POST GRADUATE AND RESEARCH DEPARTMENT OF CHEMISTRY MAHARAJA'S COLLEGE, ERNAKULAM

(A Government Autonomous College
Re-accredited by NAAC with 'A' grade
Centre for Excellence under Govt. of Kerala
Identified by UGC as College with Potential for Excellence)

CHOICE BASED CREDIT SYSTEM

SCHEME & SYLLABI FOR UNDER GRADUATE PROGRAMMES IN CHEMISTRY

2016

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FOREWORD

The Board of Studies in Chemistry take this opportunity to express our deep appreciation to all academicians and professionals who participated in the series of workshops organized by the Board for restructuring curriculum and syllabi of the UG courses in Chemistry (Model I) and Chemistry- Environment and Water Management (Model III). We express our profound gratitude to the Honourable Vice-Chancellor, Pro-Vice Chancellor, Members of the Syndicate and Members of the Academic Council, Mahatma Gandhi University, for their sincere co-operation and guidance for completion of this work. Our special thanks are due to Chairman and members of the Governing Council, Chairman and members of the Academic Council, Maharaja's College, Ernakulam.

We also extend our gratitude to Prof. (Dr). K. K. Mohammed Yusuff, Professor (Retd.), Department of Applied Chemistry, Cochin University of Science and Technology, Prof. (Dr). S. Sugunan, Professor (Retd.), Department of Applied Chemistry, Cochin University of Science and Technology, Prof. (Dr). K. Girish Kumar, Professor, Department of Applied Chemistry, Cochin University of Science and Technology, Prof. (Dr). K. Sreekumar, Professor, Department of Applied Chemistry, Cochin University of Science and Technology, Dr. E. Prasad, Associate Professor, Department of Chemistry, IIT, Madras, Dr. Kochubaby Manjooran, Dy. Manager (Energy and Envt), BPCL, Kochi Refinery, Sri. M. G. Rajagopalan. Associate Professor (Retd.) Maharaja's College, Ernakulam, Smt. K. T. Geethabali, Associate Professor (Retd.), Maharaja's College, Ernakulam, Dr. T. Narayanan, Associate Professor (Retd.), Maharaja's College, Ernakulam, Dr. Lissamma Koshy. Associate Professor (Retd.), Maharaja's College, Ernakulam and Dr. Anu Gopinath, Assistant Professor, Department of Chemical Oceanography, Kerala University of Fisheries & Ocean Studies who were entrusted with the responsibility as experts for the revision of the syllabus of different subjects. The Board of Studies in Chemistry expresses the whole hearted gratitude to all those who have helped in this endeavour.

The task of preparing the curricula and syllabi and bringing it out in the present form for the two BSc courses was not simple but it was possible with dedicated efforts and wholehearted support and involvement of all the members of the BOS and the faculty members of the Department of Chemistry. I would like to express my sincere thanks to all my fellow members of BOS and the faculty members of the Department of Chemistry for all their help, cooperation, encouragement, active participation and useful suggestions for the completion of syllabus.

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  Head of the Department
  Associate Professor
- **Dr. P V Joseph**
  Associate Professor
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  Assistant Professor

PROGRAMME STRUCTURE

a	Programme Duration	6 Semesters
b	Total Credits required for successful completion of the programme	120
c	Minimum credits required from common courses	38*
d	Minimum credit required from common courses in B.Com.	24
e	Minimum credit required from common courses in B.A. Economics(Honours), B.Sc. Instrumentation and B.Sc. Environmental Chemistry	8
f	Minimum credits required from Core + Complementary + Vocational courses including Project	74*
g	Minimum credits required from Choice Based Course I & II	8
h	Minimum attendance required	75%

*except in the case of Language Restricted Programmes [LRPs] including B. Com., B.A Economics (Honours), B.Sc. Instrumentation and B.Sc. Environment Chemistry.

Examinations

The evaluation of each course shall contain two parts:

(i) In-Semester Assessment (ISA)

(ii) End-Semester Assessment (ESA)

The in-semester to end semester, assessment ratio shall be 1:4, for both courses with or without practical. There shall be a maximum of 80 marks for end semester assessment and maximum of **20** marks for in-semester assessment. For all courses (theory & practical), grades are given on a 10- point scale based on the total percentage of marks ***(ISA+ESA)*** as given below:

Percentage of Marks	Grade	Grade Point(GP)
95 and above	S Outstanding	10
85 to below 95	A^+ Excellent	9
75 to below 85	A Very Good	8
65 to below 75	A^- Good	7
55 to below 65	B^+ Above average	6
50 to below 55	B Average	5
40 to below 50	C Pass	4
Below 40	F Fail	0
	Ab Absent	0

Credit Point (CP), Semester Grade Point Average (SGPA) & Cumulative Grade Point Average (CGPA)

Credit Point (CP) of a course is calculated using the formula

CP = C × GP, where C = Credit; GP = Grade point

Semester Grade Point Average (SGPA) of a Semester is calculated using the formula

SGPA= TCP/TC, where TCP = Total Credit Point of that Semester

TC = Total Credit of that Semester

Cumulative Grade Point Average (CGPA) of a Programme is calculated using the formula

$$CGPA = \sum(TCP \times TC) \div \sum TC$$

CGPA shall be rounded off to two decimal places

Grades for the different semesters and overall programme are given based on the corresponding CPA as shown below:

GPA	Grade
Equal to 9.5 and above	S Outstanding
Equal to 8.5 and below 9.5	A^+ Excellent
Equal to 7.5 and below 8.5	A Very Good
Equal to 6.5 and below 7.5	A^- Good
Equal to 5.5 and below 6.5	B^+ Above average
Equal to 5.0 and below 5.5	B Average
Equal to 4.0 and below 5.0	C Pass
Below 4.0	F Failure

Note: A separate minimum of 30% marks each for in-semester and end semester (for both theory and practical) and aggregate minimum of 40% are required to pass for a course. To pass in a programme, a separate minimum of Grade C is required for all the individual courses. If a candidate secures**F** Grade for any one of the courses offered in a Semester/Programme only **F** grade will be awarded for that Semester/Programme until he/she improves this to **C** grade or above within the permitted period. Candidate secures **C** grade and above shall be eligible for higher studies.

Marks Distribution for End Semester Examination and In-Semester Evaluation

The end semester examination of all semesters shall be conducted by the college at the end of each semester. All theories, practicals and project(s) are treated as individual

papers and marks should be in the 80(external)/20 (internal) pattern. In-semester evaluation is to be done through continuous assessment. Marks distribution for end semester and in-semester assessments and the components for in-semester evaluation with their marks are shown below:

Components of the in-semester evaluation and their marks are as below.

For all courses without practical

a) **Marks of End Semester Examination : 80**

b) **Marks of In Semester Evaluation : 20**

All the three components of the in-semester assessment are mandatory.

Components of In-Semester Evaluation	Marks
Attendance	**5**
Assignment /Seminar/Viva	**5**
2 Test papers*	**10**
Total	**20**

*marks of test papers shall be the average

For all courses with practical

a) **Marks of theory -End Semester Examination : 80**

b) **Marks of theory – In Semester Evaluation : 20**

Components of Theory–In Semester Evaluation	Marks
Attendance	**5**
Assignment/Seminar/Viva	**5**
2 Test papers*	**10**
Total	**20**

*marks of test papers shall be the average

c) **Marks of Practical –End semester Examination: 80**

(Practicals shall be conducted in even semesters for all programmes except commerce. For Commerce, in semester evaluation shall be conducted separately for odd and even semesters).

d) **Marks of Practical- In Semester Evaluation: 20**

Components of Practical-In Semester evaluation	Marks
Attendance	4
Record*	10
Viva / Working Model Projects	6
Total	**20**

*Marks awarded for Record should be related to number of experiments recorded.

Project Evaluation: (Maximum marks100)

Components of Project-Evaluation	Marks
In-semester Evaluation*	20
Dissertation (End semester)	50
Viva-Voce (End semester)	30
Total	**100**

*Components of Internal Evaluation	Marks
Relevance and Contents	5
Analysis and Presentation	5
Pre-submission Presentation and Viva	10
Total	**20**

Attendance Evaluation

1) For all courses without practical

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

(Decimals are to be rounded to the next higher whole number)

2) For all courses with practical

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

(Decimals are to be rounded to the next higher whole number)

B.Sc. CHEMISTRY

I. B.Sc CHEMISTRY

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

Type of course	Number of courses	Credits
A. Common Course	**10**	**38**
B. Core Course (Chemistry)	**15+6**	**54**
C. Complementary Courses		
(i) Mathematics	**4**	**14**
(ii) Physics	**4+2**	**14**
TOTAL		**120**

B.Sc. CHEMISTRY - DETAILED SCHEME

	Code	Course	Hours/ week	Credit	Marks		
					Internal	External	Total
Semester 1	ENG1CMR01	Common Course- English	5	4	20	80	100
	ENG1CMR02	Common Course- English	4	3	20	80	100
		Additional Language	4	4	20	80	100
	CHE1COR01	Inorganic Chemistry - I (General Inorganic Chemistry)	2	2	20	80	100
	CHE2P01	Qualitative Inorganic Analysis	2	1	Evaluation at the end of second semester		
	MAT1CMP01	Complementary mathematics	4	3	20	80	100
	PHY1CMP01	Complementary Physics	2	2	20	80	100
	PHY2CP01	Complementary Physics Practical	2	1	Evaluation at the end of second semester		
	Total		**25**	**20**			**600**
Semester 2	ENG2CMR03	Common Course- English	5	4	20	80	100
	ENG2CMR04	Common Course- English	4	3	20	80	100
		Additional Language	4	4	20	80	100
	CHE2COR02	Inorganic Chemistry –II (Atomic Structure And Chemical Bonding)	2	2	20	80	100
	CHE2P01	Qualitative Inorganic Analysis	2	1	20	80	100
	MAT2CMP02	Complementary mathematics	4	3	20	80	100
	PHY2CMP02	Complementary Physics	2	2	20	80	100
	PHY2CP01	Complementary Physics Practical	2	1	20	80	100
	Total		**25**	**20**			**800**
Semester 3	ENG3CMR05	Common Course- English	5	4	20	80	100
		Additional Language	5	4	20	80	100
	CHE3COR03	Organic Chemistry -1 (Reaction Mechanism & Stereochemistry)	3	3	20	80	100
	CHE4P02	Organic Chemistry Practical –I	2	1	Evaluation at the end of fourth semester		

	MAT3CMP03	Complementary mathematics	5	4	20	80	100
	PHY3CMP03	Complementary Physics	3	3	20	80	100
	PHY4CP02	Complementary Physics Practical	2	1	Evaluation at the end of fourth semester		
	Total		**25**	**20**			**500**
Semester 4	ENG4CMR06	Common Course- English	5	4	20	80	100
		Additional Language	5	4	20	80	100
	CHE4COR04	Organic Chemistry –II (Functional Group Chemistry)	3	3	20	80	100
	CHE4P02	Organic Chemistry Practical–I	2	1	20	80	100
	MAT4CMP04	Complementary mathematics	5	4	20	80	100
	PHY4CMP04	Complementary Physics	3	3	20	80	100
	PHY4CP02	Complementary Physics Practical	2	1	20	80	100
	Total		**25**	**20**			**700**
Semester 5	CHE5COR05	Inorganic Chemistry- III (Coordination Chemistry & Bioinorganic Chemistry)	3	3	20	80	100
	CHE5COR06	Organic Chemistry-III (Natural Products**)**	3	3	20	80	100
	CHE5COR07	Physical Chemistry- I (States Of Matter And Surface Chemistry)	2	2	20	80	100
	CHE5COR08	Physical Chemistry- II (Quantum Mechanics, Spectroscopy And Photochemistry)	3	3	20	80	100
	CHE5CBP01	Choice Based Course - I	4	4	20	80	100
	CHE6P03	Volumetric Analysis	3	1	Evaluation at the end of sixth semester		
	CHE6P04	Organic Chemistry	2	1	Evaluation at the end of sixth		

		Practical- II			semester		
	CHE6P05	Physical Chemistry Practical	3	1	Evaluation at the end of sixth semester		
	CHE6D01	Project	2	2	Evaluation at the end of sixth semester		
	Total		**25**	**20**			**500**
Semester 6	CHE6COR09	Inorganic Chemistry – IV (Advanced Inorganic Chemistry)	3	3	20	80	100
	CHE6COR10	Organic Chemistry- IV (Advanced Organic Chemistry)	3	3	20	80	100
	CHE6COR11	Physical Chemistry – III (Thermodynamics And Kinetics)	3	3	20	80	100
	CHE6COR12	Physical Chemistry – IV (Solution Chemistry And Electrochemistry)	3	3	20	80	100
	CHE6CBP01	Choice Based Course - II	3	3	20	80	100
	CHE6P03	Volumetric Analysis	3	1	20	80	100
	CHE6P04	Organic Chemistry Practical- II	2	1	20	80	100
	CHE6P05	Physical Chemistry Practical	3	2	20	80	100
	CHE6P06	Gravimetric Analysis	2	1	20	80	100
	CHE6D01	Project and Viva			20	80	100
	Total		**25**	**20**			**1000**

SEMESTER 1

CHE1COR01 – INORGANIC CHEMISTRY – I (GENERAL INORGANIC CHEMISTRY)

Credits: 2 **Contact lecture hours: 36**

Aim

To give the students a thorough knowledge about the role of chemistry as a central science and to give an outline of periodic table, environmental chemistry and analytical principles.

Objectives

- To have an outline of the methodology of science in general and chemistry in particular.
- To study the periodic properties of elements.
- To study the analytical principles and good laboratory practices and to develop skills required for qualitative and quantitative inorganic analysis.
- To study various atom models.
- To study the environmental chemistry.

Module 1: Perspectives of Sciences (9 Hrs)

Types of knowledge: Practical, theoretical and scientific knowledge. What is science? Scientific statements, Scientific methods – Hypothesis – theories and laws in science – observations, evidences and proofs, Scientific problem-induction, deduction, Revision of theories- Atomic theory- Democritus, Dalton, Thomson, Rutherford's atom model- postulates- demerits, Bohr atom model-postulates-merits,-demerits, Somerfield extension of Bohr theory, Schrödinger model (wave equation only, derivation not required). Role of chemistry as a central science connecting physics, biology and other branches of science. Basic ideas of interdisciplinary areas involving chemistry- inorganic chemistry, nano chemistry, biochemistry, nuclear chemistry, organic chemistry, physical chemistry, analytical chemistry, environmental chemistry, combinatorial chemistry, medicinal chemistry, engineering chemistry.

Module 2: Periodic classification **(9 Hrs)**

Modern periodic law – long form periodic table – Periodic classification of elements – groups and periods, s, p, d, f-block elements. Periodicity in properties – atomic, ionic, covalent radii. Factors affecting trends in periodic table – ionisation potential, electron affinity, electronegativity. Approaches of Pauling, Allred-Rochows, Mulliken, factors determining electronegativity, application of electronegativity, elecronegativity difference and percent ionic character. Anomalous behaviour of 1^{st} element of a group – diagonal relationship.

Module 3: Analytical Principles **(9 Hrs)**

3.1 Laboratory hygiene & safety-storage and handling of chemicals. Simple first aids: electric shocks, fire, cut glass, inhalation of poisonous gases, accidents due to acids and alkalies, burns due to phenol and bromine. Disposal of sodium and broken mercury thermometer – use of $CaCl_2$ & Silica gel in desiccators. Awareness of material safety data sheet (MSDS). R&S (elementary idea only). Good Laboratory Practices- Laboratory sign.

3.2 Inorganic qualitative analysis - Common ion effect, solubility product –Principle, Applications of solubility product and common ion effect in the precipitation of cations, principle and procedure of Interfering acid radicals and their elimination (oxalate, fluoride, borate, phosphate, chromate, arsenite and arsenate). Primary and secondary standards, standard solutions, Normality, molarity, molality and related problems. Theory of titrations involving acids and bases, $KMnO_4$, $K_2Cr_2O_7$. Indicators – Theory of acid-base, redox, adsorption indicators. Complexometric titrations (basic theory and principle only).

