, toxic chemicals in the environment, impact of toxic chemicals on enzymes, biochemical effects of As, Cd, Pb, Hg, Co, NO_x, SO_2 , O_3, PAN, CN, pesticides, carcinogenic substances.

3 Air pollution (10 hours)

Primary pollutants, hydrocarbons-photochemical smog, particulates, radioactivity, effects of atmospheric pollution - acid rain, ozone layer depletion. Indoor air pollution. Effect of electric and magnetic fields in the environment . Air pollution accidents – Bhopal and Chernobyl. Air quality standards. Sampling and analysis of pollutants – CO, SO_2, H_2S, hydrocarbons, SPM. Noise pollution –measurement, classification ,hazards.

4 Water pollution (17 hours)

Types, effects and sources of water pollution. Pollution of fresh water, ground water and ocean. Thermal pollution. Sampling and measurement of water quality – odouar,colour,EC,turbidity,TDS,salinity, COD, BOD, DO, coliform, pH, acidity, CO_2, alkalinity, hardness, NO_3^-, NO_2^-, NH_3, phosphate, fluoride, chloride, cyanide, sulphide, sulphate and metals- As, Cd, Fe, Pb, Hg,SAR,WQI. Water quality parameters and standard. Case study: Kuttanadu wetland. Waste water treatment techniques.

5 Lithosphere (12 hours)

Composition of soil - reactions in soil. Wastes and pollutants in soil. . Sampling procedures and analysis of soil- cation exchange capacity, lime status, lime requirement, gypsum requirement, pH, N, P, K, S, Ca, Mg. Management of solid waste

References

1. A. K. De, Environmental Chemistry, New age International (p) ltd.
2. G. T. Tyler, Living in the Environment, Tomson Brooke/Cole.
3. N. Manivasakam, Physico-chemical examination of water, sewage and industrial effluents, Pragathi prakashan.
4. D .Clarson, Soil and water analytical methods, ISBN:81-901483-0-3.
5. R. K. Khitoliya, Environmental Pollution – Management and Control for sustainable development, S.Chand & Company Ltd.
6. B. B. Kebbekus and S. Mitra, Enveronmental chemical analysis, Blacke Academic & Professional.
7. S. S.Dara, A Textbook of Environmental chemistry and pollution control, S.Chand & Company Ltd.
8. R. A. Malaviya, Environmental Pollution and its control under international law.
9. Pramod Singh, Environmental pollution management.
10. G. K. Ghosh, Environmental pollution – A scientific study.
11. Nelson L. Numerow, Industrial water pollution.
12. James W. Moore and S.Ramamoorthy, Organic chemicals in natural waters
13. Hutzinger, Aquatic pollutants.
14. F. Kreith Handbook of Solid waste management, Mc Graw Hill Inc.
15. Standard methods for examination of water and waste water, APHA
16. Peter O' Neil, Environmental Chemistry, Blackie Academic and Professional, London.
17. S P Mishra and S N Pandey, Essential Environmental Studies, Ane Books Pvt. Ltd, New Delhi.
18. V K Ahluwalia, Environmental Chemistry, Ane Books Pvt Ltd, New Delhi

CH6B06.5:Soil and Agricultural Chemistry

Aim: To study the fundamentals of soil and agricultural chemistry

Objectives:

- To understand the soil and its formation
- To know the physical properties of soil and other related aspects
- To acquire knowledge about chemistry aspects of soil and nitrogen fixing process
- To understand the chemistry of nutrients that are present in soil
- To understand the chemistry of pesticides, fungicides and herbicides

1 Origin of Soil

Definition of soil - origin - igneous - metamorphic and sedimentary rocks - rock systems – weathering of rocks and minerals - main components of soil- organic, inorganic, liquid and gaseous phase - minerals of importance with respect to industries and agriculture - Soil formation - physical, chemical and biological factors responsible for soil formation- soil forming processes - Major soil groups of Kerala- methods of soil survey - remote sensing and soil mapping - soil resource management - use of satellite data for source inventory. (9 Hrs)

2 Physical Properties of Soil

Physical properties of soil - soil texture and textural classification - pore space - bulk density, particle density - soil structure and soil colour - surface area - soil colloids - plasticity, shrinkage - flocculation and deflocculation - soil air, soil temperature, their importance in plant growth – soil reaction - Ion exchange reaction- cation exchange - anion exchange - Buffering capacity – hydrogen ion concentration - determination of pH values - Factors affecting soil pH - Soil pH and nutrient availability - Soil degradation - causes. (9 Hrs)

3 Chemistry Aspects of Soil

Origin of problem soils, their properties- acid, alkali and saline soils - diagnosis - remediation of acid and salt affected soils - Methods of reclamation and after care - Quality of irrigation water – causes for poor quality waters for irrigation, their effects in soils and crops. Soil testing - concept, objectives and basis - soil sampling, collection processing, despatch of soil and water samples. soil organic matter - its decomposition and effect on soil fertility - source of organic matter in soil - maintenance and distribution - soil organism - their role - nitrification - denitrification, nitrogen fixation in soils - biological nitrogen fixation - microbial interrelationship in soil - microbes in pest and disease management - Bio-conversion of agricultural wastes. (9 Hrs)

4 Plant Nutrients

Plant nutrients - macro and micro nutrients - their role in plant growth - sources- forms of nutrient absorbed by plants - factors affecting nutrient absorption - deficiency symptoms in plants - corrective measures - chemicals used for correcting nutritional deficiencies - nutrient requirement of crops, their availability, fixation and release of nutrients. Fertilizers - classification of NPK fertilizers - sources - natural and synthetic - straight – complex - liquid fertilizers, their properties, use and relative efficiency - micro nutrient fertilizers - mixed fertilizers - principle of fertilizers use - the efficient use of various fertilizers - integrated nutrient management - biofertilizers - rhizobium, azospirillum, azetobacter - Blue green algae and azolla - production and quality control of bio-fertilizers. (18 Hrs)

5 Pesticides, Fungicides and Herbicides

Pesticides: Definition – Classification – organic and inorganic pesticides – mechanism of action – Characteristics – Safe handling of pesticides – impact of pesticides on soil, plants and environment – Acts and Laws concerning the pesticides. Fungicides: definition – classification – mechanism of action – sulfur, copper, mercury compounds, dithanes, dithiocarbamates. Herbicides: definition – classification – mechanism of action – Arsenic and boron compounds – nitro compounds, chloro compounds, triazines, propionic acid derivatives, urea compounds. Acaricides – rodenticides – attractants – repellants – fumigants, defoliants (9 Hrs)

References:

1. Biswas, T. D. and Mukeherjee, S. K. Textbook of Soil Science, 1987
2. Daji, A.J. A Textbook of Soil Science, Asia Publishing House, Madras, 1970
3. Tisdale, S.L., Nelson, W.L. and Beaton, J. D. Soil Fertility and Fertilizers, Macmillian Publishing Company, New York, 1990
4. Hesse,P.R. A Textbook of Soil Chemical Analysis, John Murray, New York, 1971.
5. Buchel, K.H. Chemistry of Pesticides, John Wiley & Sons, New York, 1983
6. Sree Ramula, U. S. Chemistry of Insecticides and Fungicides, Oxford and IBH Publishing Co., New Delhi, 1979

CH6B06.6: Computer Applications in Chemistry

Aim: To provide a basic understanding of computational chemistry

Objectives

- Tto understand the use of computational chemistry as applied to modern problems in chemistry.
- To gain technical proficiency with computational chemistry software and to understand and make predictions about the properties of chemical systems through computation.
- To understand the role of cheminformatics and bioinformatics

1. **Computational Chemistry** (22 Hrs)

Introduction-Scope of computational chemistry-Computational tools-molecular mechanics- abinitio molecular orbital models- semiempirical molecular orbital models- Density Functional theory, -Introductory theory of these models- basis set-Slater and Gaussian functions-split-valence sets-selection of a suitable model for a computational problem

Molecular geometries-geometry optimization- potential energy surfaces, local and global minima, transition states, and Hessian indices-z-matrix of water, ammonia, methane, ethane, butane, ethene, and ethyne.

Constrained geometry optimization-single point energy calculation-conformational analysis of ethane and butane-constructing energy profile diagram,-determining inversion energy barrier of ammonia

Isodesmic and homodesmic reactions-comparing ring strain energy of cycloalkanes

Hands on experience on

computational chemistry softwares- Huckel theory (SHMO free software www.chem.ucalgary.ca/**SHMO**/), Molecular mechanics (Tinker free software http://dasher.wustl.edu/) Semiempircal methods (Winmopac free software www.psu.ru/science/soft/**winmopac**/index_e.html) Abinitio methods (GAMESS free software www.classic.chem.msu.su/gran/gamess/downloads.html)

Programs for chemical structure drawing (ISISDRAW www.ch.cam.ac.uk/cil/SGTL/MDL/**ISISdraw**.html, Chemsketch www.acdlabs.com/download/)-

Software for visualization of computational results –molecular structure, molecular orbitals, dipole moments, electrostatic potentials- animations-dynamics- Molekel (free software www.cscs.ch/**molekel**/) Jmol (free software http://**jmol**.sourceforge.net/download/)

2. **Cheminformatics** (16 Hrs)

Introduction to cheminformatics, History and Evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and Structure Elucidation

Nomenclature; Different types of Notations; SMILES Coding; Matrix Representations; Structure of Molfiles and Sdfiles; Libraries and toolkits; Different electronic effects; Reaction classification

Database Concepts, Structured Query Language, Design of Chemical Databases, Data Abstraction; Data Models (Elementary ideas only)

Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra;

Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Application of Cheminformatics in Drug Design, Design of combinatorial libraries;

3. **Bioinformatics** (16 Hrs)

Bioinformatics Basics- Internet Use and Search Engines- Fundamentals of Internet, WWW, HTML, URLs -Browsers: Netscape/Opera/Explorer Search Engines: Google, PUBMED, NCBI EMBL, GENBANK, Entrez, Unigene, PDB, SwissProt, And TrEMBL Bioinformatics Softwares and their uses (elementary ideas): Clustal V, Clustal W 1.7, RasMol, Oligo, Molscript, Treeview, Alscript, Genetic Analysis Software, Phylip

Introduction to Genes and Proteins- Genome Sequences ORFs, Genes, Intones, Exons, Splice Variants DNA/ RNA Secondary Structure, Triplet Coding Protein Sequences. Alignment of pairs of sequence ,Introduction to sequence analysis, Sequence analysis of biological data , models for sequence analysis and their biological motivation , methods of alignment, Application of dot matrix , Methods of optimal alignment using gap penalty and sore matrices, tools for sequence analysis

Introduction to phylogenetic tree analysis. Using pattern to predict genes, Method of gene prediction , prediction tools, protein structure databases and visualization tools, protein prediction tools, Method of protein prediction for known fold and unknown fold , protein function prediction.