Module 4: Environmental Chemistry **(9 Hrs)**

4.1 Environmental segments – Lithosphere, Hydrosphere, Biosphere, Atmosphere. Composition and structure of atmosphere – Troposphere, Stratosphere, Mesosphere, Thermosphere.

4.2 Air pollution - 3 types of classification. Types of pollutants – CO, CO_2, NO, SO_2, H_2S, Cl_2, CFC, particulate matter, metals, fly ash, asbestos, hydrocarbons – their source and influence. Ozone layer depletion, ozone hole, protection of ozone umbrella, acid rain, green house effect, photochemical smog. Management of air pollution.

4.3 Water pollution: classification of pollutants - organic, inorganic, suspended solids (heavy metals Pb, Hg, Cd) and sediments, radioactive materials, heat, industrial waste, sewage water, detergents, agricultural pollutants (eutrophication of water reservoirs). Treatment of industrial waste water, quality of drinking water, Indian standard and WHO standard, Dissolved oxygen, BOD, COD.

4.4 Soil pollution - pesticides, fertilizers, industrial waste, plastics.

4.5 Control of pollution.

References

[1] B.R. Puri, L.R. Sharma, K.C. Kalia, Principles of Inorganic Chemistry, 31st Edn., Milestone Publishers, New Delhi, 2013.

[2] J. A. Lee, Scientific Endeavor, Pearson Education India, 2010.

[3] D.A. Skoog, D.M. West and S.R. Crouch, Fundamentals of Analytical Chemistry 8th Edn., Brooks/Cole Nelson.

[4] A.I. Vogel, G.H. Jeffery, Vogel's Textbook of Quantitative Chemical Analysis, 6th Edn., Longman Scientific & Technical, 1989.

[5] S. K. Banerji, Environmental Chemistry, 2nd Edn., PHI Learning Pvt. Ltd., 1999.

[6] B.K. Sharma, Air Pollution, Krishna Prakashan Media, 1991.

[7] V.K. Ahluwalia, Environmental Studies: Basic Concepts, The Energy and Resources Institute (TERI), 2013.

[8] G.W. van Loon and S.J. Duffy, Environmental Chemistry: A global perspective, Oxford University Press, 2000.

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[11] APHA Standard Methods for Examination of Water and Waste water, American Public Health Association, Newyork, 1985.

SEMESTER 2

CHE2COR02: INORGANIC CHEMISTRY –II

(ATOMIC STRUCTURE AND CHEMICAL BONDING)

Credits : 2 **Contact lecture hours : 36**

Aim

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

Objectives

- To understand the important features of the quantum mechanical model of the atom.
- To explain the formation of different types of bonds
- To predict the geometry of simple molecules
- To explain the different types of hybridization and draw shapes of simple covalent molecules
- To understand the molecular orbital theory of diatomic molecules
- To study nuclear models and nuclear reaction

Module 1: Atomic Structure **(9 Hrs)**

Bohr model of hydrogen atom, Bohr's equation for the energy of electron in hydrogen atom, derivation of Bohr radius, velocity, energy of hydrogen atom, the hydrogen spectrum, limitations of Bohr theory. Photoelectric effect, idea of de Broglie matter waves, Heisenberg's uncertainty principle and its significance, Schrodinger wave equation (derivation not expected), wave functions, significance of Ψ and Ψ^2. Operators - Laplacian and Hamiltonian operators. 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 multi electron atom. Concept of effective nuclear charge, Slater's rules and applications. Electronic configuration of atoms.

Module 2: Chemical Bonding (18 Hrs)

2.1 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.

2.2 Covalent bond- valence bond theory and its limitations, concept of resonance, resonance energy, hybridisation and shapes of simple molecules (BeF_2, PCl_3, PCl_5, SF_6, CH_4, ethane, ethene and ethyne), VSEPR theory, shapes of molecules and ions (NH_3, XeF_6, ClF_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, polarizing power and polarisability of ions, Fajan's rule. Dipole moment and molecular structure – percentage of ionic character from dipole moment.

2.3 Metallic bonding – free electron theory, valence bond theory and band theory, explanation of weak chemical forces – hydrogen bond, inter and intra molecular hydrogen bonds, effects of hydrogen bonding, van der Waals forces.

Module 3: Nuclear Chemistry (9 Hrs)

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

3.2 Natural radioactivity, modes of decay, group displacement law, theories of disintegration, rate of decay, decay constant, half life period, average life. Radioactive equilibrium- secular and transient equilibrium. Units of radioactivity, radiation dosage. Gieger-Nuttal rule. Disintegration series, transmutation reactions – using protons, deuterons, particles and neutrons, artificial radioactivity – Positron emission and K electron capture, synthetic elements.

3.3 Application of radioactive isotopes – ^{14}C dating, rock dating, neutron activation analysis, isotopes as tracers – study of reaction mechanism (ester hydrolysis), radio diagnosis and radiotherapy.

3.4 Induced radioactivity, nuclear reactions induced by charged projectiles, neutrons and γ rays, nuclear fission, fusion, hydrogen bomb, atomic bomb, nuclear reactor. Spallation reactions, Q values of nuclear reactions, chain reaction, stellar energy – proton cycle, carbon cycle and neon cycle.

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[2] B.R. Puri, L.R. Sharma, K.C. Kalia, Principles of Inorganic Chemistry, 31st Edn., Milestone Publishers, New Delhi, 2013.

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[4] F.A. Cotton, G. Wilkinson and P.L. Gaus, Basic Inorganic Chemistry, 3rd Edn., John Wiley & Sons, 1995.

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[6] H.J. Arnikar, Essentials of Nuclear Chemistry, 2nd Edn., Wiley Eastern, 1990.

[7] R. Gopalan, Elements of Nuclear Chemistry, Vikas Publ. House, New Delhi, 1999.

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, Pvt.Ltd.New Delhi, Indian Edn., 2002.

[3] W. L Jolly, Modern Inorganic Chemistry, Tata Mc Graw Hill, 1991.

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SEMESTERS 1 & 2

PRACTICAL: CHE2P01-QUALITATIVE INORGANIC ANALYSIS

Credits : 2 **Contact lab hours : 36+36 = 72**

1. Study of the reactions of the following radicals with a view to their identification and confirmation.
   Ag^{+}, Hg^{2+}, Pb^{2+}, Cu^{2+}, Bi^{2+}, Cd^{2+}, As^{3+}, Sn^{2+}, Sb^{3+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, Li^{+}, Na^{+}, K^{+}, NH_4^{+}.
   CO_3^{2-}, S^{2-}, SO_4^{2-} , NO_3^{-}, F^{-}, Cl^{-}, Br^{-}, BO_2^{-}, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, CH_3COO^{-}, PO_4^{3-} , AsO_3^{3-}, AsO_4^{3-} and CrO_4^{2-}
2. Elimination of interfering anions such as F^{-}, BO_2^{-}, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, PO_4^{3-}, AsO_3^{3-} AsO_4^{3-} and CrO_4^{2-}
3. Systematic qualitative analysis of mixtures containing two acid and two basic radicals from the above list l by Semi-micro method only.
   (Minimum of 10 mixtures to be analyzed)

References

[1] A.I. Vogel, A Text Book of Qualitative Inorganic Analysis Including Elementary Instrumental Analysis, 3rd Edn., Longmans, Green and Co. Ltd., 1961.

[2] Vogel, A. I., A Textbook of Micro and Semi-micro Qualitative Inorganic Analysis, Longman Green & Co. 1995.

[3] V.V. Ramanujam, Inorganic Semi micro Qualitative Analysis, The National Publishing Co., Chennai.

SEMESTER 3

CHE3COR03– ORGANIC CHEMISTRY -1
(REACTION MECHANISM & STEREOCHEMISTRY)

Credits: 3 **Contact lecture hours : 54**

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.

Module 1: Basic concepts of reaction mechanism (18 Hrs)

1.1 Classification and nomenclature of organic compounds

Classification of organic compounds. Rules of IUPAC system of nomenclature of common organic compounds – alkanes, alkenes, alkynes, alkenynes, alkadienes (cumulated, conjugated and isolated dienes), butadienes, cycloalkanes, bicycloalkanes, alkyl halides, alcohols and phenols, aldehydes, ketones, carboxylic acids and its derivatives, amines and nitro compounds (both aliphatic and aromatic).

1.2 Fundamentals of organic reaction mechanism

Meaning of reaction mechanism: Curved arrow notation. Half headed and double headed arrows.

Nature of bond fission: – Homolysis and Heterolysis. Types of reagents – Electrophiles and Nucleophiles.

Types of organic reactions:- Definition and at least one example of each – substitution, addition, elimination and rearrangement.

Reactive intermediates:- Carbocations, carbanions, free radicals, carbenes and nitrenes (structure, formation and stability).

Electron displacement effects:- inductive, inductomeric, electromeric, mesomeric, hyper conjugation and steric effects.

Resonance: - Concept of resonance, resonance energy. Structure & stability of alkenes and butadienes, heat of hydrogenation and heat of combustion of benzene, mention of C-C bond lengths and orbital picture of benzene and thiophene.

Aliphatic nucleophilic substitutions:- Mechanisms of S_N1 and S_N2. Effect of 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:- Addition of halogens and hydrogen halides. Mechanisms of addition of Br_2 and hydrogen halides to double bonds- Markownikoff's rule and peroxide effect. Test for unsaturation - Bromine water, Bromine in CCl_4 and Baeyer's reagent. 1, 4 - addition in butadienes.

Module 2: Stereochemistry **(18 Hrs)**

2.1 Projection formulae - Fischer, flying wedge, sawhorse and Newman projection formulae. Stereoisomerism - definition - classification into optical and geometrical isomerism

2.2 Optical isomerism - Optical activity - optical and specific rotations - conditions for optical activity - asymmetric centre - Elements of symmetry, chirality - achiral molecules - meaning of (+) and (-) - 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. Enantiomers, Optical isomerism in glyceraldehyde, lactic acid and tartaric acid - Diastereomers - Meso compounds.

2.3 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). Enantiomeric excess, Optical activity in compounds not containing asymmetric carbon atoms - Biphenyls.

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

2.5 Conformational analysis - Introduction of terms - conformers, configuration, dihedral angle, torsional strain - Conformational analysis of ethane and n-butane including energy diagrams - Cycloalkanes:- relative stabilities, conformers of cyclohexane (chair, boat and skew boat forms) - axial and equatorial bonds- ring flipping showing axial equatorial interconversions, conformation of methylcyclohexane.

Module 3: Aromaticity **(18 Hrs)**

3.1 Aromaticity:- Concept of aromaticity – definition- Huckel's rule – application to Benzenoid – (benzene, naphthalene and anthracene) and Non–benzenoid compounds – (furan, pyrrole, indole, quinoline, cyclopropenyl cation, cyclopentadienyl anion, tropylium cation and annulenes) –Antiaromatic compounds.

3.2 Aromatic electrophilic substitution reactions – General mechanism of electrophilic substitution, mechanism of halogenation, nitration, sulphonation, 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.

3.3 Aromatic nucleophilic substitutions- bimolecular displacement mechanism- Elimination – addition mechanism, S_NAr mechanism and Benzyne mechanism.

3.4 Polynuclear hydrocarbons: - Classification-reactions and structure of naphthalene, anthracene, phenanthrene and acenaphthene. Reactivity of naphthalene towards electrophilic substitution- nitration and sulfonation.

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SEMESTER 4

CHE4COR04 - ORGANIC CHEMISTRY –II
(FUNCTIONAL GROUP CHEMISTRY)

Credits: 3 **Contact lecture hours: 54**

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, synthetic reagents and Grignard reagents.
- To understand and study organic reaction mechanisms.
- To develop skills required for the qualitative analysis of organic compounds

Module I: Hydroxy Compounds, Ethers and Organometallics (18 Hrs)

1.1 Hydroxy compounds (10 Hrs**)**

Mono, di and trihydric alcohols- Monohydric alcohols:- Classification, classical methods of preparation of methanol and ethanol, physical properties–hydrogen bonding- distinction between primary, secondary and tertiary alcohols- Ascend and descend in alcohol series, chemistry of methanol poisoning, harmful effects of ethanol on human body.

Dihydric alcohols:- Ethylene glycol- Oxidative cleavage (Lead tetra acetate, Periodic acid), Pinacol - Pinacolone rearrangement – mechanism.

Trihydric alcohols:- Glycerol- synthesis (from fats), reaction with HI, oxalic acids, oxidation.

Phenols: – Acidity of phenols- effects of substituents – comparison of acidity with alcohols. Reaction of phenol with $FeCl_3$, Formation of phenolphthalein and azo dyes. Preparation and uses of nitrophenols, picric acid, catechol, resorcinol and quinol, Mechanisms of Reimer –Tiemann reaction, Lederer- Mannase reaction, Fries Rearrangement. Liebermann's nitroso reaction.

1.2. Ethers and Epoxides (4 Hrs)

Ethers:- Williamsons Synthesis, Cleavage of ether linkages by HI- Zeisel's method of estimation of alkoxy groups.

Epoxides:- Preparation from alkenes, acid and base catalyzed ring opening reactions, Crown ethers (elementary idea only)

1.3. Organometallic compounds (4 Hrs)

Grignard reagents-formation, structure and synthetic applications, alkyl lithium, Organo Zinc compounds, Reformatsky reaction.

Module 2: Aldehydes, Ketones and active methylene compounds (18 Hrs)

2.1 Aldehydes, Ketones (14 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. Addition and condensation reactions of carbonyl compounds: Mechanisms of nucleophilic additions to carbonyl groups with special emphasis on Claisen, Claisen-Schmidt, Benzoin, Aldol, Perkin, Knoevenagel condensations, Cannizzaro's reaction.

Condensation with ammonia and its derivatives, Wittig reaction, Mannich reaction. Oxidation reactions- Baeyer-Villiger oxidation, Reduction reactions- Clemmensen, Wolff-Kishner, Meerwein-Ponndorf-Verley reduction., $LiAlH_4$ and $NaBH_4$ reductions. Use of acetal as protecting group.

2.2 Compounds containing active methylene groups (4 Hrs)

Synthetic uses of malonic ester, acetoacetic ester and cyanoacetic ester. Keto-enol tautomerism

Module 3: Carboxylic and sulphonic acids and synthetic reagents (18 Hrs)

3.1 Carboxylic and Sulphonic acids (12 hours)

Structure of carboxylate ion- effects of substituents on acid strength of aliphatic carboxylic acids- ascent and descent in fatty acid series, Arndt-Eistert synthesis (Wolff rearrangement to be mentioned), Hell-Volhard- Zelinsky reaction, Kolbe's electrolysis.

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

Methods of formation and chemical reactions of anthranilic acid, unsaturated acids (cinnamic acid, acrylic acid), hydroxy acids (malic acid, citric acid), dicarboxylic acids (oxalic acid, malonic acid, adipic acid, maleic acid, fumaric acid).

Preparation and reactions of benzene sulphonic acid, benzene sulphonyl chloride and ortho and para toluene sulphonyl chlorides- uses. Synthesis and uses of saccharin. Comparison of acidity of carboxylic acid and sulphonic acid.

3.2 Carbonic acid derivatives (3 Hrs)

Preparation, reactions and structure of urea, thiourea and semicarbazide, Manufacture of urea. Preparation and basicity of guanidine.

3.3 Synthetic reagents (3 Hrs)

NBS, Lead tetra acetate, Periodic acid, OsO_4, Selenium dioxide, MCPBA, DCC (elementary idea).