Bioinformatics in pharmaceutical industries, immunology, agriculture, forestry,

Geoinformatics- Legal, ethical and commercial ramifications of bioinformatics, Biosensing

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 , Wavefunction 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. I Levine, Quantum Chemistry
7. Oprea, T. I. Chemoinformatics in drug discovery. John Wiley & Sons: New York, NY, 2005
8. Andrew Leach, An Introduction to Chemoinformatics
   Johann Gasteiger (Editor), Thomas Engel (Editor) Chemoinformatics: A Textbook Wiley Publications
9. Varnek, A., Tropsha, A, Eds.; Chemoinformatics Approaches to Virtual Screening; RSC Publishing, Cambridge, England, 2008.
10. H. M. Dietel, P. J. Dietel and T. R. Nieto, Internet and World Wide Web- how to program, Pearson Education India.
11. S.C. Rastogi, Namita Mendirata, Parag Rastogi ‘’Bioinformatics concepts, skills and application, CBS publisher
12. D. Baxevanis and F. Oulette, "Bioinformatics: A practical guide to the analysis of genes and proteins", Wiley (2002)
13. Arthur M. Lesk, "Introduction to Bioinformatics" Oxford University(2002), James Tisdall, Beginning Perl for Bioinformatics", O'Reilly & Associates., (200I) Learning Perl, 3rd Edition.
14. A Malcolm Campbell and L.J. Heyer ,Discovering Genomics proteomics and Bioinformatics

CH6B06.7: PHARMACEUTICAL CHEMISTRY

Credits:3 Hours:54

Objectives

To understand the common diseases and the cure
To know the terms of pharmacology
To understand the mechanism of drug action
To acquire knowledge about chemotherapy and the antibiotics
To understand the drugs used for diabetes, hypertension, cholesterolemia
To acquire knowledge about various health promoting drugs

1. INTRODUCTION

Common diseases - Infective diseases - insect-borne, air-borne and water-borne – hereditary diseases. Terminology - drug, pharmacology, pharmacognosy, pharmacodynamics, pharmacokinetics, anti metabolites. Absorption of drugs - routes of

administration of drugs, factors affecting absorption. Assay of drugs - chemical, biological, immunological assays, LD_{50} and ED_{50} therapeutic index, drug dosage. (18 Hrs)

2. DESIGNATION OF DRUGS

Designation of drugs based on physiological action; Definition and two examples with structure each of : Anesthetics-General and local. Analgesics - Narcotic and synthetic. Antipyretics and anti inflammatory agents. Antibiotics - penicillin, streptomycin, chloramphenicol, tetracyclins.

Antivirals. AIDS - symptoms, prevention, treatment. Cancer and neoplastic agents. (9 Hrs)

3. COMMON BODY AILMENTS

Diabetes - Causes, hyper and hypoglycemic drugs -Psychedelic drugs, hypnotics, sedatives (barbiturates, LSD) - Blood pressure - Systolic & Diastolic Hypertensive drugs - Cardiovascular drugs – anti arrhythmic, antianginals, vasodilators – CNS depressants and stimulants – Lipid profile - HDL, LDL cholesterol, lipid lowering drugs. (9 Hrs)

4. HEALTH PROMOTING MEDICINES

Nutracenticals-Vitamins A B C D E and K (structure expected) micronutrients such as Na K Ca Cu Zn I -Medicinally important inorganic compounds of Al, P, As, Hg, Fe – Organic Pharmaceutical acids; Agents for kidney function(Aminohippuric acid); Agents for liver function (Sulfobromophthalein); Agents for pituitary function (metyrapone) - Organic pharmaceutical bases - antioxidants, treatment of ulcer and skin diseases. (18 Hrs)

Book for Study:

1. Jayashree Ghosh, Pharmaceutical chemistry, S.Chand and Company Ltd., 2006, New Delhi.

Books for Reference:

1. Lakshmi S., Pharmaceutical chemistry, S.Chand & Sons, 1995, New Delhi.
2. Ashutosh Kar, Medicinal chemistry, Wiley Eastern Ltd., 1993, New Delhi.
3. David William & Thomas Lemke, Foyes principles of medicinal chemistry, 5th editon 2005, BI publishers.
4. Romas Nogrady, Medicinal chemistry, II Edition 2004, Oxford University.

CH6B06.8: PETROCHEMICALS

Credits : 3 **Hours:54**

1 Petrochemical Industries

Introduction to crude oil, explanatory methods, oil reservoirs, transportation of crude oil, constitution of crude oil, Natural gas – constituents. Distillation of crude oil, Separation of natural gas – constituents. Distillation of crude oil, Separation of natural gas and

different fractions based on relative volatilities, Compositions of different distillates. Meaning of terms such as – Pour point depressants, drag reducers, viscosity reducers, ignition point, flash point, octane number, doctor solution. Types of hydrocarbon fuels and their characteristics. Detailed discussion of the following operations with respect to process, mechanism, catalysts used and applications; Cracking – catalytic cracking, Hydrocracking, Isomerization, Reforming, Alkylation. Sulphur, hydrogen, petroleum coke and nitrogen compounds from petroleum. General discussion of the following reactions with respect to mechanism and applications – Oxidation, ammoxidation, hydroformylation, hydration.

30 hours

2 Manufacture of Petrochemicals

Manufacture of the following compounds: Methane, ethylene, acetylene, propylene, C – 4 hydrocarbons, higher olefins. Preparation of the following from methane – methanol, carbon black, hydrogen cyanide, chlorinated methanes, carbon disulphide. Preparation of the following from ethylene – Ethyl chloride, ethanol, ethylene oxide, ethylene glycol, acetaldehyde, acetic acid, styrene, vinyl acetate, ethanolamines, vinyl chloride, acrylonitrile. Manufacture of the following from propylene; Isopropanol, cumene, glycerine, acrylonitrile. Manufacture of the following from acetylene: Vinyl chloride, chloroprene, acrylonitrile, acetaldehyde. Manufacture of the following from C – 4 hydrocarbons: Butadiene, isobutene, isobutane, butanediols, oligomers.

24 hours

References:-

1. W.L. Faith, Donald B Keyes, Ronald L Clark, Industrial Chemicals.
2. Speight G James, Marcel Dekker Inc 1991,The chemistry and technology of Petroleum
3. Tripathi G.N, Indian Petroleum Directory
4. B.K Sharma , Industrial Chemistry and Chemical Engineering ,Spits Petrochemicals-Wiley
5. ASTM Methods, Indian standards
6. Sukumar Maiti, Introduction to Petrochemicals

CH5D01:Open courses

Credits-4 72 Hours

CH5D01.I: Dairy Science

Aim: To study the fundamentals of dairy science

Objectives

- To understand the chemical composition of milk
- To know the techniques of milk processing
- To acquire knowledge about various milk products
- To understand the chemistry of other types of special milk
- To acquire knowledge about techniques of fermentation of milk and various milk products

1 Composition of Milk

Milk - definition-general composition of milk - constituents of milk - lipids, proteins, carbohydrates ,vitamins and minerals - physical properties of milk - colour, odour, acidity, specific gravity, viscosity and conductivity - factors affecting the composition of milk - adulterants, preservatives and neutraliser-examples and their detection - estimation of fat, acidity and total solids in milk. (12Hrs)

2 Processing of Milk

Microbiology of milk - destruction of micro organisms in milk - physico - chemical changes taking place in milk due to processing - boiling, pasteurisation - types of pasteurisation - Bottle, Batch and HTST (High Temperature Short Time) - Vacuum pasteurisation - Ultra High Temperature Pasteurisation. (12Hrs)

3 Major Milk Products

Cream-definition-composition-chemistry of creaming process-gravitational and centrifugal methods of separation of cream-estimation of fat in cream.

Butter - definition - composition - theory of churning - desibutter - salted butter - estimation of acidity and moisture content in butter.

Ghee - major constitutents - common adulterants added to ghee and their detection - rancidity - definition - prevention - antioxidants and synergists - natural and synthetic.

(12 Hrs)

4 Special Milk

Standardised milk - definition - merits - reconstituted milk - definition - flow diagram of manufacture - Homogenised milk - flavoured milk - vitaminised milk - toned milk -

Incitation milk – vegetable toned milk - humanised milk - condensed milk - definition composition and nutritive value. (12 Hrs)

5 Fermented and Other Milk Products

Fermented milk products - fermentation of milk - definition, conditions, cultured milk - definition of culture - examples, conditions - cultured cream - cultured butter milk - Bulgaxious milk - acidophilous milk - Yoheer Indigeneous products - Khoa and chchana -definition - Preparation of khoa and chahana- sweets - Gulabjam, chana sweet, Rassogilla. Ice cream - definition - percentage composition types - ingredients - manufacture of ice-cream stabilizers - emulsifiers and their role- milk powder - definition - need for making milk powder - drying process - types of drying- dairy detergents - characteristics - classification - washing procedure - sterilization -chloramine T and hypochlorite solution. (24 Hrs)

Visit to a pasturisation factory/Milk product company and submission of a report.

References:

1. Robert Jenness and Patom S., Wiley, Principles of Dairy Chemistry, New York
2. Rangappa K.S. and Acharya K.T., Indian Dairy Products
3. Wond F.P., Fundamentals of Dairy Chemistry, Springer.
4. Lampert L.M., Modern Dairy products, Chemical Publishing Company Inc., New York.
5. Warner, Wiley, Principles of Dairy Procesing, New York
6. Sukumar De, Outlines of Dairy technology.

CH5D01.2: Food Science

Aim: To get a basic understanding of the different aspects of food science

Objectives

- To understand the chemistry of food adulteration and adulterants
- To know the methods of analyzing the adulterants
- To know the chemistry of food poisoning
- To acquire knowledge about food additives
- To understand the chemistry of beverages and soft drinks
- To know the methods of preparing the soft drinks by field visits
- To acquire knowledge about various edible oils and the processing techniques related to oils

1 Food Adulteration

Sources of food, types, advantages and disadvantages. Food adulteration - contamination of wheat, rice, mlk, butter etc. with clay stones, water and toxic chemicals – Common adulterants. Ghee adulterants and their detection. Detection of adultered Foods by simple analytical techniques. (18 Hrs)

2 Food Poisons

Food poisons - natural poisons (alkaloids - nephrotoxic) - pesticdes. (DDT, BHC, Malathion) - Chemical poisons - First aid for poison consumed victims. (9 Hrs)

3 Food Additives

Food additives - artificial sweeteners - Saccharin - Cyclomate and aspartate. Food flavours - esters, aldehydes and heterocyclic compounds. Food colours - restricted use - spurious colours – Emulsifying agents - preservatives ,leavening agents. Baking powder yeast - taste makers – MSG, vinegar. (18 Hrs)

4 Beverages

Beverages - Soft drinks - soda - fruit juices - alcoholic beverages examples. Carbonation – addiction to alcohol - cirrhosis of liver and social problems. (9 Hrs)

5 Edible Oils

Fats, oils - Sources of oils - Production of refined vegetable oils - Preservation.
Saturated and unsaturated fatty acids – Iodine value - Role of MUFA and PUFA in preventing heart diseases - determination of iodine - value , RM value, saponification value and their significance. Estimation of I_2 and RM values in Edible oils (18 Hrs)

References:

1. Swaminathan M., Food Science and Experimental oods, Ganesh and Company.
2. Jayashree Ghosh, Fundamental concepts of Applied chemistry, S. Chand & Co. Publishers
3. Thankamma Jacob, Text Books of applied chemistry for Home Science and allied Sciences, Macmillan.
4. B. Sreelakshmi, Food Science, New Age

CH5D01.3: Forensic Science

Aim: To study some fundamental aspects of forensic science

Objectives

- To learn Crime investigation through diagnosis of poisoning and postmortem.
- To acquire knowledge about explosions, the causes (gelatin sticks, RDX etc) and the security measures.
- To understand the methods of detecting forgery in bank and educational records.
- To acquire a comprehensive knowledge about tracks and traces.
- To understand the chemical methods used in crime investigation.(Medical aspects).

1 Poisons

Poisons-types and classification-diagnosis of poisons in the living and the dead – clinical symptoms - postmortem appearances. Heavy metal contamination (Hg, Pb, Cd) of sea foods-use of neutron activation analysis in detecting Arsenic in human hair. Treatment in cases of poisoning - use of antidotes for common poisons. (12Hrs)

2 Crime Detection

Accidental explosion during manufacture of matches and fire works. Human bombs-possible explosives (gelatin sticks and RDX) - metal detector devices and other security measures for VVIP- composition of bullets and detecting powder burn. Analysis of incendiary and timed bombs - spill of toxic and corrosive chemicals from tankers.

(12Hrs)

3 Forgery and Counterfeiting

Documents - different types of forged signatures-simulated and traced forgeries - inherent signs of forgery methods - writing deliberately modified-uses of ultraviolet rays - comparison of type written letters - checking silver line water mark in currency notes - alloy analysis using AAS to detect counterfeit coins - detection of gold purity in 22 carat ornaments - detecting gold plated jewels - authenticity of diamond. (12Hrs)

4 Tracks and Traces

Tracks and traces - small tracks and police dogs-foot prints - casting of foot prints - residue prints, walking pattern or tyre marks - miscellaneous traces and tracks - glass fracture - tool markpaints – fibres. Analysis of biological substances - blood, saliva, urine and hair- Cranial analysis (head and teeth) DNA Finger printing for tissue identification in dismembered bodies -Detecting steroid consumption in athletes and race horses.

(18Hrs)

5 Medical Aspects

Aids - causes and prevention - misuse of scheduled drugs - burns and their treatment by plastic surgery. Metabolite analysis using mass spectrum – gas chromatography. Arson-natural fires and arson - burning characteristics and chemistry of combustible materials - nature of combustion. Ballistics - classification - internal and terminal ballistics - small arms - laboratory examination of barrel washing and detection of powder residue by chemical tests. (18Hrs)

References:

1. T.H.James, Forensic Sciences, Stanley Thornes Ltd.
2. Richard, Criminalistics - An Introduction to Forensic Science (College Version), 8th Edition, Sofestein, Printice Hall.

CH5D01.4: Environmental Chemistry

Aim:

The aim of the course is to enable students to study the concept and techniques in monitoring, analysing and solving environmental issues and to develop programmes to inculcate environmental awareness among the common mass.

Objectives:

To study:

- Environmental management and impact assessment
- Toxic effects of pollutants
- Air, water, and soil pollution
- Effluent and waste management

1 Environmental management and impact assessment (5 Hrs)

Basic principles, concepts and scope of environmental planning, Conservation of energy – Renewable and non renewable energy sources-nuclear energy, solar energy, hydrogen, non conventional energy sources. Environmental pollution – concepts and definition. Impact assessment- aim, concepts and methods, Environmental management system – ISO-14001.

2 Chemical toxicology (9 Hrs)

Toxicity -effects, toxic chemicals in the environment, impact of toxic chemicals on enzymes, biochemical effects of As, Cd, Pb, Hg, Co, NO_x, SO_2 , O_3, PAN, CN, pesticides, carcinogenic substances.

3 Air pollution (10 Hrs)

Primary pollutants, hydrocarbons-photochemical smog, particulates, radioactivity, effects of atmospheric pollution -acid rain, ozone layer depletion. Indoor air pollution. Effect of electric and magnetic fields in the environment Air pollution accidents – Bhopal and Chernobyl. Air quality standards. Sampling and analysis of pollutants – CO, SO_2, H_2S, hydrocarbons, SPM. Noise pollution –Measurement, Classification ,Hazards.

4 Water pollution (20 Hrs)

Types, effects and sources of water pollution. Pollution of fresh water, ground water and ocean. Thermal pollution. Sampling and measurement of water quality – odour,color,EC,turbidity,TDS, salinity, COD, BOD, DO, coliform, pH, acidity, CO_2, alkalinity, hardness, NO_3^-, NO_2^-, NH_3, phosphate, fluoride, chloride, cyanide, sulphide, sulphate and metals- As, Cd, Fe, Pb, Hg, SAR, WQI,. Water quality parameters and standards. Case study: Kuttanadu wetland. Waste water treatment techniques.

5 Effluent and waste management (20 Hrs)

Effluent – definition and characteristics. Methods for water and waste water treatment and systems (physical, chemical, and biological). Air pollution emission control devises – principle methods. Plants, animals and microorganisms for controlling pollution and treatment of effluents. Waste management – definition, characterization, sources and classification. Waste treatment and disposing methods, - recycling and reuse. Methods for management for hazardous and toxic wastes. Principle and strategies of green chemistry –Illustrate with examples.

6 Lithosphere (8 Hrs)

Composition, reactions in soil,. Wastes and pollutants in soil. . Sampling procedures and analysis of soil- cation exchange capacity, lime status, lime requirement, gypsum requirement, pH, N, P, K, S, Ca, Mg. Management of solid waste

References

1. A. K. De, Environmental Chemistry, New age International Ltd.
2. G.T.T yler, Living in the Environment, Tomson Brooke/Cole
3. N. Manivasakam, Physico-chemical examination of water, sewage and industrial effluents, Pragathi Prakashan.
4. D. Clarson, Soil and water analytical methods, ISBN:81-901483-0-3.
5. R. K. Khitoliya, Environmental Pollution – Management and Control for sustainable development, S.Chand & Company Ltd.
6. B. B. Kebbekus and S. Mitra, Enveronmental chemical analysis, Blacke Academic & Professional.
7. S. S. Dara, A Textbook of Environmental chemistry and pollution control, S.Chand & Company Ltd.
8. R. A. Malaviya, Environmental Pollution and its control under international law.
9. Pramod Singh, Environmental pollution management.
10. G. K. Ghosh, Environmental pollution – A scientific study.
11. Nelson L. Numerow, Industrial water pollution.
12. James W. Moore and S.Ramamoorthy, Organic chemicals in natural waters
13. Hutzinger, Aquatic pollutants.
14. F. Kreith Handbook of Solid waste management, Mc Graw Hill Inc.
15. Standard methods for examination of water and waste water, APHA
16. Peter O' Neil, Environmental Chemistry, Blackie Academic and Professional, London
17. S P Mishra and S N Pandey, Essential Environmental Studies, Ane Books Pvt. Ltd, New Delhi.
18. V K Ahluwalia,Environmental Chemistry, Ane Books Pvt Ltd, New Delhi

CH5D01.5: Chemistry in Everyday life

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 every day 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

CH5D01.6: Nanoscience and Nanotechnology

Aim: To study the fundamentals of nanoscience and nanotechnology

Objectives

- Why Nanotechnology?
- What are the historical landmarks in the area?
- What are the terms and concepts of Nanoscience?
- What are nanoparticles, nanotubes, nanowires and other low-dimensional systems?
- What are the principal properties used to explore nanomaterials and what are the techniques used?
- How do we manipulate nanomaterials in areas such as biology, biotechnology, medicine, medical diagnosis, sensors etc.?
- What are the main social, economic and ethical issues related to Nanotechnology?

1. **Nanomaterials:** Historical landmarks- terminology-scales-top-down and bottom-up paths in nanoscience- Feynman's hypothesis-low dimensional solids-nanoparticles: fullerene- its discovery-production-contribution to nanotechnology-unusual properties of fullerene. Nanotubes:carbon nanotubes- architectural characteristics-synthesis- properties. (18 Hrs)

2. **Nanoscience:** Its social, economic and ethical perspectives- responsible development of nanotechnology- existing laws and regulations- regulatory agencies-U.S.Govermment laws- intellectual property policy of nanotechnology-technology transfer. Energy challenges-environmental impacts of nanotechnology-Green nanotechnology- technology business: nanoeconomics- entrepreneurs in the technological ecosystem- nanoethics- challenges to mankind- future of nanotechnology. (18 Hrs)

3. **Seeing the nanoworld:** fundamental particles-elctromagnetic radiation- its components- impact on matter-the Planck's equation- de Broglie relation- matter-wave concept of radiation- concept of colour and vision- spectroscopic methods and radiation- elementary ideas of UV-visible, IR, NMR,XPES and UPES techniques. X ray techniques- SEM, TEM, STM, SPL, and SIMS - their use in the studies of nanosystems. (18 Hrs)

4. **Applications of nanotechnology:** Nanobiology- immuno targeted nanoparticles-nanomaterials in medical diagnosis- bio-nano information fusion. Nanomedicines-nanoparticle drug systems for oral, nasal, and ocular administration- therapeutic applications. Nanosensors- smart dusts- nanomaterials in war- destructive applications of nanotechnology. (18 Hrs)

References:

1. T. Pradeep, Nano: The Essentials, Mc Graw Hill Publishing Company, New Delhi (2007).
2. V. S. Muraleedharan and A. Subramania, Nanosciece and nanotechnology, Ane Books Pvt. Ltd. New Delhi, 2009
3. C. N. R. Rao and A.Govindraj, Nanotubes and Nanowires, Royal Society of Chemistry (2005)
4. J. M. M. Duart, R. J. M. Palma and F.A. Rueda,Nanotechnology and Microelectronics and optoelectronics, Elsevier (2002)
5. R. Booker and , E. Boysen, Nanotechnology, Wiley India Pvt Ltd, 2008
6. K. J. Klabunde, Nanoscale materials in chemistry, John Wiley and Sons.
7. C. P. Poole Jr and F J Owens, Introduction to nanotechnology, Wiley IndiaPvt Ltd 2009.
8. L. E. Foster, Nanotechnology: Science, Innovation and Opportunity, Pearson Education (2008).
9. http://www.zyvex.com/nanotech/feynman.html

Chemistry Resources on the Internet

ISIS Draw, Free Chemical structure drawing program

http://www.cem.msu.edu/~reusch/vtxtindex.htm An excellent virtual text book of organic chemistry
http://www.chem1.com/acad/webtext/virtualtextbook.html
www.symmetry.otterbein.edu/tutorial/index.html symmetry topics with interactive models
http://www.chem.ucalgary.ca/courses/351/Carey5th/Carey.html online organic chemistry book
http://molinspiration.com:9080/mi/webme.html molecule sketcher allows creation and editing of molecules online

http://hyperphysics.phy-astr.gsu.edu/hbase/HFrame.html website with extensive hyperlinking to explore topics in thermodynamics, kinetic molecular theory, quantum mechanics and physics in general
http://www.webelements.com/webelements/scholar/index.html periodic table

http://www.chemeddl.org/collections/ptl/ periodic table
http://www.rsc.org/chemsoc/visualelements/PAGES/pertable_fla.htm periodic table
www.chemtube3d.com/ This site contains interactive 3D animations for some of the most important organic reactions

COMPLEMENTARY COURSES IN CHEMISTRY

I-SEMESTER

CH1C01 : Basic Theoretical and Analytical Chemistry

(Common to physical sciences, life sciences geology and family and community science)

Credits-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

- To study atomic structure, basics of thermodynamics and the concept of equilibrium
- To understand principles of analytical chemistry and chromatographic techniques

1. Atomic Structure (8 Hrs)

Introduction:-Atoms, Dual nature of matter and radiation. Photoelectric effect,de Broglie equation, 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. Manas Chanda, Atomic Structure and Molecular Spectroscopy
2. P. L. Soni Inorganic Chemistry
3. B. R. Puri, L. R. Sharma, M.S. Pathania, Elements of Physical Chemistry, 3rd edn. Vishal Pub. CO., 2008 (Chapter 19)
4. C. N. R. Rao, University General Chemistry, Macmillan(Chapter 3)

2. Concept of Equilibrium (5 Hrs)

Acids and bases –Arrhenius, Lowry-Bronsted and Lewis Concepts, ionic product of water, introductory idea of pH, pOH. Strengths of acids and bases, K_a and K_b, pK_a and pK_b, buffer solution (elementary idea only), Solvation, solubility, solubility product, common ion effect, application.

References

1. B. R. Puri, L. R. Sharma, M.S. Pathania, Elements of Physical Chemistry, 3rd edn. Vishal Pub. CO., 2008 (Chapter 16)
2. C. N. R. Rao, University General Chemistry, Macmillan(Chapter 11)

3. 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 (Chapter 9,11,12)
2. C. N. R. Rao, University General Chemistry, Macmillan(Chapter 9)

4. Analytical Chemistry- Basic principles (9 Hrs)

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

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

Titrimetric method of analysis: General principle, types of titrations, requirements for titrimeric analysis. Concentration terms- molality, molarity, normality, weight percentage, ppm, and millimoles. Primary and secondary standards, criteria for primary standards, preparation of standard solutions, standardization of solutions, limitation of volumetric analysis, end point. Acid-base titrations, redox titrations (general idea only). Gravimetric method of analysis: General principle-separation by precipitation.Separation and purification techniques: Recrystallisatoin, use of drying agents, sublimation. General principles of distillation, fractional distillation, distillation under reduced pressure. Solvent extraction.