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SEMESTERS 3 & 4

CHE4P02 - ORGANIC CHEMISTRY PRACTICAL –I

Credits: 2 **Contact lab hours: 36+ 36=72**

1. Tests for elements: Nitrogen, Halogens and Sulphur (Green technique may also be adopted).
2. Tests for unsaturation.
3. Tests for aromatic character.
4. Study of the reactions of the following functional groups: alcohol, phenol, aldehyde, ketone, carboxylic acid, 1,2- dicarboxylic acid, ester, primary, secondary and tertiary amines, amide, nitro and halogen compounds, diamide, anilide, polynuclear hydrocarbons, reducing and non-reducing sugars.
5. Systematic analysis of the following organic compounds containing one functional group and characterization with its physical constant (solid and liquid) and a derivative :- alcohol, phenol, aldehyde, ketone, carboxylic acid, 1,2 dicarboxylic acid, ester, primary,secondary and tertiary amines, amide, nitro and halogen compounds, diamide, anilide, polynuclear hydrocarbons, reducing and non-reducing sugars.
   (Minimum 10 compounds to be analyzed, Chemistry of the reaction is necessary)

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SEMESTER 5

CHE5COR05 – INORGANIC CHEMISTRY- III

(COORDINATION CHEMISTRY& BIOINORGANIC CHEMISTRY)

Credits - 3 **Contact lecture hours : 54**

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.
- To understand the important analytical and instrumental tools used for practicing chemistry
- To apply these skills in the analysis of experimental data in chemistry practical

Module 1: Chemistry of d and f block Elements (9 Hrs)

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

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

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

Module 2: Coordination Chemistry (18 Hrs)

Coordination complex-define complex and ligands, 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, spectrochemical series-classification of ligand into strong field and weak field, inner orbital and outer orbital complexes. Crystal field theory, splitting of d-orbitals in octahedral, tetrahedral and square-planar complexes – low spin and high spin complexes, strong and weak field ligands, CFSE, 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(Cr, Fe, Ni &Cu).

Reactivity of metal complexes-Labile and inert complexes, ligand substitution reactions –$S_N^1$and S_N^2 substitution reactions of square planar complexes – Trans effect.

Module 3: Data Analysis **(9 Hrs)**

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.

Module 4: Metal carbonyls and metal clusters **(9 Hrs)**

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). Metal-halide cluster, Quadruple bond – structure of$[\ Re_2CI_8]^{2-}$.

Module 5: Bioinorganic Chemistry **(9 Hrs)**

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] J.D. Lee, Concise Inorganic Chemistry 5th Edn., Chapman & Hall, London, 1996.

[2] B.R. Puri, L.R. Sharma, K.C. Kalia, Principles of Inorganic Chemistry, 31st Edn., Milestone Publishers, New Delhi, 2013.

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SEMESTER 5

CHE5COR06- ORGANIC CHEMISTRY-III
(NATURAL PRODUCTS)

Credits: 3 **Contact lecture hours : 54**

Aim

To give an outline of Natural products and biomolecules and the applications of organic chemistry in various spheres of chemical sciences.

Objectives

- To learn in detail the chemistry of carbohydrates.
- To learn in detail the chemistry of amino acids, proteins and nucleic acids.
- To understand the structure and functions of enzymes, proteins and nucleic acids. To study the fundamentals of terpenoids, alkaloids, vitamins, lipids and steroids, Green Fluorescent Proteins
- To develop basic skills required for crystallisation, distillation, solvent extraction, TLC and column chromatography.

Module 1: Natural products - I (Carbohydrates) (18 Hrs)

Monosaccharides:-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.

Polysaccharides:- Structure and properties of starch and cellulose. (Elementary idea). Industrial applications of cellulose.

Module 2: Natural products –II (Terpenoids, steroids, alkaloids, vitamins and lipids)

(18 Hrs)

2.1 Terpenoids : classification, isoprene rule. Essential oils, isolation of essential oils, Structure elucidation of citral and geraniol. Natural rubber – structure, vulcanization and its advantages.

2.2 Steroids: Introduction – Diels hydrocarbon- Structure and functions of cholesterol, Biosynthesis of cholesterol, Elementary idea of HDL, LDL and Vitamin D. Biological functions of steroid hormones.

2.3 Alkaloids: Classification, general methods of isolation, structure elucidation of nicotine.

2.4 Vitamins: Classification-structure (elucidation not required) and deficiency diseases of vitamin A, C, B_1, B_2, B_6.

2.5 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.

Module 3: Natural Products –III (Amino acids, proteins, nucleic acids and enzymes) (18 Hrs)

3.1 Amino acids:- classification, Zwitter ion. Preparation of amino acids- Strecker amino acid synthesis. Peptides- structure and bonding. Solution phase peptide synthesis and solid phase peptide synthesis.

3.2 Proteins:- 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.

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

3.4 Green Fluorescent Proteins (elementary idea).

3.5 Enzymes:-Chemical nature and properties of enzymes. Nomenclature and classification of enzymes. Mechanism of enzyme action. Substrate specificity of enzymes. Enzyme inhibition.

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[1] I.L. Finar, Organic Chemistry - Volume I, Pearson Education, 1973.

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SEMESTER 5

CHE5COR07 – PHYSICAL CHEMISTRY- I

(STATES OF MATTER AND SURFACE CHEMISTRY)

Credits: 2 **Contact lecture hours - 36**

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 understand the symmetry of crystals
- To study defects in crystals
- To study adsorption.

Module 1: Gases (12 Hrs)

Kinetic molecular model of gases: pressure of an ideal gas, derivation of gas laws, Maxwell's distribution of velocities – molecular velocities (average, root mean square and most probable velocities- no derivation). Collision diameter, mean free path, viscosity of gases – temperature and pressure dependence. Relation between mean free path and coefficient of viscosity (no derivation). 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).

Module 2: Liquids **(3 Hrs)**

Intermolecular forces in liquids (qualitative idea only)- viscosity, determination of viscosity- the viscometer method- surface tension – surface energy, refractive index, physical properties and chemical constitution of liquids. Unusual behaviour of water.

Module 3: Solid state **(15 Hrs)**

The nature of the solid state- anisotropy- the law of constancy of interfacial angles, symmetry in crystal systems- elements of symmetry– centre of symmetry, plane of symmetry, proper and improper axes of symmetry, law of rational indices - Miller indices. Seven crystal systems and Fourteen Bravais lattices and crystallographic point groups. 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.

Module 4: Surface chemistry **(6 Hrs)**

Adsorption – types, adsorption of gases by solids – factors influencing adsorption – Freundlich adsorption isotherm – Langmuir adsorption isotherm (derivation). The BET theory (no derivation) – use of BET equation for the determination of surface area. Colloids- stability of colloids, origin of charge on colloidal particles, electrical double layer, zeta potential.

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SEMESTER 5

CHE5COR08- PHYSICAL CHEMISTRY- II

(QUANTUM MECHANICS, SPECTROSCOPY AND PHOTOCHEMISTRY)

Credits: 3 **Contact lecture hours : 54**

Aim

To understand the fundamentals of quantum mechanics and its applications, molecular spectroscopy and photochemistry.

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

Module 1: Quantum mechanics **(18 Hrs)**

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.

Module 2: Molecular spectroscopy- I (18 Hrs)

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

Rotational spectrum(microvave spectroscopy): diatomic molecules, energy levels of a rigid rotator, selection rules, nature of rotational spectrum, determination of bond length.

Vibrational spectrum(IR spectroscopy): the simple harmonic oscillator – energy levels, force constant, selection rulesum, nature of vibrational spectrum. 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.

Molecular Symmetry - 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

Module 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 (1H 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

Module 4: Photochemistry (3 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.

References

[1] K.L. Kapoor, A Textbook of Physical chemistry, Volume 4, Macmillan India Ltd., 2006.

[2] Mc Quarrie, J.D. Simon, Physical Chemistry – A molecular Approach, Viva Books Pvt. Ltd., 1997.

[3] I.N. Levine, Physical Chemistry, Tata Mc Graw Hill, 2009.

[4] A. Bahl, B. S. Bahl, G. D. Tuli, Essentials of Physical Chemistry, S. Chand and Company, 2000.

[5] K. J. Laidler, John H.Meiser, Physical Chemistry, 2nd Edn., 1995.

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[7] R. Puri, L.R. Sharma, M.S. Pathania, Elements of Physical chemistry, Vishal Pub. Co.

[8] K.K. Sharma, L.R Sharma, A text book of Physical Chemistry, Vikas Publishing house, 2006.

Further reading

[1] P. Atkins, J Poula, Physicl Chemistry, Macmillan Higher Education, 2006.

[2] Mc Quarrie, Quantum Chemistry, Viva Books New Delhi, 2003.

[3] I.N. Levine, Quantum Chemistry 5th Edn., Pearson, 2004.

[4] R.K. Prasad, Quantum Chemistry, New Age International, 2006.

[5] D.L. Pavia, G.M. Lampman, G.S. Kriz, Introduction to spectroscopy 3rd Edn., Thomson Brooks/Cole, 2001.

[6] D.N .Satyanarayana, Electronic absorption spectroscopy and related techniques, Universities Press, 2001.

[7] G.K. Vemulapalli, Physical Chemistry, Prentice-Hall of India Pvt. Ltd., 2009.

[8] K.K. Rohatgi-Mukherjee , Fundamentals of Photochemistry, New Age, 1978.

SEMESTER 5

CHOICE BASED COURSE - I

(Any one course to be opted from the following courses)

CHE5CBP01: CHEMISTRY IN EVERYDAY LIFE

Credits: 4 **Contact lecture hours: 72**

Aim

To learn chemistry as an intergral part of everyday life.

Objectives

- To study the general information about the food we eat, the cloths we wear and the cosmetcis we apply.
- To learn about the pros and cons of using processed food stuff, which is in vogue today.

Module 1: Chemicals in food and beverages and Nutrition (18 Hrs)

1.1 Principles of food preservation: Maintenance of anaerobic condition - high temperature and low temperature storage, drying. Functional food additives, food laws. Food colours - permitted and non – permitted- Toxicology. Flavours – natural and synthetic- Toxicology . Important chemical ingredients/ taste makers used in packed food - soft drinks - and its health hazards. Chemicals in food production. Artificial sweeteners.

1.2 Adulteration, Adulterants in milk, ghee, oil, coffee powder, tea, asafoetida, chilli powder, pulses and turmeric powder - identification. Food spoilage: Risk factors associated with food borne illness. Spoilage of milk, canned food, fruits and vegetables. Elementary idea of antioxidants.

1.3 Measurement of Energy Value of food, Calorific value, caloric requirement, Kilocalorie. Basal metabolic rate (BMR):- Significance, Condition, factors, measurement.

Module 2: House hold materials (18 Hrs)

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

2.2 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.

2.3 Cosmetics:- Introduction, classification – bathing oils, face creams, skin products, perfumes, dental cosmetics, hair dyes, shaving cream, shampoo, talcum powder, tooth paste, deodorants, lipstick –ingredients. General formulation of each type. Harmful chemicals in cosmetics. Toxicology of cosmetics.

Module 3: Plastics, Paper and Dyes (9 Hrs)

3.1 Plastics in everyday life. Brief idea of polymerization- Thermoplastic and thermosetting polymers. Use of PET, HDPE, PVC, LDPE, PP, ABS. Recycling of plastics. Biodegradable plastics. Environmental hazards of plastics.

3.2 News print paper, writing paper, paper boards, cardboards. Organic materials, wood, cotton, jute and coir. International recycling codes, and symbols for identification.

3.3 Natural and synthetic dyes (basic idea only).

Module 4: Drugs (9 Hrs)

Chemotherapy:- Drugs and their classification, Drug-target interactions. Enzymes as drug targets, Receptors as drug targets. Therapeutic action of different classes of drugs- antipyretics, antihistamines, antacids, tranquilizers, analgesics, sedatives, antibiotics, antimicrobials, antifertility drugs. Antiseptics and disinfectants.

Module 5: Chemistry and Agriculture (9 Hrs)

5.1 Fertilizers:- natural, synthetic, mixed fertilizers. NPK fertilizers. Excessive use of fertilizers and its impact on the environment. Bio fertilizers– types. Nitrogen fixation- symbiotics and non symbiotics using mycorrhiza. Plant growth hormones.

5.2 Pesticides:- Classification-insecticides, herbicides, fungicides. Excessive use of pesticides– environmental hazards. Biopesticides.

Module 6: Water Treatment and Waste Management (9 Hrs)

6.1 Water sources – specifications for water, impurities in water, characteristics imparted by impurities. Hardness – disadvantages of hard water in domestic and industrial use. Softening methods- lime soda, zeolite and ion exchange methods.

6.2 Methods of purification of water- removal of micro organisms- Desalination of brackish water- electro dialysis, reverse osmosis- Importance of dissolved oxygen, BOD & COD. Sewage treatment process - small scale and large scale process. Primary, secondary and tertiary treatment.

6.3 Solid waste disposal methods - sanitary landfills, composting, vermicomposting and biogas production. e-waste management.

References

[1] T.P. Coultate, Food- The Chemistry of its components. Royal Society of Chemistry, London, 2000.

[2] Shashi Chowls,Engineering Chemistry, 15th Edn., Danpat Rai Publication.

[3] B.K. Sharma. Industrial Chemistry, GOEL Publishing House, 1997.

[4] CNR Rao- Understanding chemistry, Universities Press, Hyderabad, 1999.

[5] B.R. Puri, L.R. Sharma, K.C. Kalia, Principles of Inorganic Chemistry, 31st Edn., Milestone Publishers, New Delhi, 2013.

[6] A. W. A. Brown. *Insect Control by Chemicals.*Chapman & Hall, London, 1951.

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[15] L E Casida, Industrial Microbiology, AGE International Publications, 2000.

[16] A.G.Murugesan, C.Rajakumari, Environmental Science and Biotechnology: Theory and techniques, MJP Publishers, 2006.

[17] Alan Evans, Informatics: Technology in action, Pearson.

SEMESTER 5

CHE5CBP02: DAIRY SCIENCE

Credits: 4 **Contact lecture hours: 72**

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

Module 1: Composition of Milk **(12 Hrs)**

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.

Module 2: Processing of Milk **(12 Hrs)**

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.

Module 3: Major Milk Products **(12 Hrs)**

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.

Module 4: Special Milk (12 Hrs)

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.

Module 5: Fermented and Other Milk Products (24 Hrs)

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.

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.

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[5] Warner, Wiley, Principles of Dairy Procesing, New York.

[6] Sukumar De, Outlines of Dairy technology.

SEMESTER 5

CHE5CBP03: FOOD SCIENCE

Credits: 4 **Contact lecture hours: 72**

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

Module 1: Food Adulteration (18 Hrs)

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.

Module 2: Food Poisons (9 Hrs)

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

Module 3: Food Additives (18 Hrs)

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.

Module 4: Beverages **(9 Hrs)**

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

Module 5: Edible Oils **(18 Hrs)**

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

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.

SEMESTER 5

CHE5CBP04: FORENSIC SCIENCE

Credits: 4 **Contact lecture hours: 72**

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).

Module 1: Poisons **(12 Hrs)**

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.

Module 2: Crime Detection **(12 Hrs)**

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.

Module 3: Forgery and Counterfeiting (12 Hrs)

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.

Module 4: Tracks and Traces (18 Hrs)

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.

Module 5: Medical Aspects (18 Hrs)

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.

References:

[1] T.H.James, Forensic Sciences, Stanley Thornes Ltd.

[2] Richard, Criminalistics - An Introduction to Forensic Science (College Version), 8th Edn., Sofestein, Printice Hall.

SEMESTER 5

CHE5CBP05: ENVIRONMENTAL CHEMISTRY

Credits: 4 **Contact lecture hours: 72**

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

Module 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.

Module 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, NOx, SO_2, O_3, PAN, CN, pesticides, carcinogenic substances.

Module 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.

Module 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.

Module 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.

Module 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.

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[7] S. S. Dara, A Textbook of Environmental chemistry and pollution control, S.Chand & Company Ltd.

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[11] Nelson L. Numerow, Industrial water pollution.