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. Chromatographic Techniques (6 Hrs)

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

Refernces

1. R. A. Day Junior, A.L. Underwood, Quantitative Analysis, 5th edn. Prentice Hall of India Pvt. Ltd. New Delhi, 1988(Chapters17,18)
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.

II –SEMESTER

CH2C01: Basic Organic Chemistry

(Common to physical sciences, life sciences geology and family and community science)

Credits-2 **(36Hrs)**

Aim

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

Objectives:

To study

- Stereochemistry of organic compounds
- Mechanisms of some basic organic reactions
- Classification of polymers, polymerization reactions, and the structure and uses of some commercial and natural polymers

1. Stereochemistry of Organic Compounds (13 Hrs)

Geometrical isomerism- cis and trans configuration, determination of configuration and interconversion of cis-trans isomers, E and Z configuration .Optical isomerism- Optical activity, Chirality, Stereogenic Centre, Enantiomers and diastereomers, Racemisation Conformation- Newman projection, Saw-horse projection, Conformations of Ethane, n-Butane, 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,NewAge International(P) Ltd,2006(Chapter 2)

2. Mechanisms of Organic Reactions **(**15 Hrs)

Hybridization- sp^3, sp^2 and sp, (ethane, ethene, ethyne). Polarity of bonds. Inductive, mesomeric, and hyperconjugative effects. Bond fission- homolytic and heterolytic fission. Reaction intermediates- radicals, carbocations and carbanions.

Classification of reagents- electrophiles, nucleophiles. Types of organic reactions – addition, substitution and elimination reactions.

Substitution reactions: nucleophilic substitution of alkyl halides- S_N1 and S_N2 mechanisms. Electrophilic substitution in benzene-reaction mechanism.

Addition reactions: electrophilic addition to ethene, propene and ethyne-the Markwonikoff's rule, Peroxide effect.

Elimination reactions: E1 and E2 mechanisms

References

1. I. L. Finar , Organic Chemistry, 6th edn. Vol. I Pearson(Chapters 2,4,5,20)
2. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th edn. Orient Longman,1988(Chapters 4,7,9)
3. S. M. Mukherji, S.P Singh, Reaction Mechanism in Organic Chemistry, Macmillan, Third Edn.,2003(Chapters 1,2,4,5,6,9)

3. Natural and Synthetic Polymers (8 Hrs)

Classification of polymers: Natural, synthetic; linear, cross-linked and network; plastics, elastomers, fibres; homopolymers and copolymers. Polymerization reactions, typical examples- polyethene, polypropylene, PVC, phenol-formaldehyde and melamine-formaldehyde resins, polyamides (nylons) and polyester. Natural rubber: structure, vulcanization. Synthetic rubbers- SBR, nitrile rubber, neoprene. Biodegradability of polymers, environmental hazards.

Reference

1. V. R. Gowariker, Polymer Science, Wiley Eastern(Chapters 1,2,9)

PRACTICAL-I

(Semester I and II)

(Common to physical sciences, life sciences geology and family and community science)

CH2C02: Volumetric Analysis

Credits 2 **72 hours**

Standard solution must be prepared by the student

1. 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.

2. 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 $KMnO_4$.

3. Dichrometry

1. Estimation of Ferrous ions (external indicator)
2. Estimation of Ferrous ions (internal indicator)
3. Estimation of $FeSO_4$. 7 H_2O (external indicator)

4. Iodimetry and Iodometry

1. Standardization of Iodine solution
2. Standardization of Sodium thiosulphate
3. Estimation of $KMnO_4$
4. Estimation of Copper

5. Gravimetric Analysis

1. Determination of percentage of water in Barium chloride crystals
2. Estimation of Barium as Barium Sulphate

6. 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 Hallof India Pvt. Ltd.

SEMESTER-III

CH3C01.1 : Advanced Physical Chemistry – I

(For students who have opted Physical Sciences and Geology as Main)

Credits-3 **(54 Hrs)**

Aim: To give the students a thorough knowledge about molecular structure and its electrical and nuclear properties and to develop proper aptitude towards the study of molecular structure

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. Nuclear Chemistry - (13 Hrs)

Stability of Nucleus:- binding energy, magic number, packing fraction, n/p ratio. Radioactivity: detection, GM counter, units of radioactivity.Nuclear Processes: natural radioactivity, induced radioactivity, fertile and fissile isotopes.Nuclear Reactions: fission and fusion, chain reactions, disposal of nuclear wastes.Applications: Reactors – conventional and breeder, energy generation,

rock dating and radiocarbon dating, neutron activation analysis; medical, agricultural and industrial applications.

2. Symmetry and Molecular Structure (6 Hrs)

Symmetry elements and symmetry operation – Centre of symmetry, plane of symmetry, proper and improper axes of symmetry, identity, molecular point groups, Schoenflies symbol (determination of point groups not expected

3. Solid State (15 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, Bravaice 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.Magnetic Properties: classification - diamagnetic, paramagnetic, antiferromagnetic, ferro and ferrimagnetic, permanent and temporary magnets.

4. Liquid State (6 Hrs)

Intermolecular forces, liquids compared with gases and solids (qualitative idea only), viscosity, surface tension (method of determination not expected), structure of liquids (a qualitative description).Liquid crystals – the intermediate phase between solid and normal liquid phases, thermographic behaviour, classification, structure of nematic and cholesteric phases.

5. Surface Chemistry and Colloids (6 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, electroosmosis, surfactants, micelle, applications of colloids.

6. Phase Equilibrium **(8 Hrs)**

The phase rule, definition, equilibrium between phases, one component system – water system, two component systems: solid- liquid equilibrium – simple eutectic, lead-silver system, solid solution.Distribution law, partition coefficient, applications.

References:

1. H.J. Arnikar ,Essentials of Nuclear Chemistry (Revised IV edn.) ,New Age International Pub. (1995)
2. B.R. Puri, L.R. Sharma, M.S. Pathania ,Elements of Physical Chemistry, 40th edn. Vishal Pub. Co. Jalandhar (2003)
3. Ashcroft/ Mermin ,Solid State Physics,Thomson Publishers
4. J. Tareen and T. Kutty ,A basic course in Crystallography,University Press.

CH3C01.2: Advanced Inorganic and Organic Chemistry

(For students who have opted Biological Sciences and Family and Community Science 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.

I .Nuclear Chemistry **(10 Hrs)**

Radioactivity- natural radioactivity, artificial radioactivity, disintegration rates, half life period and disintegration constant.

Nuclear Reactions - nuclear fission and nuclear fusion, nuclear reactors

Applications of radioisotopes - carbon dating, rock dating, in medicine, in agriculture, and in industry.

2. Chemistry and Agriculture (12 Hrs)

NPK representation, superphosphates, triple super phosphate ,uses of mixed fertilizers, micronutrients and their role, bio-fertilizers, plant growth hormones.

Pesticides-classifications with simple examples, mention of biopesticides.

Insecticides – stomach poisons, contact insecticides, fumigants. Method of preparation and use of DDT, BHC, pyrethrin.

Herbicides- structure and function of 2, 4,-D and 2,4,5 –T

Fungicides- inorganic and organic- Bordeaux mixture, diothio carbamates

Excessive use of pesticides – environmental hazards.

3. Chemistry of Living cell (9 Hrs)

Thermodynamics of Living cell- Exergonic and endergonic reactions, coupled reactions, biological oxidation reactions (general idea)

Photosynthesis- Metalloporphyrin, chlorophyll, elementary idea of photophosphorylation. Photosynthesis and respiration – comparison.

Biologically important molecules (structure not required): Haemoglobin – general functions of haemoglobin, transport of oxygen, pH of blood, myoglobin, cytochromes, Ferredoxine (elementary idea)

4. Heterocyclic Compounds (12 Hrs)

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

5. Chemotherapy (6 Hrs)

Outline study and applications of antibiotics, sulpha drugs antipyretics, analgesics tranquillizers, and antidepressants (preparation not needed) .Drug addiction abuse and prevention.

6. Food Additives (5 Hrs)

Artificial sweeteners – saccharin, cyclamate aspartame (general idea)

Food Flavours (names only) –esters, aldehydes and heterocyclic compounds.

Food colours- Restricted use, spurious colours.

General discussion of emulsifying agents, preservatives, leavening agents, baking powder, yeast.Taste-enhancers- MSG, vinegar

References

1. I. L Finar ,Organic Chemistry Vol 1&2, 6th Edition ,Pearson
2. H. J. Arnikar,Essentials of nuclear chemistry, Revised 4th edition, New Age International Publications ,1995.
3. C.N. R Rao, University General Chemistry, Macmillion
4. G. T. Austin, Shreve's Chemical process Industries,. 5th edition , Mc Graw Hill, 1984.
5. Rastogi, Biochemistry, Tata Mc Graw. Hill Publication, 1996.
6. B. Sreelakshmi, Food Science, New Age International Pvt Ltd, New Delhi

IV-SEMESTER

CH4C01.1: Advanced Physical Chemistry – II

(For students who have opted Physical Sciences and Geology 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, λ 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 chemiluminescene.Frank-Condon principle – fluorescence and phosphorescence.

4. Electrochemistry (12 Hrs)

Conductance of electrolytic solution, electrolytic conductivity (K), and molar conductivity (Λ) 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 – K_w, K_{sp}, 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 (6Hrs)

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).

CH4C01.2 :Advanced Bio- organic Chemistry

(For students who have opted Biological Sciences and
Family and Community Science 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 α - 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. Enzymes and Nucleic acids **(9 Hrs)**

Enzymes – General nature, classification, cofactors, characteristics of enzyme action, mechanism of enzyme action (elementary idea only)

Energy rich molecules: elementary structure of ATP, ADP and AMP.

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

3. Carbohydrates (11 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 and Hormones (9 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)

5. Lipids (5 Hrs)

Simple lipids and complex lipids- isolation- properties. Analysis of oils and fats- acid value, saponification value, iodine value. Soaps, cleaning action of soaps. Detergents (general idea)

6. Natural Products (8 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.
3. Rastogi,Biochemistry, Tata Mc Graw –Hill Publication ,1996
4. Dr. A.C. Deb, Fundamentals of Biochemistry
5. C. N. R Rao, University General Chemistry, Macmillan.

CH4C02:PRACTICAL-II

(Semesters III and IV)

Credits-2 **(72Hrs)**

CH4C02.1 :Physical Chemistry Practical

(For students who have opted Physical Sciences and Geology as Main)

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 nephthalein, camphor or biphenyl as solvenet 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

CH4C02.2 : Organic Chemistry Practicals

(For students who have opted Biological Sciences and Familiy and Community Science as Main)

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.