[12] James W. Moore and S.Ramamoorthy, Organic chemicals in natural waters

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[14] F. Kreith Handbook of Solid waste management, Mc Graw Hill Inc.

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[18] V K Ahluwalia,Environmental Chemistry, Ane Books Pvt Ltd, New Delhi.

SEMESTER 5

CHE5CBP06: NANOSCIENCE AND NANOTECHNOLOGY

Credits: 4 **Contact lecture hours: 72**

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-dimensiona 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?

Module 1: .Nanomaterials (18 Hrs)

Historical landmarks- terminology-scales-top-down and bottom-up paths in nanoscience- Feynman's hypothesis-low dimensional solids-nanoparticlesfullerene- its discovery-production-contribution to nanotechnology-unusuaproperties of fullerene. Nanotubes:carbon nanotubes- architectural characteristics-synthesis- properties.

Module 2: Nanoscience (18 Hrs)

Its social, economic and ethical perspectives- responsible development of nanotechnology- existing laws and regulations- regulatoryagencies-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 ofnanotechnology.

Module 3: Seeing the nanoworld (18 Hrs)

Fundamental particles-elctromagnetic radiation- its components- impact on matter- the Planck's equation- de Broglie relation- matterwave concept of radiation- concept of colour and vision- spectroscopic methods and radiation- elementary ideas of UV-visible, IR, NMR, XPES and UPES techniques. Xray techniques- SEM, TEM, STM, SPL, and SIMS - their use in the studies ofnanosystems.

Module 4: Applications of nanotechnology (18 Hrs)

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.

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 India Pvt. Ltd. 2009.

[8] L.E. Foster, Nanotechnology: Science, Innovation and Opportunity, Pearson Education, 2008.

[9] http://www.zyvex.com/nanotech/feynman.html

SEMESTER 5

CBCS PROJECT GUIDELINES - BSc CHEMISTRY PROGRAMME

PROJECT

The compulsory project work is a two credit course that can be carried out individually or as a group of three. However, the viva-voce examination on this will be conducted individually. The project completed as lab work under the guidance of a supervising teacher. It is to be submitted during the practical examination for external valuation.

TOPIC SELECTION

The choice is entirely personal with the help of a teacher from the area of interest or career prospects of students which can be done in the college library.

PROJECT WORK AND EXPERIENTIAL LEARNING

Project work is the best way to practice what you have learned. It provides an opportunity to investigate a problem by applying concepts in a scientific manner. It enables the application of conceptual knowledge in a practical situation and to learn the art of conducting a study in a systematic way and presenting its findings in a coherent report.

A MODEL PROJECT DESIGN

1. Selection of atopic
2. Pilot survey- a trial run
3. Significance
4. Review of literature
5. Coverage (Sample and period of study)
6. Data source
7. Methods of analysis, i.e., tools and techniques
8. Limitation of the study
9. Chapter outline
10. Result chapters
11. Conclusion

STRUCTURE OF THE PROJECT

1. Title page
2. Name of the candidate, name and designation of the supervising teacher
3. Declaration of the student
4. Content
5. Introduction
6. Objective
7. Materials and methods
8. Results and discussion
9. Conclusion
10. References

PROJECT GUIDELINES

Project can be done in about 18 hours and shall be of 10-15 pages in writing. Project reports shall be prepared and submitted to the department at the end of the sixth semester and are to be produced before the practical examiners. The valuation will be done in two stages.

Internal evaluation (the supervising teacher will assess the project and award marks).

External evaluation to be done by the practical examiners.

PROJECT EVALUATION

Sl. No.	Component	Internal marks	External marks
1	Report	8	32
2	Presentation	8	32
3	Viva-voce	4	16
	TOTAL	**20**	**80**

SEMESTER 6

CHE6COR09 - INORGANIC CHEMISTRY – IV
(ADVANCED INORGANIC CHEMISTRY)

Credits – 3 **Contact lecture hours: 54**

Aim

The aim of the course is to develop the interest to research and application field.

Objectives

To understand

- the method behind research
- the preparation and uses of inorganic polymers
- preparation and application of nano materials
- the chemistry of the compounds of p block elements
- thermal and chromatographic techniques

Module I: Research in Science (9 Hrs)

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.

Module 2: Inorganic polymers (9 Hrs)

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

Module 3: Nano materials (9 Hrs)

Nano materials – Introduction, General method of synthesis – chemical precipitation, mechano-chemical method, micro emulsion method, reduction technique, chemical vapour deposition and sol-gel method (brief study). Synthesis, Properties and applications of fullerenes and carbon nano tubes.

Module 4: Compounds of p block Elements (9 Hrs)

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).

Module 5: Organometallic Compounds (9 Hrs)

Definition, classification of organometallic compounds, , 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.

Module 6: Analytical Techniques (9 Hrs)

Thermo analytical methods: Principle of thermo gravimetry, differential thermal analysis, differential scanning calorimetry. 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 Rf-Values, significance of Rf 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.

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SEMESTER 6

CHE6COR10 - ORGANIC CHEMISTRY- IV

(ADVANCED ORGANIC CHEMISTRY)

Credit: 3 **Contact lecture hours : 54**

Aim

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

Objectives

To enable the students-

- To learn the chemistry of nitro compounds, amines, heterocyclics.
- To understand and study mechanism of reactions of nitro compounds and amines.
- To have an elementary idea of organic spectroscopy, photochemistry and pericyclic reactions.
- To identify organic compound using UV, IR and PMR spectroscopic techniques and elementary idea on green chemistry and.
- To give an outline of applied organic chemistry including chemotherapy, polymer chemistry, green chemistry, supramolecular chemistry and dyes.
- To develop basic skills required for crystallization, distillation, solvent extraction, TLC and column chromatography.

Module I: Organic compounds containing Nitrogen and Heterocyclic compounds (18 Hrs)

1.1 Nitro compounds (3Hrs**):-** nitromethane- tautomerism- Difference between alkyl nitrites and nitroalkanes. Reduction products of nitrobenzene in acidic, neutral and alkaline media- electrolytic reduction and selective reduction of poly nitro compounds- formation of charge transfer complexes.

1.2 Amines (5Hrs):- 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.

1.3 Diazonium salts (3Hrs):-Preparation, structure, synthetic applications of benzene diazonium chlorides, azo coupling-. Preparation and uses of Phenyl hydrazine. Diazomethane - preparation, structure and synthetic uses. Arndt Eistert synthesis-mechanism –Wolff rearrangement

1.4 Heterocyclic compounds (7Hrs)

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.

Module 2: Structure elucidation using spectral data (12 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 and 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)

Module 3: Pericyclic Reactions and Organic photochemical reactions (6 Hrs)

3.1 Pericyclic reactions:-Classification- electrocyclic, cycloaddition (Diels Alder reaction and its stereochemical aspects) and sigmatropic reactions. Claisen rearrangement

3.2 Photochemical reactions:-Introduction- Photochemical versus Thermal reactions, Jablonski diagram, Norrish reactions of acyclic ketones. Patterno-Buchi reaction, Photo-Fries rearrangement.

Module 4: Applied Organic Chemistry (18 Hrs)

4.1 Chemotherapy (3 Hrs)

Drugs: Introduction, Elementary idea of the structure and mode of action of the following drugs:- Sulphanilamide, Ampicillin, Chloramphenicol, Chloroquine, Paracetamol and Analgin.

Drugs in cancer therapy- Chlorambucil. Application of nanomaterials in medicine.

4.2 Synthetic Polymers (5 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. Plastic identification codes, Biodegradable polymers: PGA, PLA and PHBV. Synthetic rubbers –SBR and Nitrile rubber. Polymerization reactions-Types of polymerization-free radical, cationic and anionic polymerizations - including mechanism.

4.3 Green Chemistry (2Hrs)

Introduction-need of green chemistry-twelve principles of green chemistry, atom economy, microwave and ultrasound assisted green synthesis (elementary idea only), green solvents.

4.4 Supramolecular Chemistry (2Hrs)

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

4.5 Soaps, Detergents and cosmetics (2 Hrs)

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

4.6 Dyes (4 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 Fluorescein 4) Vat dye - indigo 5) Anthraquinone dye - alizarin.

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SEMESTER 6

CHE6COR11 - PHYSICAL CHEMISTRY – III (THERMODYNAMICS AND KINETICS)

Credits : 3 **Contact lecture hours: 54**

Aim

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

Objectives

- To study the laws of thermodynamics
- To derive Gibbs-Helmholtz, Clausius-Clapeyron, Gibbs-Duhem equations
- To derive the relation between Kp, Kc and Kx
- 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 catalysis.

Module 1: Thermodynamics (18 Hrs)

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, Cp and Cv relation in ideal gas systems, change in thermodynamic properties of an ideal gas during (i) isothermal/adiabatic, reversible/irreversible processes. Joule-Thomson experiment, Joule-Thomson coefficient JT , inversion temperature.

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.

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.

Module 2: Chemical Equilibrium and Phase Equilibria (18 Hrs)

Chemical equilibrium: conditions for chemical equilibrium, relation between Kc and Kx – Kp , van't Hoff reaction isotherm. Temperature dependence of Kp – van't Hoff equation.

The phase equilibria: Phase rule, derivation of the phase rule, equilibrium between phases – conditions. One component system – water system, sulphur system. Two component systems – solid-liquid equilibrium – simple eutectic, thermal analysis, 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. Nernst distribution law, thermodynamic derivation, applications of distribution law.

Module 3: Kinetics (18Hrs)

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

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

Kinetics of complex (composite) reactions: Opposing reactions, consecutive reactions, and parallel (simultaneous) reactions. Chain reactions – steady state treatment, hydrogen bromine reaction.

Catalysis: Homogeneous catalysis, enzyme catalysis – Michaelis - Menten equation (no derivation needed). Heterogeneous catalysis – surface catalysis, uni and bi molecular reactions on surface. Elementary idea about autocatalysis.

References

[1] R.P. Rastogi, R.R. Misra, An Introduction to Chemical Thermodynamics, 6th Edn., Vikas Pub. Pvt. Ltd. 2003.

[2] P. Atkins and J Paula, The elements of Physical chemistry, W. H. Freeman, 2009

[3] K.K. Sharma, L.K. Sharma, A Textbook of Physical Chemistry, 4th Edn.,Vikas publishing House, 2009.

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SEMESTER 6

CHE6COR12 - PHYSICAL CHEMISTRY – IV
(SOLUTION CHEMISTRY AND ELECTROCHEMISTRY)

Credit: 3 **Contact lecture hours: 54**

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.

Module 1: Solutions **(18 Hrs)**

Introduction- Binary liquid solutions – Raoult's law- ideal and non-ideal solutions- Gmix, Vmix, and Smix 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.

Module 2: Ionic Equilibria (3Hrs)

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.

Module 3: pH and theory of indicators (3Hrs)

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.

Module 4: Electrical Conductance (15 Hrs)

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

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

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

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

Module 5: Electromotive force (15 Hrs)

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 G, H and S 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.

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SEMESTER 6

CHOICE BASED COURSE - II

(Any one course to be opted from the following courses)

CHE6CBP01: POLYMER CHEMISTRY

Credits: 3 **Contact lecture hours: 54**

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

Module 1: Introduction to Polymers (9Hrs)

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.

Module 2: Physical Properties and Reactions of Polymers (18Hrs)

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.

Module 3: Polymerisation Techniques and Processing (9 Hrs)

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

Module 4: Chemistry of Commercial Polymers (9Hrs)

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.

Module 5: Advances in Polymers (9Hrs)

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

References:

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SEMESTER 6

CHE6CBP02: NANOCHEMISTRY AND NANOTECHNOLOGY

Credits: 3 **Contact lecture hours: 54**

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

Module 1: History **(12Hrs)**

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.

Module 2: Characterization of nanomaterials **(15Hrs)**

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).

Module 3: Electrical and optical properties of nanomaterials (15Hrs)

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

Module 4: Applications of nanomaterials (12Hrs)

Nanocrystals- immunogold labeling- applications in medical diagnosis- nanobased drug delivery- applications in biotechnology- nanosensors- self-assembly, nanosensor based on quantum size effects- nanobiosensors- nanomedicines- destructive applications of nanomaterials- nanomaterials in war.

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SEMESTER 6

CHE6CBP03: INDUSTRIAL CHEMISTRY

Credits: 3 **Contact lecture hours: 54**

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.

Module 1: Industrial Requirements (18 hours)

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.

Module 2: Petrochemical Industries (18 hours)

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.

Module 3: Fertilizers and Speciality Chemicals (9 hours)

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.

Module 4: Oils, Soaps and Detergents (9 hours)

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, gamexane, malathion, parathion.

References:

[1] B.K Sharma, Industrial chemistry, Goel publishing House, Meerut, 2003.

[2] C.E Drydens, Outlines of Chemical Technology, 3rd Edn., (Edited and Revised by M. Gopal Rao and M. Sittig) Eastwest press, NewDelhi, 1997.

[3] R.V Shreve, Chemical Process Industries, 5th Ed., Mc Graw Hill Pub., 1984.

[4] H. Steines, Introduction to Petrochemicals, Pergaman Press, 1961.

SEMESTER 6

CHE6CBP04: ENVIRONMENTAL CHEMISTRY

Credits: 3 **Contact lecture hours: 54**

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

Module 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.

Module 2: Chemical toxicology (10 Hrs)

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

Module 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.

Module 4: Water pollution **(17 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, 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.

Module 5: Lithosphere **(12 Hrs)**

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, 3rd Edn., New age International Pvt. Ltd. 1996.

[2] G.T. Tyler, Living in the Environment, Tomson Brooke/Cole, 2003.

[3] N. Manivasakam, Physico-chemical examination of water, sewage and industrial effluents, Pragathi prakashan, 2009.

[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, 2004.

[6] B. B. Kebbekus and S. Mitra, Enveronmental chemical analysis, Blacke Academic & Professional, 1998.

[7] S.S.Dara, A Textbook of Environmental chemistry and pollution control, S.Chand & Company Ltd, 2014.

[8] R.A. Malaviya, Environmental Pollution and its control under international law, Rawat Publication, 1997.

[9] Pramod Singh, Environmental pollution management. Anmol Pub, 1985.

[10] G. K. Ghosh, Environmental pollution – A scientific study. APH Publishing Corporation, New Delhi, 1992.

[11] Nelson L. Numerow, Industrial water pollution. R.E. Krieger Publishing Company, 1978.

[12] James W. Moore and S.Ramamoorthy, Organic chemicals in natural waters, Springer science+ Business media, NewYork, 1984.

[13] Hutzinger, Aquatic pollutants, Van Lelyveld and Zoeteman, New York, 1977

[14] F. Kreith, Handbook of Solid waste management, Mc Graw Hill Inc, 1994.

[15] Peter O' Neil, Environmental Chemistry, Blackie Academic and Professional, London, 2004.

[16] S P Mishra and S N Pandey, Essential Environmental Studies, Ane Books Pvt. Ltd, New Delhi, 2011.

[17] V K Ahluwalia, Environmental Chemistry, Ane Books Pvt Ltd, New Delhi, 2012.

SEMESTER 6

CHE6CBP05: SOIL AND AGRICULTURAL CHEMISTRY

Credits: 3 **Contact lecture hours: 54**

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

Module 1: Origin of Soil **(9 Hrs)**

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.

Module 2: Physical Properties of Soil **(9 Hrs)**

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.

Module 3: Chemistry Aspects of Soil (9 Hrs)

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.

Module 4: Plant Nutrients (18 Hrs)

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.

Module 5: Pesticides, Fungicides and Herbicides (9 Hrs)

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.

References:

[1] T. D. Biswas, and S. K. Mukeherjee, Textbook of Soil Science, 1987.

[2] A.J. Daji, A Textbook of Soil Science, Asia Publishing House, Madras, 1970.

[3] S.L Tisdale, W.L Nelson, and J.D. Beaton, Soil Fertility and Fertilizers, Macmillian Publishing Company, New York, 1990.