N. B : These complementary courses are applicable to relevant Model-II and other courses

II. BSc CHEMISTRY(Vocational)- Model II

The structure of the B.Sc chemistry (Vocational) Model-II Programme is as follows:

Type of course	Number of courses	Credits
A. Common courses	6	24
B. Core (Chemistry)	14	48
Core Vocational (Industrial Chemistry)	10	28
C. Complementary Course Mathematics	4	16
D. Open course	1	4
Total	**35**	**120**

B.Sc. Chemistry (Vocational)- Detailed Scheme

Sl. No.	Study components	No. of Courses	Credit per Course	Total Credits	Total Instructional hours/ week/ for the program	Contact hours/ week SEMESTER					
						1	2	3	4	5	6
A	**LANGUAGES AND COMMON COURSES**										
	Language: English	**4**	4	**16**	20	5	5	5	5		
	Language: **Second Language**	**2**	4	**8**	10	5	5				
	Total			**24**							
B	**Core Courses (Chemistry)**										
	1. Theory and Practical	**2**	3	**6**	2 × 4 = 8	4	4				
	2. Theory	**2**	3	**6**	2 × 3 = 6					3	3
	3. Theory and Practical	**5**	4	**20**	5 × 5 = 25			5	5	10	5
	4. Theory and Practical	**3**	4	**12**	3 × 6 = 18					6	12
	5. Practical	**1**	1	**1**	1 × 2 = 2						2
	6. Choice based course	**1**	3	**3**	1 ×3 = 3						3
	Total			**48**							
	Core Vocational Industrial Chemistry										
	Theory	**2**	3	**6**	8	4	4				
	Theory	**4**	3	**12**	12			6	6		
	Practical	**3**	2	**6**	12	2	2	4	4		
	On the job training/Project	**1**	4	**4**	2					2	
	Total			**28**							
C	**Complementary Course** Mathematics	**4**	4	**16**	20	5	5	5	5		
D	**Open Course**	**1**	4	**4**	4					4	
	TOTAL	**36**		**120**	**150**	**25**	**25**	**25**	**25**	**25**	**25**

Detailed Scheme of Instruction of the Core Courses

Sl No.	Course Code	Title of the course	Exam. Duration Hrs	Credit per Course	Total Contact Hours for the course	Contact Hours/ week
		First Semester				
1.	CH1B01	Theory : Methodology of Chemistry As a discipline of Science	3	**2**	36	2
		Practical : Volumetric Analysis	3	**1**	36	2
		Second Semester				
2.	CH2B01	Theory : Theoretical and Inorganic Chemistry	3	**2**	36	2
		Practical : Volumetric analysis	3	**1**	36	2
		Third Semester				
3.	CH3B01	Theory : Fundamentals of Organic Chemistry	3	**3**	54	3
		Practical : Qualitative organic analysis	3	**1**	36	2
		Fourth Semester				
4.	CH4B01	Theory : Basic Organic Chemistry I	3	**3**	54	3
		Practical : Qualitative organic analysis	3	**1**	36	2
		Fifth Semester				
5.	CH5B01	Theory : Chemistry of d and f block elements	3	**3**	54	3
		Practical : Qualitative Inorganic Analysis	3	**1**	54	3
6.	CH5B02	Theory : Basic Organic Chemistry II	3	**3**	54	3
		Practical : Preparation and basic Lab Skills	3	**1**	36	2
7.	CH5B03	Theory : States of matter	3	**2**	36	2
		Practical : Physical chemistry Practical	3	**2**	54	3
8.	CH5B04	Theory : Quantum mechanics and Spectroscopy	3	**3**	54	3
9.	CH5D01	Open course	3	**4**	72	4

Sl. No	Course Code	Title of the course	Exam. Duration Hrs	Credit per Course	Total Contact hours for the course	Contact Hours/ week
		Sixth Semester				
10.	CH6B01	Theory : Applied Inorganic Chemistry	3	**3**	54	3
		Practical : Qualitative Inorganic Analysis	3	**1**	54	3
11.	CH6B02	Theory : Chemistry of Natural Products and Biomolecules	3	**3**	54	3
		Practical : Preparation and basic Lab. Skills	3	**1**	36	2
12.	CH6B03	Theory : Equilibrium and kinetics	3	**3**	54	3
		Practical : Physical Chemistry Practicals	3	**1**	54	3
13.	CH6B04	Theory : Solution chemistry	3	**3**	54	3
14.	CH6B05	Practical : Gravimetric Analysis	3	**1**	36	2
15.	CH6B06	Theory : Choice Based Course	3	**3**	54	3

Detailed Scheme of Instruction of the Vocational Courses

Sl. No	Course Code	Title of the course	Exam. Duration Hrs	Credit per Course	Total Contact hours for the course	Contact Hours/ week
		First Semester				
1.	IC1B01	Industrial Aspects of Inorganic and Organic Chemistry	3	**3**	72	4
2.	-	Practical-I	No Exam.	-	36	2
		Second Semester				
3.	IC2B01	Industrial Aspects of Physical Chemistry	3	**3**	72	4
4.	IC2B02	Practical – I	3	**2**	36	2
		Third Semester				
3.	IC3B01	Unit Operations in Chemical Industry	3	**3**	54	3
4.	IC3B02	Unit Process in Organic Chemicals Manufacture	3	**3**	54	3
5.	-	Practical-II	No Exam	-	36	2
6.	-	Practical-III	No Exam	-	36	2
		Fourth Semester				
7.	IC4B01	Instrumental Methods of Chemical Analysis-I	3	**3**	54	3
8.	IC4B02	Instrumental Methods of Chemical Analysis-II	3	**3**	54	3
9.	IC4B03	Practical-II	3	2	36	2
10.	IC4B04	Practical-III	3	2	36	2
		Fifth and Sixth Semester				
11.	IC6B05	On the job training/Project		4	36	2(Sem.V)

On the job training/Project: All students have to undergo on the job training in a chemical industry for a minimum period of thirty days and submit a project report. The minimum period of thirty days need not be at a single stretch.The vacation days can be utilised for this purpose. The report of the project should be submitted in duplicate to the department at the end of the sixth semester and should be produced before the examiners appointed by the University.

SYLLABUS FOR VOCATIONAL COURSES (INDUSTRIAL CHEMISTRY)

Semester I

IC1B01: Industrial Aspects of Inorganic and Organic Chemistry

Credits-3 **(72 Hrs)**

Aim: The aim of this course is to provide an exposure to the industrial aspects of different branches of chemistry and some aspects of chemical engineering.

Objectives:

To study**:**

- The various natural sources of energy and industrially important materials derived from them
- The basic concepts of metallurgical operations
- The basic concepts of the energy and material balance

Industrial Aspects of Organic chemistry

Module 1

Nomenclature-generic name-trade name-raw materials for organic compounds: Petroleum-
Natural gas-fraction of crude oil-cracking-reforming-hydro forming-isomerisation (12Hrs)

Module 2

Coal: types-structure –properties-distillation of coal-chemicals derived from them (12Hrs)

Module 3

Renewable natural resources: Cellulose-starch-properties- modification -important industrial
chemicals derived from them-alcohols and alcohol based chemicals –oxalic acid –furfural (12Hrs)

Industrial Aspects of Inorganic Chemistry

Module 4

Basic metallurgical operations: Pulverisation-calcinations –roasting-refining-
Physicochemical principle of extraction of iron-copper-lead-silver-sodium-aluminium-magnesium –zinc and chromium (9Hrs)

Module 5

Inorganic materials of industrial importance: Their availability-forms-structure and modification.

Alumina-silica –silicates-clays-mica-carbon-zeolites- (9Hrs)

Module 6

Basic Engineering Aspects

Unit operations of chemical engineering –foundations-material balance-molecular units-mole - volume-mechanical laws-Energy balances-Dimensional analysis-Dimensionless groups-

Graphical integration-Mean values (9Hrs)

Module 7

Transportation of Fluids

Pipe- pipe standards-strength of pipe-Tubing- Fittings-pipe joints- Flanges-Valves-Cocks- Globe

valves-Globe valves-Gate valves-Check valves-Pumps-Reciprocating pumps-piston pumps-

plunger pumps-Centrifugal pumps-Self priming pumps (9Hrs)

References:

1. E. J. Hoffmann ,Coal conversion –the Energon Co.Lavamic, Wyoming USA
2. Steiner, Introduction to petroleum chemicals, Pergamon press
3. L. F. Hath, S Matarm, From Agro carbons to petrochemicals, Gulf publishing Co. Houston
4. A. G. Hall,Cotton, Cellulose, its Chemistry and Technology Cellulose
5. E. Heuser, Chemistry of cellulose
6. R. L. Whistler ,Methods in CarbohydrateChemistry Vol.3
7. R.W. Kerr ,Chemistry and industry of starch
8. O. B. Wurzburg ,Modified starches- properties and uses
9. Herbash, Principles of extractive metallurgy Vol.1 and 2
10. A. Volskky, E. Sergievskaya ,Theory of metallurgical process
11. A. R. Baiky , Clays ,H .Ries ,Text book of Metallurgy, John Wiley and sons
12. Fillipoy, Theory of metallurgical process, MIR Publications
13. Pchlke, Unit processes of extractive metallurgy ,Elsevier publication
14. Walter L Badger,Introduction to chemical engineering
15. McCabe,Text book of unit operations in chemical engineering
16. Kale, Unit operations I& II.

Semester II

IC2B01: Industrial Aspects of Physical Chemistry

Credits-3 **(72Hrs)**

Aim: This course aims at the industrial applications of some aspects of physical chemistry **.**

Objectives:

To understand:

- Surface phenomena of liquid
- Different methods of separation

Module 1

Surface and interfacial phenomena

Preparation and properties of colloids (9Hrs)

Module 2

Adsorption isotherm, sols-gels-emulsions-micro emulsions-micelles-aerosols-effect of surfactants-hydrotropes

(12Hrs)

Module 3

Catalysis

Introduction-types-homogeneous and heterogeneous –basic principles –mechanism-factors affecting the
performance. Introduction to phase transfer catalysis.

(9Hrs)

Module 4

Enzyme Catalysed reactions –rate –model –industrially important reactions (6Hrs)

Module 5

Size separation

Standard screens-Screen analysis-Wire screen-Types of screening equipment—Grizzlies-Trommels-Shaking screens- Vibrating screens-Air separation methods-Cyclone separators-Bag filters-Corttell precipitator-Scrubbers

(9Hrs)

Module 6

Filters

Air filters-size separation by settling-simple classifiers-Classifiers using hydraulic water-Mechanical classifiers-General laws of settling-free settling-viscous resistance-sedimentation-The Kynch theory

(9Hrs)

Module 7

Crushing and grinding

Introduction-Jaw crushers-intermediate crushers-rolls-selection of crushing rolls-edge runners-fine grinders-roller mills-centrifugal grinders-boll mills-ultra fine grinders-closed circuit grinding

(9Hrs)

Module 8

Health –diet and environment

Nutrient requirements-major and minor nutrients-carbohydrate-fat-proteins-vitamins-minerals and trace elements - cholesterol-nutrient content of food-anorexia and obesity

(9Hrs)

References:

1. Shepherd, Aerosol science and technology
2. B. Delmon, G. Janner, Catalysis Heterogeneous and homogeneous.
3. J .Anderson, Catalysis science and technology
4. J. Fendler, E. Fendler Catalysis in micellar and macro molecular systems
5. E. K. Rideal, H. S. Taylor, Catalysis in theory and practice
6. C. Starles, Phase transfer catalysis, Principles and techniques
7. J. J. Bikermann, Surface chemistry, Academic press
8. A.W. Adamson,Physical chemistry of surfaces
9. Delmon, Catalysis: Heterogeneous and homogeneous, Elseiver science publisher
10. Walter L Badger, Introduction to chemical engineering
11. Mc Cabe, Text book of unit operations in chemical engineering
12. Kale Unit operations I& II
13. Robert S. Boikess, Elements of chemistry.

VOCATIONAL COURSE PRACTICALS

Semester I & II

IC2B02 Practical-I

Credits-2 **(72 hrs)**

1. Simple Laboratory techniques: Crystallisation-fractional crystallization-distillation-
2. Fractional distillation, boiling point diagram (12expts)
3. Extraction process: Phase diagram-Partition coefficient (4expts)
4. Preparation of standard solution: Primary and secondary solution-determination of H_2SO_4, H_3PO_4 in a mixture

5. Calibration of thermometers (2 expts)
6. Acquaintance with safety measures in laboratory, hazard of chemicals (4expts)
7. Ore analysis-dolomite, lime stone, calcite, analysis of alloys such as cuprous nickel

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 Hallof India Pvt. Ltd

SEMESTER-III

IC3B01:Unit Operations in Chemical Industry

Credits-3 (54 Hrs)

Aim

The course aims at giving an exposure to the various unit operations and processes in industry

Objectives

To study unit operations and processes such as

- Distillation
- Absorption
- Evaporation
- Filtration
- Crystallisation
- Solvent Extraction

Module 1

Distillation: Introduction: Batch and continuous distillation, separation of azeotropes, Plate columns and packed columns **(9Hrs)**

Module 2

Absorption: Introduction: Equipment- packed columns, spray columns, bubble columns, packed bubble columns, mechanically agitated contractors **(9Hrs)**

Module 3

Evaporation: Introduction: Equipment- short tube (standard) evaporator, forced circulation evaporators. Falling film evaporators. Climbing film(upward flow) evaporators, wiped(agitated)film evaporators. **(12Hrs)**

Module 4

Filtration: Introduction: Filter media and filter aids, Equipment- plate and frame filter press, nutch filter, rotary drum filter, sparkler filter, candle filter, bag filter, centrifuge
Drying: Introduction: free moisture, bound moisture, drying curve, Equipment- tray dryer, rotary dryer, flash dryer, fluid bed dryer, drum dryer, spray dryer. **(9Hrs)**

Module 5

Crystallization: Introduction: solubility, super saturation, nucleation, crystal growth, Equipment- tank crystallizer, agitated crystallizer, evaporator crystallizer, draft tube crystalliser.
Extraction: Introduction: selection of solvents; Equipment-spray columns, mixer settler.
Mixing: Introduction: mixing of liquid-liquid, solid-liquid, solid-solid systems **(15Hrs)**

References:

1. W.L.Badger and J.T.Bachero,Introduction to Chemical Engineering, Tata McGraw Hill, U.S.A
2. W.L.McCabe and J.C.Smith,Unit operations in Chemical Engineering, Tata McGraw Hill N.Y
3. J.H.Perry, Chemical Engineering Hand Book, McGraw Hill, N.Y
4. D.D.Kale, Unit Operations – 1 and 2 , Pune Vidyarthi Griha Prakashan, Pune

IC3B02:Unit Processes in Organic Chemicals Manufacture

Credits-3 (54 Hrs)

Aim

The aim of the course is to provide an understanding of some important unit processes in organic chemicals manufacture

Objectives

To study unit processes such as:

- Nitration
- Halogenation
- Sulphonation
- Oxidation
- Hydrogenation
- Alkylation
- Esterification
- Ammination
- Hydrolysis

Module 1

Nitration: Introduction: Nitrating agents, kinetics and mechanism of nitration processes such as nitration of (a) Paraffinic hydrocarbons(b)Benzene to nitro benzene and meta di nitro benzene (c) Chlorobenzene to o- and p- nitrochlorobenzene (d) Acetanilide to p-nitro acetanilide (e) Toluene (f) Continuous vs batch nitration

Halogenation: Introduction: Kinetics of halogenation reactions, reagents for halogenation, Halogenation of aromatics- side chain and nuclear halogenations. Chloral, mono chloroacetic acid and chloromethanes, dichlorofluoromethane.

Sulphonation: Introduction: Sulphonating agents, chemical and physical factors in sulphonation. Kinetics and mechanism of sulphonation reaction. Commercial sulphonation of benzene, naphthalene, alkyl benzene. Batch vs continuous sulphonation.

(15 Hrs)

Module 2

Oxidation: Introduction – types of oxidation reactions. Oxidizing agents .Kinetics and mechanism of oxidation of Organic compounds, Liquid phase oxidation, Vapour phase oxidation. Commercial manufacture of benzoic acid, acrolein, acetaldehyde, acetic acid

Hydrogenation: Introduction- Kinetics and thermodynamics of hydrogenation reactions. Catalysts for hydrogenation reactions, Hydrogenation of vegetable oil, Manufacture of methanol from carbon monoxide and hydrogen, hydrogenation of acids and esters to alcohols, catalytic reforming. **(12Hrs)**

Module 3

Alkylation: Introduction: Types of Alkylation, Alkylating agents. Thermodynamics and mechanism of alkylation reactions, manufacture of alkyl benzene (for detergent manufacture), ethyl benzene, phenyl ethyl alcohol, N-alkyl anilines (mono and di-methyl and ethyl anilines)

(9Hrs)

Module 4

Esterification: Introduction: Hydrodynamics and kinetics of esterification, esterification by organic acids, by addition of unsaturated compounds, esterification of carboxylic acid derivatives, commercial manufacture of ethyl acetate, dioctyl phthalate, vinyl acetate, cellulose acetate **(9Hrs)**

.

Module 5

Amination : (a) By reduction: Introduction, Methods of reduction- metal and acid, catalytic, sulphide, electrolytic, metal and alkali sulphites, metal hydrides, sodium metal, concentrated caustic oxidation, reduction, commercial manufacture of aniline, meta nitro aniline , para amino phenol,(b)By ammonolysis: Introduction, aminating agents, factors affecting

Hydrolysis: Introduction, hydrolysing agents, kinetics, thermodynamics and mechanism of hydrolysis

(9Hrs)

Reference :

1. P.H.Groggins, Unit Process in Organic Synthesis, McGraw Hill, N.Y

SEMESTER IV

IC4B01:Instrumental Methods of Chemical Analysis-I

Credits-3 (54 Hrs)

Aim

The aim of the course is to give an understanding of the principle and instrumentation of different instrumental methods of chemical analysis

Objectives

To study the principle and instrumentation of

- UV-Visible and IR spectrophotometry
- Spectrofluorimetry
- Atomic Absorption Spectrophotometry
- Column, Paper, Thin- layer, and Gas Chromatography
- Different Electroanalytical techniques

Module 1

Principles of Instrumentation

Characteristics of measurement system: Introduction- Functional units – Classification (automatic/manual type, self operated/power operated, analogue/digital)-Performance characteristics (Static/dynamic characteristics) –Zero order instrument and first order instrument

Signal and noise- types of noises- chemical noise- instrumental noise -thermal-shot – flicker and environmental noise-S/N ratio and its significance- techniques for S/N enhancement – hardware and software methods.

Transducers – characteristics of transducers, sensitivity and transfer function- some typical examples. Photo emissive- photo conductive and photovoltaic systems- photo multiplier and photo diode. Thermocouples and thermistors

(12 Hrs)

Module 2

Typical Analytical Instruments -1

Spectrophotometry **:** Interaction of electromagnetic radiation with matter- classification of methods- Beer Lambert law- Deviation from Beer Lambert law.

UV- Visible spectrometry**:** Origin of absorption spectra, components of typical instrument – Source- Tungsten filament lamp, Hydrogen and Deuterium discharge lamps. Wavelength selectors- filters, prisms and grating -Sample cell - Detectors
Single and double beam spectrophotometers

I.R spectrophotometry**:** classification of the types-Sources – Nernst glower, globar, Nichrome wire-Wavelength selectors-Sample cell – characteristics- sample preparation-solvent selection-Detectors – thermal, pneumatic and pyroelectric-NDIR instruments
(12Hrs)

Module 3

Typical Analytical Instruments -2
Molecular fluorescence: spectrofluorimetry – factors affecting fluorescence –typical instrumentation
Atomic spectroscopy: (1) AAS – Principle- typical instrumentation –Flames, Nebulisers-burner system- Non flame techniques-Resonant line source –HCL and EDL- source modulation- sample preparation- Interference in measurements
(2) AES: Excitation techniques- arc, spark and ICP
Sampling:Basis of sampling- sampling procedure- Importance of representative sampling- sample preparations of solid, liquid and gaseous analytes- Hazards in sampling. (10Hrs)

Module 4

Chromatography: General aspects of chromatography- Classification: Adsorption, Partition, Ion exchange ,Gel permeation and molecular sieving
Column chromatography: Construction and operation of column- choice of adsorbents and eluents, methods of detection. Derivatisation- HPLC equipment-
Thin layer and paper chromatography:Different techniques- typical examples- Ion exchange chromatography and Ion chromatography.
Gas chromatography: principle- types of carrier gases- stationary phases- different types of columns- capillary columns- temperature programming- Typical detectors- TCD, FID and ECD
(10 Hrs)

Module 5

Electro Analytical Instrumentation
(1)Potentiometric methods : Principle- technique and detection limit
(2)Non Potentiometric methods:(a)Conductometry (b)Polarography (c)Amperometry (d)Anodic stripping analysis (e) coulometry (primary and secondary)
Introduction to various ion selective electrodes
(10 Hrs)

References:

1. Jeffry,Basset, Mendhem,R.C Denwy ,Vogel's Text Book of Quantitative Inorganic Analysis, 4th &5th Edition
2. Skoog and Leary, Principles of Instrumental analysis ,4th Edition, Sanders College Publishing
3. D.Patranabis, Principles of Industrial Instrumentation, 2nd Edition , Tata McGraw-Hill Company Delhi

IC4B02:Instrumental Methods of Chemical Analysis-II

Credits-3 (54 Hrs)

Aim

The aim of the course is to give an exposure to process instrumentation

Objectives

To study :

- The principle, construction and working of devices for the measurement of temperature,pressure,liquid level, density,and viscosity
- The working of microprocessor based instruments
- The use of computers in chemistry

Module 1

Process Instrumentation

Difference between Process Instrumentation and Laboratory Instrumentation- concept of measurement and accuracy

Principle, construction and working of following measurements

(1)Temperature**:** Glass thermometers- bimetallic thermometers- pressure spring thermometers- vapour filled thermometers- resistance thermometers- radiation pyrometers

(2)Pressure**:** Manometers- barometers -Bourdon pressure gauge.- bellow and diaphragm type gauges- McCleod gauge - Pirani gauge, Electrical pressure transducer (Linear Variable Differential Transformer type)

(12Hrs)

Module 2

Principle, construction and working of following measurements

(1)Liquid level measurement**:** Direct and Indirect measurements

Float type liquid level gauge- ultrasonic level gauge-bubbler system
(2)Density measurements (3) Viscosity measurements

(12Hrs)

Module 3

Microprocessor Based Instruments
Telemetry: Pneumatic- electrical (voltage telemetering)- frequency telemetering, multiplexing- Modulation of digital data- transmission channels- fibre optics

(15Hrs)

Module 4

Use of Computers in Chemistry
Introductory concepts of Hardware and Software- ALU- CPU- Algorithm- Flow chart etc
Fundamentals of C programming-

Data types- int, float ,char ..