[4] P.R Hesse, A Textbook of Soil Chemical Analysis, John Murray, New York, 1971.

[5] K.H Buchel, Chemistry of Pesticides, John Wiley & Sons, New York, 1983.

[6] U.S. Sree Ramula, Chemistry of Insecticides and Fungicides, Oxford and IBH Publishing Co., New Delhi, 1979.

SEMESTER 6

CHE6CBP06: PHARMACEUTICAL CHEMISTRY

Credits: 3 **Contact lecture 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

Module 1: Introduction (18 Hrs)

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, LD50 and ED50 therapeutic index, drug dosage.

Module 2:Designation of Drugs (9 Hrs)

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.

Module 3: Common Body Ailments (9 Hrs)

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.

Module 4: Health Promoting Medicines (18 Hrs)

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.

References

[1] J. Ghosh, Pharmaceutical chemistry, S. Chand and Company Ltd., New Delhi, 2006.

[2] Lakshmi S., Pharmaceutical chemistry, S. Chand & Sons, New Delhi, 1995.

[3] Ashutosh Kar, Medicinal chemistry, Wiley Eastern Ltd., New Delhi, 1993.

[4] D. William & T. Lemke, Foyes principles of medicinal chemistry, 5th Edn., BI publishers, 2005,

[5] Romas Nogrady, Medicinal chemistry, 2nd Edn., Oxford University, 2004.

SEMESTERS 5 & 6

PRACTICAL: CHE6P03 - VOLUMETRIC ANALYSIS

Credits : 2 **Contact lab hours: 54 + 54= 108**

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. Permanganometry

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

C. Dichrometry

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

D. 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.

E. 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, 2006.

[2] G.H Jeffery, J. Bassett, J. Mendham, R. C Denney, Vogel's Textbook of Quantitative Chemical Analysis 5th Edn, John Wiley & Sons.,1989.

[3] G. D. Christian, Analytical Chemistry, 6th Edn., John Wiley and Sons, 2004.

[4] R.D. Day, A.L. Underwood, Quantitative analysis,6th Edn., Prentice Hall of India Pvt. Ltd.,1991.

SEMESTERS 5 & 6

PRACTICAL: CHE6P04 – ORGANIC CHEMISTRY PRACTICAL-II

Credits :2 **Contact lab hours: 36+36= 72**

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) Crystallization – Any four compounds using ethyl acetate, ethanol, and water- Record the yield recovery.

c) Soxhlet extraction

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. Preparations

Single stage 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).
6) Acylation (Benzoylation of aniline, phenol, β -naphthol).
7) Esterification (benzoic acid).
8) Iodoform from acetone or ethyl methyl ketone.
9) Side chain oxidation (benzyl chloride to benzoic acid).
10) Claisen –Schmidt: Dibenzal acetone from benzaldehyde

The product to be recrystallized and purity checked by TLC and melting point.

References

[1] F.G. Mann and B.C. Saunders, 'Practical Organic Chemistry' 4th Edn., Pearson Education Ltd, 1960.

[2] A.I. Vogel, Vogel's Textbook of Practical Organic Chemistry, Including Qualitative Organic Analysis English Language Book Society Longman, 1978.

[3] V.K. Ahluwalia and S.Dhingra, Comprehensive Practical Organic Chemistry, Universities Press, 2004.

[4] Gem Mathew, Practical Organic Chemistry.

SEMESTERS 5 & 6

PRACTICAL: CHE6P05 – PHYSICAL CHEMISTRY PRACTICAL

Credits : 2 **Contact lab hours: 54 + 54= 108**

1) Viscosity – percentage composition of a mixture.
2) Heat of solution – KNO_3, NH_4Cl
3) Heat of neutralization strong acid with strong base.
4) Determination of equivalent conductance of an electrolyte
5) Conductometric titration – strong acid *vs.* strong base.
6) Determination of partition coefficient of non-volatile solute between two immiscible solvents. E.g. I_2 between CCl_4 and water.
7) Transition temperature of salt hydrates. (Sodium thiosulphate, sodium acetate)
8) Critical solution temperature. Phenol-water system
9) Determination of molecular weight by Rast's Method (using naphthalene, camphor or biphenyl as solvent and acetanilide, p-dichlorobenzene etc. as solute.)
10) Kinetics of simple reactions eg. Acid hydrolysis of methyl acetate.
11) Potentiometric titration – Fe^{2+} *vs.* $Cr_2O_7^{2-}$, I^- *vs.* MnO_4^-
12) Data analysis of kinetic experiments using spreadsheet program (determination of rate constant)
13) Determination of equivalence point of potentiometric and conductometric titrations using spreadsheet program.

References

[1] W.G. Palmer, Experimental physical chemistry, Cambridge University Press, 1941.

[2] J.B. Yadav: Advanced Practical Physical Chemistry, 9th Edn., Goel Publishing House, 1989.

[3] R.C. Das and B. Behra, Experimental Physical Chemistry, Tata McGraw hill, New Delhi, 1983.

[4] K.K. Sharma and DS Sharma, Introduction to Practical Chemistry, Vikas Publishing House, New Delhi, 1989.

SEMESTERS 5 & 6

PRACTICAL: CHE6P06 – GRAVIMETRIC ANALYSIS

Credit : 1 **Contact lab hours: 36**

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': 3rd Edn., ELBS and Longman, London, 1971.

[2] J.Bassett, R.C.Denney, G.H. Heffery and J Mendham,. 'Vogel's Textbook of quantitative Inorganic Analysis' John Wiley & Sons, 5th Edn., 1989.

B.Sc. COMPLEMENTARY COURSE - CHEMISTRY

COMPLEMENTARY COURSES - DETAILED SCHEME

Sl No.	Course Code	Title of the course	Exam. Duration Hours	Credit per Course	Total Contact Hours for the course	Contact Hours/ week
		First Semester				
		Theory:				
1.	CHE1CMP01	Basic Theoretical and Analytical Chemistry	3	2	36	2
		Practical:		*Evaluation at the end of the 2nd semester*		
	CHE2CP01	Volumetric Analysis	3		36	2
		Second Semester				
		Theory:				
2.	CHE2CMP02	Basic Organic Chemistry	3	2	36	2
		Practical:				
	CHE2CP01	Volumetric Analysis	3	2	36	2
		Third Semester				
3.		Theory:				
	CHE3CMP03.1	Advanced Physical Chemistry	3	3	54	3
	CHE3CMP03.2	- I	3	3	54	3
		Advanced Inorganic and Organic Chemistry - I		*Evaluation at the end of 4th semester*		
	CHE4CP02.1	Physical Chemistry Practical	3		72	2
	CHE4CP02.2	Organic Chemistry Practical	3		72	2
		Fourth Semester				
4.		Advanced Physical Chemistry				
	CHE4CMP04.1	- II	3	3	54	3
	CHE4CMP04.2	Advanced Bio-organic Chemistry	3	3	54	3
	CHE4CP02.1	Physical Chemistry Practical	3	2	72	2
	CHE4CP02.2	Organic Chemistry Practical	3	2	72	2

SEMESTER I

CHEICMP0I- BASIC THEORETICAL AND ANALYTICAL CHEMISTRY

(Common to physical sciences and life sciences)

Credits: 2 **Contact Lecture Hours: 36**

Aim

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 and the concept of equilibrium.
- To understand principles of analytical chemistry and chromatographic techniques.
- To understand the basics of environmental chemistry.

Module 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 and d), Electronic configuration of atoms- Aufbau principle, Hund's rule of maximum multiplicity and Pauli's exclusion principle.

Module 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, Ka and Kb, pKa and pKb, buffer solution (elementary idea only), Solvation, solubility, solubility product, common ion effect. Applications.

Module 3: Environmental Chemistry (8 Hrs)

Atmosphere, Hydrosphere, Lithosphere, Biosphere. Natural resources, Renewable energy resources, Solar energy, Solar cells, Wind Energy, Biomass Energy, Biogas. Environment pollution: Air pollution, Water pollution, Nuclear pollution. Air pollutants-CO_2, Sulphur oxides, oxides of nitrogen. Effect of fluorocarbons on ozone depletion, green house effect. Control of air pollution. Water pollution: Some industrial

sources of water pollution-soap, detergent, fertilizer and industries, Control of water pollution. Nuclear hazards: Sources-Natural, Anthropogenic, Effects of radiation, Control of Nuclear pollution. Role of an individual in prevention of pollution.

Module 4: Analytical Chemistry- Basic principles (9 Hrs)

Laboratory operations(Non-evaluative): Use of different glassware 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 titrimetric 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 of separation by precipitation. Separation and purification techniques: Recrystallisation, use of drying agents, sublimation. General principles of distillation, fractional distillation, distillation under reduced pressure. Solvent extraction.

Module 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), R_f value, Column chromatography, Gas chromatography(GC), High performance liquid chromatography (HPLC), Ion exchange chromatography (IEC).

References

[1] B. R. Puri, L. R. Sharma, M.S. Pathania, Elements of Physical Chemistry, 3rd Edn., Vishal Pub. Co. Ltd., 2008.

[2] B. R. Puri, L. R. Sharma, K.C. Kalia, Principles of Inorganic Chemistry, 3rd Edn. Milestone Pub. Co. Ltd., 2009.

[3] R. A. Day Junior, A.L. Underwood, Quantitative Analysis, 5th Edn., Prentice Hall of India Pvt. Ltd. New Delhi, 1988.

[4] J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, Vogel's Text Book of Quantitative Chemical Analysis, 6th Edn. Pearson Education 2003.

[5] J.H. Kennedy, Analytical Chemistry: Principles, Saunders College Pub., 1990.

[6] A. K. De, Environmental Chemistry, 3rd Edn., New Age International Pvt. Ltd., 1996.

SEMESTER 2

CHE2CMP02- BASIC ORGANIC CHEMISTRY

(Common to physical sciences & life sciences)

Credits: 2 **Contact Lecture Hours: 36**

Aim

To understand some fundamental aspects of organic chemistry.

Objectives

- To study stereochemistry of organic compounds, mechanisms of some basic organic reactions.
- To understand classification of polymers, polymerization reactions, and the structure and uses of some commercial and natural polymers.

Module 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, resolution. Conformation-Newman projection, Saw-horse projection. Conformations of ethane, n-butane and cyclohexane.

Module 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 and 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. Markwonikoff's rule, peroxide effect.

Elimination reactions: E1 and E2 mechanisms.

Module 3: Natural and Synthetic Polymers (8 Hrs)

Classification of polymers: Natural, synthetic; linear, cross-linked and network polymers. 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.

References

[1] I.L. Finar, Organic Chemistry - Volume I, Pearson Education, 1973.

[2] S.M. Mukherji, S.P. Singh, R.P. Kapoor, Organic Chemistry Vol. 1, New Age International (P) Ltd,2006.

[3] Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edn., Orient Longman, 1988.

[4] S. M. Mukherji, S.P Singh, Reaction Mechanism in Organic Chemistry, Macmillan, 3rd Edn., 2003.

[5] V. R. Gowariker, Polymer Chemistry, New Age International Pvt. Ltd., New Delhi, 2010.

[6] K.S. Tiwari, N.K. Vishnoi, A Text Book of Organic Chemistry, Vikas Publishing House, 2006.

[7] Bahl and B.S. Bahl, Advanced Organic Chemistry, 1st Multicolour Edition, S. Chand & Company, New Delhi, 2010

SEMESTERS 1 & 2

CHE2CP01 VOLUMETRIC ANALYSIS PRACTICAL - I

(Common to physical sciences & life sciences)

Credits: 2 **Contact Lab Hours: 36+36 = 72**

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 ion (external indicator).
2. Estimation of Ferrous ion (internal indicator).
3. Estimation of $FeSO_4 \cdot 7H_2O$ (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.

References

[1] D.A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry, 8th Edn, Brooks/Cole Nelson, 2006.

[2] A.I. Vogel, G.H. Jeffery, Vogel's Textbook of Quantitative Chemical Analysis, 6th Edn., Longman Scientific & Technical, 1989.

[3] G. D. Christian, Analytical Chemistry, 6th Edn, John Wiley & Sons, 2004.

[4] R.D. Day, A.L. Underwood, Quantitative analysis, 6th Edn., Prentice Hall of India Pvt. Ltd., 1991.

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SEMESTER 3

CHE3CMP03.1 - ADVANCED PHYSICAL CHEMISTRY – I

(For students who have opted Physical Sciences as Main)

Credits: 3 **Contact Lecture Hours: 54**

Aim

To give the students a thorough knowledge about molecular structure and its electrical and nuclear properties.

To develop proper aptitude towards the study of molecular structure.

Objectives

- To enable the students to get a clear idea about the symmetry and molecular structure.
- To study nuclear chemistry, surface chemistry, liquid state and thermodynamics.

Module 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. Half life period, disintegration constant, Nuclear Reactions: fission and fusion, chain reactions, disposal of nuclear wastes.

Reactors – conventional and breeder, energy generation, rock dating and radiocarbon dating, neutron activation analysis; medical, agricultural and industrial applications.

Module 2: Symmetry and Molecular Structure (6 Hrs)

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

Module 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, Bravais lattices, X-ray diffraction – Bragg's equation, structure determination of NaCl by X-ray diffraction. Theories of Solids: 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.

Module 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.

Module 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.

Module 6: Laws of Thermodynamics (8 Hrs)

System and surroundings. 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 and spontaneity based on ΔG values. Effect of temperature on spontaneity of reaction. Third law of thermodynamics.

References

[1] H.J. Arnikar, Essentials of Nuclear Chemistry, 4th 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] P. Atkins and J Paula, The elements of Physical chemistry, Oxford University Press, 2009.

[4] A.R. West, Solid State Chemistry and its applications, John Wiley, 2014.

[5] L.V. Azaroff, Introduction to Solids, McGraw Hill, 1984.

SEMESTER 3

CHE3CMP03.2- ADVANCED INORGANIC AND ORGANIC CHEMISTRY

(For students who have opted Biological Sciences)

Credits: 3 **Contact Lecture Hours: 54**

Aim

To promote understanding of 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, chemotherapy and the role of chemistry in agriculture.

Module 1: 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.

Module 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, diothiocarbamates.

Excessive use of pesticides – environmental hazards.

Module 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).

Module 4: Aromaticity and Heterocyclic Compounds (12 Hrs)

Aromaticity – Huckel rule, theories of aromaticity, structure and aromaticity of furan, pyrrole, pyridine, indole, pyrimidine and purine.

Heterocyclic compounds- classification, nomenclature and methods of preparation (any one method) of furan, pyrrole, pyridine, indole, pyrimidine and purine.

Module 5: Chemotherapy (6 Hrs)

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

Module 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 (structures not needed).

References

[1] I.L. Finar, Organic Chemistry - Volume I, Pearson Education, 1973.

[2] I. L. Finar, Organic Chemistry – Volume II, Pearson Education, 1956.

[3] H. J. Arnikar, Essentials of nuclear chemistry, Revised 4th Edn., New Age International Publications,1995.

[4] G. T. Austin, Shreve's Chemical process Industries, 5th Edn., McGraw Hill,1984.

[5] Rastogi, Biochemistry, Tata McGraw. Hill Publication, 1996.

[6] B. Sreelakshmi, Food Science, New Age International Pvt Ltd, New Delhi, 2010.

[7] C. N. Pillai, Organic Chemistry for under graduates, Universities Press, 2008.

[8] A. Kar, Medicinal Chemistry, New Age International, 2007.

SEMESTER 4

CHE4CMP04.1- ADVANCED PHYSICAL CHEMISTRY – II
(For students who have opted Physical Sciences as Main)

Credits: 3 **Contact Lecture Hours: 54**

Aim

To promote understanding of the basic facts and concepts in spectroscopy.

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 and photochemistry.
- To enable the students to study the rules governing chemical reactions and factors influencing them.
- To study basics of electrochemistry, electro motive force and chemical kinetics.

Module1: 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.

Module 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 and determination of order of reactions. Influence of temperature on reaction rate – Arrhenius equation, concept of activation energy, importance of activated complex, catalysis –examples.

Module 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.

Module 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.

Module 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.

Module 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. Co. Ltd., New Delhi, 1994.

[2] K.K. Rohatgi-Mukherjee, Fundamentals of Photochemistry, 2nd Edn., New Age International, 1986.

[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.

CHE4CMP04.2- ADVANCED BIO- ORGANIC CHEMISTRY

(For students who have opted Biological Sciences)

Credits: 3 **Contact Lecture Hours: 54**

Aim

To promote understanding of facts and concepts in bioorganic chemistry.

To develop interest in the study of biomolecules.

Objectives

- To study the classification and properties of amino acids.
- To study the structure and functions of proteins and nucleic acids, ADP, ATP and AMP.
- To study classification, properties and structure of carbohydrates.
- To study classification and characteristics of enzymes and mechanism ofenzyme action.
- To study fundamentals of vitamins, hormones, steroids, essential oils, lipids and alkaloids.

Module 1: Amino acids and proteins (12 Hrs)

Classification of amino acids, zwitter ion and isoelectric point, general chemical properties of amino acids, synthesis of glycine, alanine, phenyl alanine (anyone method). Peptides – peptide bond- dipeptides (eg. Aspartame), tripeptides (eg. Glutathione), polypeptides. Proteins- amino acids as building block of proteins, classifications, prosthetic group, properties- denaturation, tests of protein. Structure of proteins- primary, secondary, tertiary and quaternary structures. Amino acid sequence- Analysis of amino acids- N-terminal amino acid analysis –Edman method, sequenator, DNP method. C-Terminal amino acid analysis- enzymatic method (Carboxypeptidase).

Module 2: Enzymes and Nucleic acids (9 Hrs)

Enzymes – General nature, nomenclature, classification, cofactors-coenzyme, characteristics of enzyme action, mechanism of enzyme action-the lock and key model and the induced fit model, Kinetics of enzyme catalysis, factors affecting enzyme action, enzyme inhibitors, enzyme deficiency diseases, uses of enzymes.

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

Nucleic acids- Chemical composition, nucleosides, nucleotides. Structure of DNA &RNA (mention only different types of bases and sugars, no structures are required). Structural biological functions- DNA replication, protein biosynthesis, coding for amino acids.

Module 3: Carbohydrates (11 Hrs)

Classification of carbohydrates, preparation, physical and chemical properties of glucose, fructose and sucrose. Configuration of glyceraldehyde- D and L configuration, Hemiacetal form, Haworth projections of D(+)glucose and D(-) fructose, sucrose and maltose (ring size determination not expected). Mutarotation, Inversion of cane sugar. Conversion of glucose to fructose and vice-versa.Structure of starch and cellulose. Industrial applications of cellulose.

Module 4: Vitamins, Steroids and Hormones (9 Hrs)

Vitamins-Classification, Structure, properties, biological functions and deficiency diseases of vitamin A, B and C.

Steroids- General introduction, structure, stereochemistry and physiological importance of cholesterol and bile acids.

Hormones-Introduction, steroid hormones- sex hormones and adrenal cortex hormones, peptide hormones-insulin, oxytocin, vasopressin and angiotensin II.

Amine hormones-Adrenaline, thyroxine, artificial hormones- Anabolic streroids, Oral Contraceptives, Diethylstilbosterol and Prednisone.

(Structures not required. Mention only functions.)

Module 5: Lipids (5 Hrs)

Classification- Simple lipids and complex lipids with examples, occurrence, isolation, nomenclature, properties and biological functions of oils and fats, Rancidity, Analysis of oils and fats- acid value, saponification value and iodine value.

Soaps, types of soaps, cleaning action of soap. Detergents-anionic, cationic and non ionic detergents, superiority of detergents over soap.

Module 6: Natural Products **(4 Hrs)**

Terpenoids: classification, isoprene rule.

Essential oils- citral and geraniol –chemical properties and uses.

Alkaloids- Classification based on source, isolation, general properties, tests and physiological effects. Structure elucidation of coniine and nicotine.

Module 7: Bioenergetics **(4 Hrs)**

Thermodynamics- First and Second laws of thermodynamics (qualitative and quantitative statements only), Gibbs free energy, condition for spontaneity, exergonic and endergonic reactions.

Introduction to metabolism- catabolism, anabolism, Carbohydrate metabolism- introduction, aerobic and anaerobic pathways, glycolysis and its pathways.

References

[1] I. L. Finar, Organic Chemistry - Volume I, Pearson Education, 1973.

[2] I. L. Finar, Organic Chemistry – Volume II, Pearson Education, 1956.

[3] K. S. Tewari, N. K. Vishnoi, A Text Book of Organic chemistry, 3rd Edn.,Vikas Publishing House Pvt. Ltd,2006.

[4] Rastogi, Biochemistry, Tata McGraw Hill Publication, 1996.

[5] D. Voet, J. G. Voet, Biochemistry, 4th Edn., John Wiley and Sons, 2010.

[6] O.P. Agarwal, Chemistry of Natural Products, Goel Publications, 1989.

SEMESTERS 3 & 4

CHE4CP02.1- PHYSICAL CHEMISTRY PRACTICAL

(For students who have opted Physical Sciences)

Credits: 2 **Contact Lab Hours: 36+36 = 72**

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 naphthalene, camphor or biphenyl as solvent and acetanilide, p–dichlorobenzene etc. as solute).
12. Kinetics of simple reactions, eg. Acid hydrolysis of methyl acetate.

References

[1] W.G. Palmer, Experimental Physical Chemistry, Cambridge University Press, 1941.

[2] J.B. Yadav, Advanced Practical Physical Chemistry, 9th Edn., Goel Publishing House, 1989.

[3] R.C. Das and B. Behra, Experimental Physical Chemistry, Tata McGraw Hill. New Delhi, 1983.

[4] K.K. Sharma and D.S. Sharma, Introduction to Practical Chemistry, Vikas Publishing House, New Delhi, 1989.

SEMESTERS 3 & 4

CHE4CP02.2 - ORGANIC CHEMISTRY PRACTICAL

(For students who have opted Biological Sciences)

Credits: 2 **Contact Lab Hours: 36+36 = 72**

1. Tests for elements: Nitrogen, Halogen and Sulphur (Green methods can also be included).
2. Study of reactions of common functional groups.
3. 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, acetophenone, benzophenone, benzoic acid, phthalic acid, cinnamic acid, salicylic acid, ethyl benzoate, methyl salicylate, benzamide, urea, aniline, N,N-dimethyl aniline, nitrobenzene, *m*-dinitrobenzene and glucose.
4. Organic preparation involving halogenation, nitration, oxidation, reduction, acetylation, benozylation, hydrolysis and diazotization.
5. Determination of R_f value (non-evaluative).
    1. o-nitroaniline
    2. p-nitroaniline
6. Determination of Physical constants.
    1. Melting point
    2. Boiling point

References

[1] A.I. Vogel, B.S. Furniss, Vogel's Textbook of Practical Organic Chemistry, Longman, 1989.

[2] F.G. Mann and B.C. Saunders, Practical Organic Chemistry, 4th Edn., Pearson Education, 2009.

[3] V. K. Ahluwalia and S. Dhingra, Comprehensive Practical Organic Chemistry, Universities Press, 2004.

B.Sc. CHEMISTRY

ENVIRONMENT AND WATER MANAGEMENT

B.Sc. CHEMISTRY- ENVIRONMENT & WATER MANAGEMENT - DETAILED SCHEME

	Code	Course	Hours/ week	Credit	Marks		
					Internal	External	Total
Semester 1	ENG1CMR01	Common Course- English	5	4	20	80	100
	CHE1COR01	Inorganic Chemistry - I (General Inorganic Chemistry)	2	2	20	80	100
	CHE2P01	Qualitative Inorganic Analysis	2	1	Evaluation at the end of second semester		
	ENV1COR01	Basic Concepts of Environmental Sciences	3	3	20	80	100
	ENV1COR02	Environmental Toxicology and Occupational Health	3	3	20	80	100
	ENV2P01	Physico – Chemical Analysis of Water	2	1	Evaluation at the end of second semester		
	MAT1CMP01	Complementary mathematics	4	3	20	80	100
	PHY1CMP01	Complementary Physics	2	2	20	80	100
	PHY2CP01	Complementary Physics Practical	2	1	Evaluation at the end of second semester		
	Total		**25**	**20**			**600**
Semester 2	ENG2CMR02	Common Course- English	5	4	20	80	100
	CHE2COR02	Inorganic Chemistry –II (Atomic Structure And Chemical Bonding)	2	2	20	80	100
	CHE2P01	Qualitative Inorganic Analysis	2	1	20	80	100
	ENV2COR03	Atmospheric Chemistry and Air Pollution	3	3	20	80	100
	ENV2COR04	Environmental Pollution	3	3	20	80	100
	ENV2P01	Physico – Chemical Analysis of Water	2	1	20	80	100
	MAT2CMP02	Complementary mathematics	4	3	20	80	100
	PHY2CMP02	Complementary Physics	2	2	20	80	100
	PHY2CP01	Complementary Physics Practical	2	1	20	80	100
	Total		**25**	**20**			**900**

Semester 3	CHE3COR03	Organic Chemistry -1 (Reaction Mechanism & Stereochemistry)	3	3	20	80	100
	CHE4P02	Organic Chemistry Practical –I	2	1	Evaluation at the end of fourth semester		
	ENV3COR05	Environmental Analytical Techniques	3	3	20	80	100
	ENV3COR06	Environmental Engineering	3	3	20	80	100
	ENV4P02	Physico Chemical Analysis of Soil and Effluent – I	2	1	Evaluation at the end of fourth semester		
	ENV4P03	Physico Chemical Analysis of Soil and Effluent – II	2	1	Evaluation at the end of fourth semester		
	MAT3CMP03	Complementary mathematics	5	4	20	80	100
	PHY3CMP03	Complementary Physics	3	3	20	80	100
	PHY4CP02	Complementary Physics Practical	2	1	Evaluation at the end of fourth semester		
	Total		**25**	**20**			**500**
Semester 4	CHE4COR04	Organic Chemistry –II (Functional Group Chemistry)	3	3	20	80	100
	CHE4P02	Organic Chemistry Practical–I	2	1	20	80	100
	ENV4COR07	Environmental Microbiology and Biotechnology	3	3	20	80	100
	ENV4COR08	Environmental Management	3	3	20	80	100
	ENV4P02	Physico Chemical Analysis of Soil and Effluent – I	2	1	20	80	100
	ENV4P03	Physico Chemical Analysis of Soil and Effluent – II	2	1	20	80	100
	MAT4CMP04	Complementary mathematics	5	4	20	80	100
	PHY4CMP04	Complementary Physics	3	3	20	80	100
	PHY4CP02	Complementary Physics Practical	2	1	20	80	100
	Total		**25**	**20**			**900**

Semester 5	CHE5COR05	Inorganic Chemistry- III (Coordination Chemistry& Bioinorganic Chemistry)	3	3	20	80	100
	CHE5COR06	Organic Chemistry-III (Natural Products)	3	3	20	80	100
	CHE5COR07	Physical Chemistry- I (States Of Matter And Surface Chemistry)	2	2	20	80	100
	CHE5COR08	Physical Chemistry- II (Quantum Mechanics, Spectroscopy And Photochemistry)	3	3	20	80	100
	CHE5CBP01	Choice Based Course - I	4	4	20	80	100
	CHE6P03	Volumetric Analysis	3	1	Evaluation at the end of sixth semester		
	CHE6P04	Organic Chemistry Practical- II	2	1	Evaluation at the end of sixth semester		
	CHE6P05	Physical Chemistry Practical	3	1	Evaluation at the end of sixth semester		
	CHE6D01	Project	2	2	Evaluation at the end of sixth semester		
	Total		**25**	**20**			**500**
Semester 6	CHE6COR09	Inorganic Chemistry – IV (Advanced Inorganic Chemistry)	3	3	20	80	100
	CHE6COR10	Organic Chemistry- IV (Advanced Organic Chemistry)	3	3	20	80	100
	CHE6COR11	Physical Chemistry – III (Thermodynamics And Kinetics)	3	3	20	80	100
	CHE6COR12	Physical Chemistry – IV (Solution Chemistry And Electrochemistry)	3	3	20	80	100
	CHE6CBP01	Choice Based Course - II	3	3	20	80	100
	CHE6P03	Volumetric Analysis	3	1	20	80	100
	CHE6P04	Organic Chemistry Practical- II	2	1	20	80	100
	CHE6P05	Physical Chemistry Practical	3	2	20	80	100
	CHE6P06	Gravimetric Analysis	2	1	20	80	100
	CHE6D01	Project and Viva			20	80	100
	Total		**25**	**20**			**1000**

SEMESTER 1

CHE1COR01 – INORGANIC CHEMISTRY – I
(GENERAL INORGANIC CHEMISTRY)

Credits: 2 **Contact lecture hours: 36**

Aim

To give the students a through knowledge about the role of chemistry as a central science and to give an outline an periodic table, environmental chemistry and analytical principles.

Objectives

- To have a outline of the methodology of science in general and chemistry in particular.
- To study the periodic properties of elements.
- To study the analytical principles and good laboratory practices and to develop skills required for qualitative and quantitative inorganic analysis. various atom models.
- To study the environmental chemistry.

Module 1: Perspectives of Sciences **(9 Hrs)**

Types of knowledge: Practical, theoretical and scientific knowledge. What is science? Scientific statements, Scientific methods – Hypothesis – theories and laws in science – observations, evidences and proofs, Scientific problem- induction, deduction, Revision of theories- Atomic theory- Democritus, Dalton, Thomson, Rutherford's atom model- postulates- demerits, Bohr atom model- postulates-merits,-demerits, Somerfield extension of Bohr theory, Schrödinger model (wave equation only, derivation not required). Role of chemistry as a central science connecting physics, biology and other branches of science. Basic ideas of interdisciplinary areas involving chemistry- inorganic chemistry, nano chemistry, biochemistry, nuclear chemistry, organic chemistry, physical chemistry, analytical chemistry, environmental chemistry, combinatorial chemistry, medicinal chemistry, engineering chemistry.

Module 2: Periodic classification (9 Hrs)

Modern periodic law – long form periodic table – Periodic classification of elements – groups and periods, s, p, d, f- block elements. Periodicity in properties – atomic, ionic, covalent radii. Factors affecting trends in periodic table – ionisation potential, electron affinity, electronegativity. Approaches of Pauling, Allred-Rochows, Mulliken, factors determining electronegativity, application of electronegativity, elecronegativity difference and percent ionic character. Anomalous behaviour of 1^{st} element of a group – diagonal relationship.

Module 3: Analytical Principles (9 Hrs)

3.1 Laboratory hygiene & safety-storage and handling of chemicals. Simple first aids: electric shocks, fire, cut glass, inhalation of poisonous gases, accidents due to acids and alkalies, burns due to phenol and bromine. Disposal of sodium and broken mercury thermometer – use of $CaCl_2$ & Silica gel in desiccators. Awareness of material safety data sheet (MSDS). R&S (elementary idea only). Good Laboratory Practices- Laboratory sign.

3.2 Inorganic qualitative analysis - Common ion effect, solubility product –Principle, Applications of solubility product and common ion effect in the precipitation of cations, principle and procedure of Interfering acid radicals and their elimination (oxalate, fluoride, borate, phosphate, chromate, arsenite and arsenate). Primary and secondary standards, standard solutions, Normality, molarity, molality and related problems. Theory of titrations involving acids and bases, $KMnO_4$, $K_2Cr_2O_7$. Indicators – Theory of acid-base, redox, adsorption indicators. Complexometric titrations (basic theory and principle only).