Functions in C (main (),Input/Output functions, getchar(),putchar(),getch()….)
Standard library functions in C

Looping
Conditional operators like – if else, do while, switch break

File handling concept
Simple programs (Use of arrays and pointers not expected)
To calculate rate constant of first order reactions (Kinetics)
To calculate interplanar distance in crystals (crystallography)
To classify atoms into Fermions and bosons (Atomic structure)

(15Hrs)

References:
1. Byron Gottfried, Programming with C , 2nd Edition ,Tata McGraw Hill
2. P. Balaguruswami, Programming with ANSI C , Tata McGraw Hill
3. K. V. Raman, Computers in Chemistry
4. D. P. Eckman, Industrial Instrumentation ,John Wiley &Sons
5. D. Patranabis, Principles of Industrial Instrumentation, 2nd Edition , Tata McGraw-Hill Company Delhi

Further Reading
1. Willard, Merrit, Dean &Settle- Instrumental Methods of Analysis, C.B.S Publishers, 4thEdition
2. J.G.Dick, Analytical Chemistry, McGraw Hill

IC4B03:Practical-II

Semester (III&IV)

Credits-2 (72 Hrs)

1 .Unit Process: (16 experiments)
One or two examples for each of the following unit process:
Nitration,sulphonation,Friedelcraft
reaction,esterification,hydrolysis,oxidation,halogenations,
chlorosulphonation,reduction,polymerisation ,reactionsof diazonium salts
2 .Determination of acid value, saponification value, and iodine value of oil.
3 Depression and elevation in boiling /melting point of solids and liquids
4 Chromatography-Column, paper, thin layer
5 Ore analysis-dolomite, lime stone, calcite, analysis of alloys such as cuprous nickel

IC4B04:Practical-III

Semester (III&IV)

Credits-2 (72 Hrs)

1.Instrumental methods of analysis: use of colorimeter, pH meter, potentiometer, conductometer, refractometer, polarimeter
2.Material testing: testing of alloys, identification of plastics/ rubber, estimation of yield point,
Young's modulus, flaredness,optical ,thermal, mechanical, and electrical properties
3. Process instrumentation: transducers for measuring, flow control
4. Determination of flash point and ignition point of liquids
5. Water analysis: solid content, hardness, COD, and other tests as per industrial specifications
6. Flow measuring devices: floats
7.Monographs of representative raw materials such as sulphuric acid ,toluene, sodium carbonate, sodium hydroxide, carbon tetrachloride, benzoic acid (5- 6) compounds
8. Limit tests for heavy metals Pb, As, Hg, Fe, and ash content

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 Hallof India Pvt. Ltd
5. D.D Despande,Physical Chemistry of macromolecules, Vishal Publication, New Delhi

III.BSc PETROCHEMICALS

The structure of the B.Sc Petrochemicals Programme is as follows:

Type of course	Number of courses	Credits
A. Common courses(English)	2	8
B. Core courses (Chemistry)	14	48
Petrochemicals	9	28
C. Complementary courses		
i. Mathematics	4	16
ii. Computer Science	4	16
D. Open course	1	4
Total	**34**	**120**

B.Sc Petrochemicals- Detailed Scheme

Sl. No.	Study components	No. of Courses	Credit per Course	Total Credits	Total Instructional hours/ week/ for the program	Contact hours/ week SEMESTER					
						1	2	3	4	5	6
A	**LANGUAGES AND COMMON COURSES**										
	Language: English	**2**	4	**8**	10	5	5				
	Total			**8**							
B	**Core Courses (Chemistry)**										
	1. Theory and Practical	**2**	3	**6**	2 × 4 = 8	4	4				
	2. Theory	**2**	3	**6**	2 × 3 = 6					3	3
	3. Theory and Practical	**5**	4	**20**	5 × 5 = 25			5	5	10	5
	4. Theory and Practical	**3**	4	**12**	3 × 6 = 18					6	12
	5. Practical	**1**	1	**1**	1 × 2 = 2						2
	6. Choice Based Course	**1**	3	**3**	3						3
	Total			**48**							
	Petrochemicals										
	Theory	**4**	3	**12**	14	4	4	3	3		
	Theory	**2**	4	**8**	8			4	4		
	Practical	**2**	2	**4**	8	2	2	2	2		
	On the job training/Project	**1**	4	**4**						2	
	Total			**28**							
C	**Complementary Courses**										
	i. Mathematics	**4**	4	**16**	21	5	5	5	6		
	ii. Computer Science	**4**	4	**16**	21	5	5	6	5		
	Total			**32**							
D	**Open Course**	**1**	4	**4**	4					4	
	TOTAL	**39**		**120**	**150**	**25**	**25**	**25**	**25**	**25**	**25**

Detailed Scheme of Instruction of the Core Courses

Sl No.	Course Code	Title of the course	Exam. Duration Hrs	Credit per Course	Total Contact Hours for the course	Contact Hours/ week
		First Semester				
1.	CH1B01	Theory : Methodology of Chemistry As a discipline of Science	3	**2**	36	2
		Practical : Volumetric Analysis	3	**1**	36	2
		Second Semester				
2.	CH2B01	Theory : Theoretical and Inorganic Chemistry	3	**2**	36	2
		Practical : Volumetric analysis	3	**1**	36	2
		Third Semester				
3.	CH3B01	Theory : Fundamentals of Organic Chemistry	3	**3**	54	3
		Practical : Qualitative organic analysis	3	**1**	36	2
		Fourth Semester				
4.	CH4B01	Theory : Basic Organic Chemistry I	3	**3**	54	3
		Practical : Qualitative organic analysis	3	**1**	36	2
		Fifth Semester				
5.	CH5B01	Theory : Chemistry of d and f block elements	3	**3**	54	3
		Practical : Qualitative Inorganic Analysis	3	**1**	54	3
6.	CH5B02	Theory : Basic Organic Chemistry II	3	**3**	54	3
		Practical : Preparation and basic Lab Skills	3	**1**	36	2
7.	CH5B03	Theory : States of matter	3	**2**	36	2
		Practical : Physical chemistry Practical	3	**2**	54	3
8.	CH5B04	Theory : Quantum mechanics and Spectroscopy	3	**3**	54	3
9.	CH5D01	Open course	3	**4**	72	4

Sl. No	Course Code	Title of the course	Exam. Duration Hrs	Credit per Course	Total Contact hours for the course	Contact Hours/ week
		Sixth Semester				
11.	CH6B01	Theory : Applied Inorganic Chemistry	3	**3**	54	3
		Practical : Qualitative Inorganic Analysis	3	**1**	54	3
12.	CH6B02	Theory : Chemistry of Natural Products and Biomolecules	3	**3**	54	3
		Practical : Preparation and basic Lab Skills	3	**1**	36	2
13.	CH6B03	Theory : Equilibrium and kinetics	3	**3**	54	3
		Practical : Physical Chemistry Practicals	3	**1**	54	3
14.	CH6B04	Theory : Solution chemistry	3	**3**	54	3
15.	CH6B05	Practical : Gravimetric Analysis	3	**1**	36	2
16.	CH6B06	Theory :Choice Based Course	3	**3**	54	3

Detailed Scheme of Instruction of the Petrochemicals Courses

Sl. No	Course Code	Title of the course	Exam. Duration Hrs	Credit per Course	Total Contact hours for the course	Contact Hours/ week
		First Semester				
1.	PC1B01	Origin and Recovery of Crude Oil	3	**3**	72	4
2.	-	Practical-I	No Exam.	**-**	36	2
		Second Semester				
3.	PC2B01	Test Methods and Petroleum Process	3	**3**	72	4
4.	PC2B02	Practical – I	3	**2**	36	2
		Third Semester				
5.	PC3B01	Production and application of compounds from Petroleum	3	**4**	72	4
6.	PC3B02	Manufacture of Petrochemicals-I	3	**3**	54	3
7.	-	Practical-II	No Exam	**-**	36	2
		Fourth Semester				
8.	PC4B01	Manufacture of Petrochemicals-II	3	**4**	72	4
9.	PC4B02	Petroleum Industries in India	3	**3**	54	3
10.	PC4B03	Practical-II	3	**2**	36	2
		Fifth and Sixth Semester				
11.	PC6B01	On the job training/Project		**4**	36	2(Sem.V)

On the job training/Project: All students have to undergo on the job training in a chemical industry preferably in a petrochemical industry for a minimum period of thirty days and submit a project report.The minimum period of thirty days need not be at a single stretch.The vacation days can be utilised for this purpose. The report of the project should be submitted in duplicate to the department at the end of the sixth semester and should be produced before the examiners appointed by the University.

SYLLABUS FOR PETROCHEMICALS COURSES

Semester- 1

PC1B01: Origin and Recovery of Crude Oil

Credits- 3 **(72 hrs)**

Aim: The aim of the course is to give an insight into the origin and exploration of petroleum.

Objectives :-

To study:

- Theories regarding the origin of petroleum
- Methods of exploration and composition of crude oil
- Refining of petroleum
- Characteristics and uses of fuels and bitumen from crude oil

Module-1.

Crude Oil : Historical review, chemistry of petroleum hydrocarbons---study of ASTM and Institute of petroleum(IP) ,composition of crude oil.

Oil reservoirs ----Anticline trap—Fault___stratigraphic trap ----Constitution of crude oil, Oil Exploration methods- geophysical exploration---magnetic method, gravimetric method , electrical method---radio acitive method. Core sampling, Drilling operations. Petroleum production- natural method—dissolved gas drive—water drive—gravity drive-secondary methods. Other source of petroleum. Petroleum from coal, natural gas and its constitution. .

Elemental analysis of crude oil, hydrocarbon compounds, non -hydrocarbon compounds in crude oil, metallic constituents (18 hrs)

Module-2

Transportation and storage of crude oil: Crude transportation and product transferring. Type of storage tanks - Cone roof and floating roof, nitrogen blanketing, truck and tankers,LPG bullets. Pipe line transfer, Rail way. Crude Reservoirs .Indian resources of petroleum (18 hrs)

Module-3

Function of refineries: simple refinery ,complex refinery, integrated refinery sweetening process , stripping, distillation procedures, heat exchangers,separation of products from crude oil, reduced crude oil ,vacuum distillation Composition of different distillates

(18 hrs)

Module-4

Type of hydrocarbon fuels and its characteristics. ASTM methods of product testing. Specifications for various fuels. Detailed study of

Naphtha, LPG ,Gasoline, Kerosene, Diesel, Fuel oils , Bitumen ,Rubberized bitumen and bitumen emulsion (18 hrs)

References

1. Speight G James, Marcel Dekker,The Chemistry and Technology of Petroleum , Inc 1991
2. Tripathi G.N ,Indian Petroleum Directory , Indian Petroleum Publishers
3. Asphalt hand book, Manual series , Asphalt institute 1989
4. W.L.Nelson ,Petroleum refining engineering,Mc.Graw Hill
5. R.A.Meyers ,Handbook of petroleum refining process
6. B.K Sharma ,Industrial Chemistry,Goyal Publication
7. Sukumar Maiti ,Introduction to Petrochemicals
8. D.S.J Jones ,Elements of Petroleum Processing
9. Dr.KochuBaby Manjooran ,Modern Petroleum Chemistry –An Overview
10. R.A.Meyers ,Handbook of petroleum refining process
11. B.K Sharma ,Industrial Chemistry,Goyal Publication
12. Sukumar Maiti ,Introduction to Petrochemicals
13. D.S.J Jones ,Elements of Petroleum Processing
14. Dr.Kochu Baby Manjooran ,Modern Petroleum Chemistry –An Overview
15. Rakesh Rathi ,Petroleum refining Process ,S.B.S Publishers

Semester- 2

PC2B01: Test Methods and Petroleum Processes

Credits- 3 (72 hrs)

Aim: the aim of the course is to provide an account of some important quality parameters of crude oil fractions and also some important chemical modifications of petroleum fractions

Objectives :-

. To study:

- Important quality parameters of crude oil fractions
- Cracking and reforming of petroleum
- Characteristics of aviation fuel
- Physical properties of bitumen

Module-1

Introduction – Significance –effect of blending and illustration of the following:Pour point, Cloud point ,Cetane number ,Pour point Depressants
Octane number and octane boosters ,Distillation, viscosity and its reducers
Flash point ,copper corrosion, calorific value, Reid vapor pressure, Aniline point.
Detailed study of Abel and PMC method.
Doctor solution and its uses.API gravity, existent gum and potential gum (20 hrs)

Module-2

Evaluation of Bitumen: Elastic recovery, ductility ,softening point, penetration test. (8 hrs)

Module-3

Aviation fuels: Different types of Aviation fuels .and analysis; silver corrosion , WSIM, JEFTOT ,anti oxidants, static electricity reducers, final boiling point.,total sulphur, mercaptans,lubricity, smoke point freezing point, calorific value (12 hrs)

Module-4

Manufacture of gasoline by cracking, antiknock performance, research octane numbermotor octane number, road octane number (10 hrs)