Module 4: Environmental Chemistry (9 Hrs)

4.1 Environmental segments – Lithosphere, Hydrosphere, Biosphere, Atmosphere. Composition and structure of atmosphere – Troposphere, Stratosphere, Mesosphere, Thermosphere.

4.2 Air pollution - 3 types of classification. Types of pollutants – CO, CO_2, NO, SO_2, H_2S, Cl_2, CFC, particulate matter, metals, fly ash, asbestos, hydrocarbons – their source and influence. Ozone layer depletion, ozone hole, protection of ozone umbrella, acid rain, green house effect, photochemical smog. Management of air pollution.

4.3 Water pollution: classification of pollutants - organic, inorganic, suspended solids (heavy metals Pb, Hg, Cd) and sediments, radioactive materials, heat, industrial waste, sewage water, detergents, agricultural pollutants (eutrophication of water reservoirs). Treatment of industrial waste water, quality of drinking water, Indian standard and WHO standard, Dissolved oxygen, BOD, COD.

4.4 Soil pollution - pesticides, fertilizers, industrial waste, plastics.

4.5 Control of pollution.

References

[1] B.R. Puri, L.R. Sharma, K.C. Kalia, Principles of Inorganic Chemistry, 31st Edn., Milestone Publishers, New Delhi, 2013.

[2] J. A. Lee, Scientific Endeavor, Pearson Education India, 2010.

[3] D.A. Skoog, D.M. West and S.R. Crouch, Fundamentals of Analytical Chemistry 8th Edn., Brooks/Cole Nelson.

[4] A.I. Vogel, G.H. Jeffery, Vogel's Textbook of Quantitative Chemical Analysis, 6th Edn., Longman Scientific & Technical, 1989.

[5] S. K. Banerji, Environmental Chemistry, 2nd Edn., PHI Learning Pvt. Ltd., 1999.

[6] B.K. Sharma, Air Pollution, Krishna Prakashan Media, 1991.

[7] V.K. Ahluwalia, Environmental Studies: Basic Concepts, The Energy and Resources Institute (TERI), 2013.

[8] G.W. van Loon and S.J. Duffy, Environmental Chemistry: A global perspective, Oxford University Press, 2000.

[9] G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th Edn., Pearson Education India, 2008

[10] R.H.Hill, D. Finster, Laboratory safety for chemistry students, 1st Edn, wiley, Hoboken N J, 2010.

[11] APHA Standard Methods for Examination of Water and Waste water, American Public Health Association, Newyork, 1985.

SEMESTER I

ENV1COR01: BASIC CONCEPTS OF ENVIRONMENTAL SCIENCE

Credit: 3 **Contact Lecture Hours: 54**

Aim

To get a basic idea about environmental science, biodiversity, ecology, ecosystem and natural resources.

Objectives

- To understand the components of environment.
- To understand the importance of ecology and ecosystems in environment
- To understand the significance of biodiversity and need for its conservation and various strategies adopted for its conservation.
- To study the need for sustainable use of renewable and non renewable energy resources.

Module 1: Fundamentals of Environmental Science (9Hrs)

Definition and concepts in environmental science - principles and scope of environmental science. Components of environment - atmosphere, hydrosphere, lithosphere and biosphere. Fundamentals of sustainable development and environmental impact assessment - pollution resource depletion - Trans boundary movements of pollutants - Environmental education.

Module 2: Ecology and Ecosystem (9Hrs)

Ecology, concepts - pollution growth and its dynamics- growth patterns - natality, mortality intra specific and inter specific interactions - neutralism, commensalism, mutualism and parasitism. Ecosystem concepts, structure and function - producers, consumers, decomposers - energy flow - ecological successions - food chain and food web - ecological pyramids, productivity in an ecosystem - primary and secondary productivity.

Module 3: Biodiversity (18Hrs)

Biodiversity concepts, component types - alpha, beta and gamma - ecological and economic importance, key stone umbrella and flagship species - ecotone and niche hotspot- threatened species, IUCN red list- endangered species, vulnerable species, rare species, extinct species and endemic species. Biodiversity conservations - *in situ* conservation - sanctuaries - national parks-biosphere reserves - nature reserves, *ex situ* conservation, germplasm and gene bank - tissue culture - pollen and spore bank, DNA bank.

Module 4: Natural resources (18Hrs)

Renewable resources - land resources - land as a resource - land degradation and conservation measures. Water resources - sources, use and exploitation of ground water and surface water. Renewable energy resources - biomass, bio fuel, hydro power, tidal energy, wave energy, wind energy, geothermal energy, solar energy, magneto hydro power, hydrogen energy and OTEC. Non renewable energy resources - fossil fuels and nuclear fuels

References

[1]. Odum E.P., (1971) Fundamentals of Ecology. W.B Saunders Company, Philadelphia.

[2]. Agarwal S.K., (2003) Ecology and Environment. S.Chand and company, New Delhi

[3]. De A.K., (2003) Environmental Science, Wiley Eastern Hd, New Delhi.

[4]. Sharma P.D., (2009) Ecology and Environment, Rastogi Publications, Meerut.

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SEMESTER I

ENV1COR02: ENVIRONMENTAL TOXICOLOGY AND OCCUPATIONAL HEALTH

Credit: 3 **Contact Lecture Hours: 54**

Aim

To understand the fundamentals of toxicology and occupational health.

Objectives

- To understand importance of air, water and soil in sustaining life in earth.
- To study the toxic effects of chemical in organisms and environment
- To study the occupational health

Module 1: Fundamentals of toxicology (9Hrs)

Definition of toxicology - branches of toxicology and its importance- environmental toxicology - principles of toxicology – toxicants and their classifications. Categories of toxic effects - factors influencing toxicity - toxic effects due to combination of chemicals - dose response relationship.

Module 2: Toxins in environment (18Hrs)

Organic and inorganic toxicants - entry into the environment - cycles and residence time - toxicity of pesticides - organo chlorine, organo phosphate and carbamides - insecticides, heavy metals, arsenic and fluorine in ground water, radioactive substance and fertilizers.

Module 3: Mode of action of toxicants (9Hrs)

Mechanism of pollutants in degradable and non degradable toxic substances - bio transformation of toxicants - bio accumulation of xenobiotics - bio concentration and bio magnification - toxicity tests: LD50 and LC50. Fate and transport of toxicants.

Module 4: Occupational health (18Hrs)

Principles and methods of occupational health - relationship of occupation with hygiene, safety and diseases - health maintenances - survey analysis and recommendation regarding health and safety problems in working and living environments.

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SEMESTER 2

CHE2COR02: INORGANIC CHEMISTRY –II

(ATOMIC STRUCTURE AND CHEMICAL BONDING)

Credits: 2 **Contact lecture hours : 36**

Aim

To impart essential theoretical knowledge on atomic structure, 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 explain the formation of different types of bonds
- To predict the geometry of simple molecules
- To explain the different types of hybridization and draw shapes of simple covalent molecules
- To understand the molecular orbital theory of diatomic molecules
- To study nuclear models and nuclear reaction

Module 1: Atomic Structure **(9 Hrs)**

Bohr model of hydrogen atom, Bohr's equation for the energy of electron in hydrogen atom, derivation of Bohr radius, velocity, energy of hydrogen atom, the hydrogen spectrum, limitations of Bohr theory. Photoelectric effect, idea of de Broglie matter waves, Heisenberg's uncertainty principle and its significance, Schrodinger wave equation (derivation not expected), wave functions, significance of Ψ and Ψ^2. Operators - Laplacian and Hamiltonian operators. 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 multi electron atom. Concept of effective nuclear charge, Slater's rules and applications. Electronic configuration of atoms.

Module 2: Chemical Bonding (18 Hrs)

2.1 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.

2.2 Covalent bond- valence bond theory and its limitations, concept of resonance, resonance energy, hybridisation and shapes of simple molecules (BeF_2, PCl_3, PCl_5, SF_6, CH_4, ethane, ethene and ethyne), VSEPR theory, shapes of molecules and ions (NH_3, XeF_6, ClF_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, polarizing power and polarisability of ions, Fajan's rule. Dipole moment and molecular structure – percentage of ionic character from dipole moment.

2.3 Metallic bonding – free electron theory, valence bond theory and band theory, explanation of weak chemical forces – hydrogen bond, inter and intra molecular hydrogen bonds, effects of hydrogen bonding, van der Waals forces.

Module 3: Nuclear Chemistry (9 Hrs)

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

3.2 Natural radioactivity, modes of decay, group displacement law, theories of disintegration, rate of decay, decay constant, half life period, average life. Radioactive equilibrium- secular and transient equilibrium. Units of radioactivity, radiation dosage. Gieger-Nuttal rule. Disintegration series, transmutation reactions – using protons, deuterons, particles and neutrons, artificial radioactivity – Positron emission and K electron capture, synthetic elements.

3.3 Application of radioactive isotopes – ^{14}C dating, rock dating, neutron activation analysis, isotopes as tracers – study of reaction mechanism (ester hydrolysis), radio diagnosis and radiotherapy.

3.4 Induced radioactivity, nuclear reactions induced by charged projectiles, neutrons and γ rays, nuclear fission, fusion, hydrogen bomb, atomic bomb, nuclear reactor. Spallation reactions, Q values of nuclear reactions, chain reaction, stellar energy – proton cycle, carbon cycle and neon cycle.

References

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SEMESTER 2

ENV2COR03: ATMOSPHERIC CHEMISTRY AND AIR POLLUTION

Credit: 3 **Contact Lecture Hours: 54**

Aim:

To understand the fundamentals of weather, climate and factors affecting it

Objectives:

- To understand basic concepts of weather and climate
- To study the composition and structure of atmosphere
- To study the chemistry of atmosphere and atmospheric pollution

Module 1: Weather and climate (9Hrs)

Basic concepts - weather and climate - meteorological factors affecting climate- weather and climate monitoring equipments - meteorological data collection - energy of atmosphere - earth heat balance - air sea interactions - *el nino* and *la nina* effects - climate change - causes and effects, regional scenarios in climate change.

Module 2: Introduction to atmosphere (9Hrs)

Black body radiation - radiation loss - composition of atmosphere and structure- chemical composition of earth's atmosphere - major and minor constituents - vertical structure radiation balance - temperature regulation in thermosphere, stratosphere and troposphere. Radiation balance and green house effect - global warming.

Module 3: Atmospheric chemistry (18Hrs)

Biogeochemical cycles of carbon, oxygen, nitrogen, and sulphur cycles - halogen and trace elements cycle. Photochemical processes - photo dissociation and ionization reaction of chemically excited species - formation, growth and transformation of aerosols - species formation. Physical and chemical properties of aerosols- cloud interaction. Stratospheric chemistry - Chapman model - chemical mechanism of polar ozone depletion - anthropogenic impacts - oxygen only chemistry - consequences of ozone perturbations - ozone variations and trends.

Module 4: Air pollution **(18Hrs)**

Effects of atmospheric pollution - global warming and green house effect - acid rain - ozone layer depletion - cause and consequences, primary and secondary pollutants - photochemical smog - particulates composition and health effects. Air pollution accidents - Bhopal gas tragedy and Chernobyl disaster. Air quality standards - sampling and analysis of atmospheric pollutants - cascade impacters - electrostatic precipitators - thermo precipitators - cold trapping. Sampling and analysis of CO, hydrocarbons and suspended particulate matters.

References

[1]. Barry G.R, Chorley J.R., (1968). Atmosphere, weather and climate. Matheun & CO. Ltd, Oxon.

[2]. Ahrens C.D., (2012). Essentials of Meterology. Cengage learning, USA

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SEMESTER 2

ENV2COR04: ENVIRONMENTAL POLLUTION

Credit: 3 **Contact Lecture Hours: 54**

Aim

To understand the impacts of environmental pollution.

Objectives.

- To know about the water pollutants and their effects in environment.
- To study detrimental effects of soil pollution and its control measures.
- To understand the sources and effects of noise, radioactive and thermal pollution

Module 1: Marine coastal and estuarine pollution (18 Hrs)

Definition and significance. Types of water pollution - point and non point source of water pollution - surface and groundwater pollution. Sources of water pollution - domestic, industrial, agricultural and natural sources. Impact of water pollution on human being, animals, plants and environment. Eutrophication - control measures of water pollution. Marine pollution - definition, sources of marine pollution - natural and anthropogenic sources. Control measures of marine pollution. Pollution status of coastal and ocean waters. Oil pollution - sources - effects and control measures. Coastal zone management.

Module 2: Soil Pollution (9 Hrs)

Types of soil, salt affected soil, sources of soil pollution - natural sources and anthropogenic sources - agricultural practices, industrial and municipal discharges, municipal solid waste dumping, land fill leachates, plastics, radioactive leakage, mining activities and electronic wastes. Absorption of toxic metals in soil. Salt stress in soil. Impact of soil / land pollution. Soil fertility - redox reactions in soils. Effects of industrial & urban waste - effect of modern agro technology, multi cropping - effects of soil pollution in plants and animals - control measures.

Module 3: Noise Pollution (9Hrs)

Definition and concept of Noise pollution. Sources of noise pollution - Indoor and outdoor noise pollution, natural and anthropogenic sources. Measurement of noise - unit of sound - noise level - sound power. Silence zone, ambient air quality standards for noise. Impact of noise pollution on plants and animals. Control measures adopted for abatement of noise pollution. Noise pollution analyser.

Module 4: Thermal and Radioactive Pollution (18 Hrs)

Thermal and nuclear power plants as source of thermal pollution. Impacts of thermal pollution on aquatic fauna and flora. Controlling measures of thermal pollution**.** Radioactive pollution - types of radiation. Sources of Radioactivity-natural and anthropogenic sources, nuclear test race and chronic radiation pollution, radio waste generated from nuclear power plant, classification and effects of radiation - biological effects of radiatons, protection and control from radiation. Disposal of radioactive waste - radioactive pollution episodes.

References

[1]. Dhara S.S., (1993).A Text book on environmental chemistry and pollution control, S Chand Publishers, New Delhi.

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SEMESTERS 1 & 2

PRACTICAL: CHE2P01-QUALITATIVE INORGANIC ANALYSIS

Credits: 2 **Contact lab hours: 36+36 = 72**

1. Study of the reactions of the following radicals with a view to their identification and confirmation.
   Ag^{+}, Hg^{2+}, Pb^{2+}, Cu^{2+}, Bi^{2+}, Cd^{2+}, As^{3+}, Sn^{2+}, Sb^{3+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, Li^{+}, Na^{+}, K^{+}, NH_4^{+}.
   CO_3^{2-}, S^{2-}, SO_4^{2-} , NO_3^{-}, F^{-}, Cl^{-}, Br^{-}, BO_2^{-}, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, CH_3COO^{-}, PO_4^{3-} , AsO_3^{3-}, AsO_4^{3-} and CrO_4^{2-}
2. Elimination of interfering anions such as F^{-}, BO_2^{-}, $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, PO_4^{3-}, AsO_3^{3-} AsO_4^{3-} and CrO_4^{2-}
3. Systematic qualitative analysis of mixtures containing two acid and two basic radicals from the above list l by Semi-micro method only.
   (Minimum of 10 mixtures to be analyzed)

References

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[2] Vogel, A. I., A Textbook of Micro and Semi-micro Qualitative Inorganic Analysis, Longman Green & Co. 1995.

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SEMESTERS 1 & 2

PRACTICAL: ENV2P01 PHYSICO - CHEMICAL ANALYSIS OF WATER

Credits: 2 **Contact lab hours: 36+36 = 72**

1. Determination of pH
2. Determination of conductivity
3. Determination of turbidity
4. Determination of total dissolved solids (Gravimetry)
5. Determination of total solids (Gravimetry)
6. Determination of total suspended solid
7. Estimation of total hardness
8. Estimation of calcium and Magnesium hardness
9. Estimation of Alkalinity
10. Estimation of Acidity.
11. Determination of chlorides in water sample
12. Determination of salinity (argentometric method)
13. Determination of dissolved oxygen
14. Calculate porosity, specific yield and specific capacity of an aquifer.
15. Windrose diagram
16. Determination salinity (Gravimetry)

INSTRUMENTATION

1. pH meter
2. Lux meter
3. Wet and dry bulb Hygrometer
4. BOD incubator

References

[1]. K Grasshoff. K, Ehrhardt. M and K Kremling. K., (1999). Methods of Seawater Analysis. 3rd Edn. Wiley – VCH.