Module-5

Cracking operations :Different types of cracking.Thermal cracking of petroleum products,thermal cracking of vacuum gas oil. Types of thermal cracking:mixed phase cracking , vapor phase cracking, selective cracking, visbreaking. Catalytic cracking-Commercial processes. Feed stocks of catalytic cracking, process variables of cracking.Catalysts for cracking. Hydro cracking,hyro processing. Comparison of hydro cracking and hydro treating. Hydro forming , plat forming ,uniforming, ultra forming, auto forming. Catalysts for hydro cracking. Reforming: Thermal reforming, catalytic reforming , fixed bed reforming, hyperforming. Isomerism . Hysomer process. Penex process-Alkylation

(22 hrs)

References

1. ASTM Methods, Indian standards(Methods of test for petroleum and its Products,)
2. Speight G James, Marcel Dekker ,The chemistry and technology of Petroleum ,Inc 1991
3. Tripathi G.N,Indian Petroleum Directory , Indian Petroleum Publishers
4. Asphalt hand book, Manual series , Asphalt institute 1989,
5. W.l. Nelson, Petroleum engineering .
6. B.K. Sharma ,Industrial Chemistry
7. Navid Nader Pow ,Petrochemical Production Process,S.B.S Publishers
8. Dr.KochuBaby Manjooran ,Modern Petroleum Chemistry

PC2B02:Practical -I

(Semester I and II)

Credits- 2 **(72 hrs)**

1.Determination of softening point
2.Determination of penetration of bitumen
3.Determination of Ductility of Bitumen
4.Determination of Aniline point of diesel fuel
5.Determination of Diesel Index
6.Distillation of Petrol
7.Distillation of Kerosene
8.Distillation of Diesel
9.Determination of water content in diesel –Dean Stark Method
10.Determination of water content in furnace oil- Dean Stark Method

Reference:

ASTM Methods, Indian standards(Methods of test for petroleum and its Products,)

Semester 3

PC3B01:Production and Application of Compounds from Petroleum

Credits-4 **(72 hrs)**

Aim: The aim of this course is to give an account of the methods of preparation and applications of some important petrochemicals

Objectives:

To study**:**

- Manufacture of sulphur, hydrogen, petroleum coke and nitrogen compounds
- Ammoxidation, hdroformylation and hydration reactions
- Manufacturing processes of ethylene,acetylene ,propylene and higher olefin
- Manufacture and processing of plastics

Module-1

Manufacture of sulphur from under ground --Freush process--From hydrogen sulphide Partial oxidation method and Engineering problems-- Hydrogen --Properties--hydrogen as a fuel--- manufacture of hydrogen from naphtha cracking,--From hydrocarbons by partial oxidation.-- Petroleum coke--Uses-manufacture by Hot oven method---thermal cracking--- fluidized coking--- Delayed coking--- and Nitrogen compounds in petroleum. Nitroparaffins--Nitro ethane---I nitro propane---2nitropropane.--manufacture of nitrogen compounds from petroleum (24 Hrs)

Module-2

.Study of following reactions and applications :

Ammoxidation-- Applications of ammoxidation --.preparation of acrylonitrile-- Terephthalic acid by ammoxidation -Lummns process—Hydroformylation ---oxo process--Modifications of oxo process --Uses of oxo process—Hydrogenation-- Aldex process--Aldol condensation---oxidation-- Hydration – categories of hydration-- Clathrates-Applications of hydration---preparation of ethyl alcohol--Isopropyl alcohol—acrylonitrile-- Dow chemical process--Acetaldehyde--Oxidation-type of oxides-- Classification of oxides--application of oxidation in petroleum compounds.---union carbide process --weaker process

(24 Hrs)

Module-3

Steam naphtha cracking of Hydrocarbons:

Manufacture of Ethylene--- Acetylene—Propylene-- Higher olefins from naphtha-- Process-- economics .(present day procedures and its economics) (12 hrs)

Module-4

Plastics: Properties—uses-thermoplastics- thermosetting plastics - moulding constituents of a plastic-moulding of plastics into articles- compression moulding-injection moulding-transfer moulding—extrusion moulding—engineering plastics. (12 Hrs)

References:-

1. W.L. Faith, Donald B Keyes, Ronald L Clark, Industrial Chemicals.
2. Speight G James, Marcel Dekker Inc 1991,The chemistry and technology of Petroleum
3. Tripathi G.N, Indian Petroleum Directory
4. B.K Sharma , Industrial Chemistry and Chemical Engineering ,Spits Petrochemicals-Wiley
5. A.L Waddan , Chemicals from petroleum
6. l.F Hatels and S. Mater Gulf, From Hydrocarbons to Petrochemicals
7. Jain an d Jain, Engineering chemistry
8. Navid Nadar Pow **,** Ptrochemical production process
9. H Steiner ,Introduction to petrochemicals
10. Rakesh Rati, Petrochemical refining process

PC3B02: Manufacture of Petrochemicals-I

Credits-3 **(54 hrs)**

Aim: To make the students aware ofthe methods of manufacture and uses of some of the important petrochemicals.

Objectives: To study the manufacturing methods and uses of:

- Methanol, carbon black, chlorinated methane,and hydrogen cyanide from methane and natural gas
- Ethyl chloride, ethanol, ethanolamines, ethylene oxide, acrylonitrile,vinyl acetate, styrene,ethylene glycol,acetaldehyde and acetic acid from ethylene.

Module-1

Manufacture from Natural gas and Methane

Methanol-properties and uses- manufacturing methods –catalytic hydration method.-side reactions, Carbon black-uses and properties-Channel black-Furnace black(gas and oil)-thermal black-Acetylene black-manufacture, Hydrogen cyanide-uses and properties-manufacture by Andrew sons process-By Degusser process, Shawnigan process Chlorinated methane-uses ,Manufacture of methyl chloride-methyl dichloride-Chloroform-carbon tetra chloride, carbon disulphide –uses- manufacture by Thacker process –Acetylene-uses-manufacture by sachse process-wulf process (30 Hrs)

Module-2
Manufacture from Ethylene

Ethyl chloride-uses-manufacture by hydrochlorination ,Ethanol-Different process of manufacture-uses-manufacture by catalytic hydration-, Ethylene oxide –uses and properties- Manufacture by oxidation ,Ethanolamines- monoethanol amine - diethanol amine-triethanol amines--uses- manufacture- Engineering problems
Ethylene glycol-uses-Different methods of preparation-Manufacture through chlorohydrin-Manufacture by oxidation, Acetaldehyde-Process of manufacture- recent advances-uses-Production by Thekar process., Acetic acid-Uses and manufacture by oxidation, styrene-uses-manufacture-by benzene-Purification--
Vinyl acetate-uses and manufacture by acetic acid and oxygen-- Ethanol amines-- Vinyl chloride-uses-manufacture by thermal pyrolysis- Acrylonitrile- uses and Manufacture by ethylene oxide and hydrogen cyanide (24 Hrs)

References:-

1. W.L. Faith, Donald B Keyes, Ronald L Clark, Industrial Chemicals.
2. Speight G James, Marcel Dekker Inc 1991,The chemistry and technology of Petroleum
3. Tripathi G.N, Indian Petroleum Directory
4. B.K Sharma , Industrial Chemistry and Chemical Engineering ,Spits Petrochemicals-Wiley
5. ASTM Methods, Indian standards

Semester 4

PC4B01: Manufacture of Petrochemicals -II

Credits-4 **(72 hrs)**

Aim: To make the students aware of the methods of manufacture and uses of some industrially important chemicals from petroleum.
Objectives: To study the methods of manufacture and uses of of the following petrochemicals

- Isopropanol, cumene,glycerine and acrylonitrile from propylene
- Vinyl chloride,acetaldehyde,chloroprene,and acrylonitrile from acetylene
- Butadiene and benzene from C- 4 hydrocarbons
- Benzene, toluene, xylenes,naphthalene, linear alkyl benzene,detergents and explosives

Module-1
Manufacture from propylene
Isopropanol---uses-properties-manufacture by hydration method-- Cumene-uses-manufacturing methods. Propylene-alkylation method,---Glycerin uses-natural glycerin

synthetic glycerin--manufacture by allyl chloride-- manufacture via acrolein---
Acrylonitrile -- uses-- manufacture by amoxidation method (24 Hrs)

Module-2

Manufacture from Acetylene

Vinyl chloride-uses-manufacture-engineering problems-economics-- Acetaldehyde-uses-properties-hydration of acetylene-hydration solutions-process of manufacture---
Chloroprene –uses- Neoprene- manufacture,---Acrylonitrile –uses-properties-manufacture by hydrogen cyanide process---disadvantages

(24 Hrs)

Module-3

Manufacture from C-4 hydrocarbons

Butadiene-uses-occurrence-methods of preparation-manufacture by Houdry Process---
Benzene-uses –manufacture by hydrodealkylation--- C-4 oligomers

4 .BTX aromatics –Principal sources-Benzene-Toluene-Xylenes-uses -manufacture
Naphthalene-uses-sources-manufacture by hydrodealkylation, Linear alkyl benzene-General reactions-side reactions-manufacture

Detergents- classification of detergents-uses of detergents-surfactants-additives-manufacture-cleaning action of detergents. Difference between soap and detergents.

(24 Hrs)

References:-

7. W.L. Faith, Donald B Keyes, Ronald L Clark, Industrial Chemicals.
8. Speight G James, Marcel Dekker Inc 1991,The chemistry and technology of Petroleum
9. Tripathi G.N, Indian Petroleum Directory
10. B.K Sharma , Industrial Chemistry and Chemical Engineering ,Spits Petrochemicals-Wiley
11. ASTM Methods, Indian standards
12. Sukumar Maiti, Introduction to Petrochemicals

PC4B02: Petroleum Industries in India

Credits-3 **(54hrs)**

Aim:.To create awareness among students about the petroleum industries in India

Objectives: To study:

- Catalysts in petroleum industry
- Petroleum and petrochemical industries in india
- Energy crisis and petrochemical industries
- Ecology and energy crisis

Module-1

Catalysts in petroleum industry –General properties-classification—catalytic activity-catalysts in refining process-Reforming catalysts-hydro treating catalysts-catalysts in petro chemical industry-Ziegler catalyst-preparation-properties-disadvantages-miscellaneous polymerization catalysts- recent advances in catalysts-Role of polymers in catalysts-enzyme catalysts- preparation, structure, selectivity and application (18 Hrs)

Module-2

Pollution from petroleum industry—refinery pollution-water pollution—air pollution-sea water pollution-effect of oil pollution- physical and chemical—control methods--environmental protection-- National standards of air and water pollution (12 Hrs)

Module-3

Energy crisis ---coal as an alternative to oil –non-conventional sources of energy—solar energy—bio gas-advantages-tidal energy –geothermal energy-wind energy—nuclear fuels (general study only) (8 Hrs)

Module-4

Importance of Petroleum and petrochemical industry in the contest of Indian economy – general cost-capital cost-production cost-R&D economics-
Major govt oil companies engaged in refining and marketing petroleum
Function of ONGC. (8 Hrs)

Module-5

Indian petrochemical industry –Difficulties encountered in Indian petro chemical industries.-Public sector and private sector –Petroleum conception pattern
Indian reserves, Developments in petrochemical industry -developments in quality of petroleum fuels and future –Future of petrochemical industry.
(8 Hrs)

References:-

1. W.L. Faith, Donald B Keyes, Ronald L Clark, Industrial Chemicals.
2. Trimn , Catalysts in petrochemical refining
3. Jain and Jain, Engineering Chemistry
4. B.K Sharma , Industrial Chemistry and Chemical Engineering ,Spits Petrochemicals-Wiley
5. ASTM Methods, Indian standards
6. Sukumar Maiti, Introduction to Petrochemicals

PC4B03:Practical -II

(Semester III and IV)

Credits-2 72 Hours

1. Determination of density of light oils
2. Determination of density of medium type oils
3. Determination of surface tension of kerosene
4. Determination of Viscosity of Diesel
5. Determination of Viscosity of furnace oil
6. Determination of Ried vapour pressure of petrol

Reference: ASTM methods, Indian standards