[2]. APHA (2012). Standard methods for the Examination of water and waste water. 22nd Edn.

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SEMESTER 3

CHE3COR03– ORGANIC CHEMISTRY -1
(REACTION MECHANISM & STEREOCHEMISTRY)

Credits: 3 **Contact lecture hours: 54**

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.

Module 1: Basic concepts of reaction mechanism (18 Hrs)

1.1 Classification and nomenclature of organic compounds

Classification of organic compounds. Rules of IUPAC system of nomenclature of common organic compounds – alkanes, alkenes, alkynes, alkenynes, alkadienes (cumulated, conjugated and isolated dienes), butadienes, cycloalkanes, bicycloalkanes, alkyl halides, alcohols and phenols, aldehydes, ketones, carboxylic acids and its derivatives, amines and nitro compounds (both aliphatic and aromatic).

1.2 Fundamentals of organic reaction mechanism

Meaning of reaction mechanism: Curved arrow notation. Half headed and double headed arrows.

Nature of bond fission: – Homolysis and Heterolysis. Types of reagents – Electrophiles and Nucleophiles.

Types of organic reactions:- Definition and at least one example of each – substitution, addition, elimination and rearrangement.

Reactive intermediates:- Carbocations, carbanions, free radicals, carbenes and nitrenes (structure, formation and stability).

Electron displacement effects:- inductive, inductomeric, electromeric, mesomeric, hyper conjugation and steric effects.

Resonance: - Concept of resonance, resonance energy. Structure & stability of alkenes and butadienes, heat of hydrogenation and heat of combustion of benzene, mention of C-C bond lengths and orbital picture of benzene and thiophene.

Aliphatic nucleophilic substitutions:- Mechanisms of S_N1 and S_N2. Effect of 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:- Addition of halogens and hydrogen halides. Mechanisms of addition of Br_2 and hydrogen halides to double bonds- Markownikoff's rule and peroxide effect. Test for unsaturation - Bromine water, Bromine in CCl_4 and Baeyer's reagent. 1, 4 - addition in butadienes.

Module 2: Stereochemistry **(18 Hrs)**

2.1 Projection formulae - Fischer, flying wedge, sawhorse and Newman projection formulae. Stereoisomerism - definition - classification into optical and geometrical isomerism

2.2 Optical isomerism - Optical activity - optical and specific rotations - conditions for optical activity - asymmetric centre - Elements of symmetry, chirality - achiral molecules - meaning of (+) and (-) - 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. Enantiomers, Optical isomerism in glyceraldehyde, lactic acid and tartaric acid - Diastereomers - Meso compounds.

2.3 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). Enantiomeric excess, Optical activity in compounds not containing asymmetric carbon atoms - Biphenyls.

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

2.5 Conformational analysis - Introduction of terms - conformers, configuration, dihedral angle, torsional strain - Conformational analysis of ethane and n-butane including energy diagrams - Cycloalkanes:- relative stabilities, conformers of cyclohexane (chair, boat and skew boat forms) - axial and equatorial bonds- ring flipping showing axial equatorial interconversions, conformation of methylcyclohexane.

Module 3: Aromaticity (18 Hrs)

3.1 Aromaticity:- Concept of aromaticity – definition- Huckel's rule – application to Benzenoid – (benzene, naphthalene and anthracene) and Non–benzenoid compounds – (furan, pyrrole, indole, quinoline, cyclopropenyl cation, cyclopentadienyl anion, tropylium cation and annulenes) –Antiaromatic compounds.

3.2 Aromatic electrophilic substitution reactions – General mechanism of electrophilic substitution, mechanism of halogenation, nitration, sulphonation, 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.

3.3 Aromatic nucleophilic substitutions- bimolecular displacement mechanism- Elimination – addition mechanism, S_NAr mechanism and Benzyne mechanism.

3.4 Polynuclear hydrocarbons: - Classification-reactions and structure of naphthalene, anthracene, phenanthrene and acenaphthene. Reactivity of naphthalene towards electrophilic substitution- nitration and sulfonation.

References

[1] I.L. Finar, Organic Chemistry, 6th Edn., Vol. 1, Pearson Education,1994.

[2] A. Bahl and B.S. Bahl, Advanced Organic Chemistry, S. Chand & Company, New Delhi, 2010.

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SEMESTER 3

ENV3COR05: ENVIRONMENTAL ANALYTICAL TECHNIQUES

Credit: 3 **Contact Lecture Hours: 54**

Aim:

To provide a basic understanding about environmental sampling and analytical techniques.

Objectives:

- To understand the basics of environmental sampling - water, sediment and biological samples.
- To understand in detail about spectrophotometric and chromatographic methods of analyses.
- To provide the fundamentals of biostatistics.

Module 1: Sampling and analysis (9 Hrs)

Sampling: Concepts of sampling; types of sampling - random and non random sampling. Sampling criteria - protocols in water, sediments and biological samples - types of samples - water and sediments - sample preservation strategies. Analysis of trace metals in water, sediment and biological samples. Important water quality parameters DO, BOD, COD, salinity, nutrients and alkalinity.

Module 2: Spectrophotometry (9 Hrs)

Fundamental laws of photometry. Instrumentation of photometers - flame photometry, detection and estimation of Na^+, K^+, Li^+ and Ca^{2+} - flame emission spectrophotometry. Atomic absorption spectrophotometry - principles and instrumentation, cold vapour techniques for mercury estimation. Atomic fluorescence spectrophotometry - inductively couple plasma analysis - basic instrumentation of UV spectrophotometer.

Module 3: Chromatographic techniques (18 Hrs)

Classification of chromatographic techniques - experimental techniques and application of ion exchange, column, thin layer and paper chromatography. HPLC and GC - principle, instrumentation - detectors and applications.

Module 4: Biostatistics **(18 Hrs)**

Scope of biostatic observational studies - experimental studies - explanation and presentation of data scales of measurement. Population and samples, tabulation of data, frequency tables and frequency curves. Mean, mode and median; variance and standard deviation. Tables, graphs – histograms - box viscor plot - scatter plots - confidence limits. Types of errors, p – values, ANOVA one way, two way correlations and regression - Pearson's correlation coefficients - regression equation - prediction with regression equation.

References

[1]. Grasshoff. K, Ehrhardt. M and Kremling K., (1999). Methods of Seawater Analyses. 3rdEdn Wiley - VCH.

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SEMESTER 3

ENV3COR06: ENVIRONMENTAL ENGINEERING

Credit: 3 **Contact Lecture Hours: 54**

Aim

To understand the methods adopted to control environment pollution.

Objectives

- To know the sampling methods and techniques which are adopted for water and sediment sampling.
- To study the processes involved in water treatment plant and evaluate its performance.
- To understand the air pollution control measures adopted for environment protection.
- To assess gaseous and particulate pollutants present in the atmosphere both quantitatively and qualitatively.

Module 1: Introduction to Environmental Engineering (9Hrs)

Introduction to environmental engineering. Principles and scope of environmental engineering. Modern trends in environmental engineering. Water quality monitoring. Water quality requirement and standards for various uses. Quality of water in different sources.

Module 2: Conventional Water Treatment (9Hrs)

Conventional Water Treatment Process: Filtration, Slow and Rapid sand filters - Water Treatment, mixing, flocculation, and coagulation, Jar Test, Aeration, Water softening techniques - Lime Soda process, zeolite process, demineralisation. Removal of iron and manganese, Defluoridation of water. Desalination evaporation and distillation. Electro dialysis method, reverse osmosis, freezing process. Flow diagram for conventional sewage treatment.

Module 3: Waste Water Treatment (18Hrs)

Municipal, sewage and industrial Treatment - basic treatment process, water flow rates and their assessment. Unit operation of pre - treatment and primary treatment- screening, comminuting, equalization and sedimentation, Skimming. Secondary treatment - Design concept, biological unit process, nature and kinetics of biological growth, aerobic process, activated sludge process and its modification. Oxidation ponds, oxidation ditch. Attached Growth System - Trickling filters, rotating biological conductors, high rate anaerobic reactor, up flow anaerobic filters. expanded, fluidized bed reactors tertiary/advanced treatment system, filtration, absorption, nitrogen and phosphorous removal, Biological Nutrient Removal (BNR) Systems, Sewage disposal method. Disinfection - chlorination. Characteristics and treatment of typical industrial waste water. Maintenance of effluent treatment plants, Waste water disposal, reuse and recycle.

Module 4: Air Pollution Control (18Hrs)

Sampling equipment, Control of particulate matter - gravitational settling chamber, cyclonic separator, fabric filters, electrostatic precipitators, wet Collectors, Venturi Scrubber. Control of Gaseous Contaminants, adsorption, absorption, and combustion. Air quality monitoring techniques for particulates and gaseous contaminants - Instrumental and analytical techniques for air pollutants - suspended particles, sulphur compounds, hydrogen sulphide, sulphur dioxide, Oxides of nitrogen, carbon monoxide and hydrocarbons. Air pollution from Automobiles- source and control.

References

[1]. APHA (1985) Standard methods for examination water and waste water, American public health association. New York.

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SEMESTER 4

CHE4COR04 - ORGANIC CHEMISTRY –II

(FUNCTIONAL GROUP CHEMISTRY)

Credits: 3 **Contact lecture hours: 54**

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, synthetic reagents and Grignard reagents.
- To understand and study organic reaction mechanisms.
- To develop skills required for the qualitative analysis of organic compounds

Module 1: Hydroxy Compounds, Ethers and Organometallics (18 Hrs)

1.1 Hydroxy compounds (10 Hrs**)**

Mono, di and trihydric alcohols- Monohydric alcohols:- Classification, classical methods of preparation of methanol and ethanol, physical properties–hydrogen bonding- distinction between primary, secondary and tertiary alcohols- Ascend and descend in alcohol series, chemistry of methanol poisoning, harmful effects of ethanol on human body.

Dihydric alcohols:- Ethylene glycol- Oxidative cleavage (Lead tetra acetate, Periodic acid), Pinacol - Pinacolone rearrangement – mechanism.

Trihydric alcohols:- Glycerol- synthesis (from fats), reaction with HI, oxalic acids, oxidation.

Phenols: – Acidity of phenols- effects of substituents – comparison of acidity with alcohols. Reaction of phenol with $FeCl_3$, Formation of phenolphthalein and azo dyes. Preparation and uses of nitrophenols, picric acid, catechol, resorcinol and

quinol, Mechanisms of Reimer –Tiemann reaction, Lederer- Mannase reaction, Fries Rearrangement. Liebermann's nitroso reaction.

1.2. Ethers and Epoxides (4 Hrs)

Ethers:- Williamsons Synthesis, Cleavage of ether linkages by HI- Zeisel's method of estimation of alkoxy groups.

Epoxides:- Preparation from alkenes, acid and base catalyzed ring opening reactions, Crown ethers (elementary idea only)

1.3. Organometallic compounds (4 Hrs)

Grignard reagents-formation, structure and synthetic applications, alkyl lithium, Organo Zinc compounds, Reformatsky reaction.

Module 2: Aldehydes, Ketones and active methylene compounds (18 Hrs)

2.1 Aldehydes, Ketones (14 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. Addition and condensation reactions of carbonyl compounds: Mechanisms of nucleophilic additions to carbonyl groups with special emphasis on Claisen, Claisen-Schmidt, Benzoin, Aldol, Perkin, Knoevenagel condensations, Cannizzaro's reaction.

Condensation with ammonia and its derivatives, Wittig reaction, Mannich reaction. Oxidation reactions- Baeyer-Villiger oxidation, Reduction reactions- Clemmensen, Wolff-Kishner, Meerwein-Ponndorf-Verley reduction., $LiAlH_4$ and $NaBH_4$ reductions. Use of acetal as protecting group.

2.2 Compounds containing active methylene groups (4 Hrs)

Synthetic uses of malonic ester, acetoacetic ester and cyanoacetic ester. Keto-enol tautomerism

Module 3: Carboxylic and sulphonic acids and synthetic reagents (18 Hrs)

3.1 Carboxylic and Sulphonic acids (12 hours)

Structure of carboxylate ion- effects of substituents on acid strength of aliphatic carboxylic acids- ascent and descent in fatty acid series, Arndt-Eistert synthesis

(Wolff rearrangement to be mentioned), Hell-Volhard- Zelinsky reaction, Kolbe's electrolysis.

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

Methods of formation and chemical reactions of anthranilic acid, unsaturated acids (cinnamic acid, acrylic acid), hydroxy acids (malic acid, citric acid), dicarboxylic acids (oxalic acid, malonic acid, adipic acid, maleic acid, fumaric acid).

Preparation and reactions of benzene sulphonic acid, benzene sulphonyl chloride and ortho and para toluene sulphonyl chlorides- uses. Synthesis and uses of saccharin. Comparison of acidity of carboxylic acid and sulphonic acid.

3.2 Carbonic acid derivatives (3 Hrs)

Preparation, reactions and structure of urea, thiourea and semicarbazide, Manufacture of urea. Preparation and basicity of guanidine.

3.3 Synthetic reagents (3 Hrs)

NBS, Lead tetra acetate, Periodic acid, OsO_4, Selenium dioxide, MCPBA, DCC (elementary idea).

References

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Further reading

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SEMESTER 4

ENV4COR07: ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Credit: 3 **Contact Lecture Hours: 54**

Aim

To understand the role of microbes and biotechnological applications in environmental sciences.

Objective

- To get a basic idea on environmental microbiology.
- To understand the influence of microorganisms in biosphere.
- To study about indicator organism causes microbial infections in human beings.
- To get a basic idea on Environmental biotechnology.

Module 1: Introduction to environmental microbiology (9 Hrs)

Scope and history of environmental microbiology - characteristics - classification - identification and morphology of micro organisms, bacteria, archae, fungi , algae, virus and protozoa - growth curve of bacteria - lag phase - exponential phase - stationary phase - and death phase.

Module 2: Microbes and segments of environment (18 Hrs)

Earth environment, physico - chemical characteristics of earth environment- soil as microbial environment- biotic stress and abiotic stress – distribution of microorganism in sub surface soil - shallow surface - deep surface. Biogeochemical role of microbes - aero micro biology - microbial survival in air aero microbiological pathway- bio aerosols and its control. Microbial habitat in aquatic environment - plank tonic, benthic microbial mat and biofilm - microbes in fresh water, brackish water, marine water, subterranean water and wet lands.

Module 3: Microbial infectious diseases and indicator microorganism (9 Hrs)

Environment and human pathogenic microbes - soil borne, water borne and air borne. Roots of exposure - environmental change and microbial infectious disease. Indicator microorganism, concepts - total coli forms - MPN test, membrane filter technique - other potential indicator species - standards and criteria for indicators.

Module 4: Environmental Biotechnology (18 Hrs)

Basic concepts - application in industry - agriculture and energy sectors - bio remediation and phytoremediation. Over view methodology - vermiculture - bio fertilizer techniques. Elemental information of gene transfer - cloning - recombinant DNA technology and its implementation. Microbial management of hazards.

References

[1]. Chapman J. L and Reiss M J (1992), Ecology-Principles and Applications, Cambridge University Press, Cambridge.

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[12]. Markandey. D. K., and Rajvaidya. N., (2004). Environmental Biotechnology. A.P.H. Printing house, New Delhi.

SEMESTER 4

ENV4COR08: ENVIRONMENTAL MANAGEMENT

Credit: 3 **Contact Lecture Hours: 54**

Aim

To understand the different aspects of environment management

Objectives

- To study about environment Impact assessment.
- To understand the significance of planning in various environmental aspects.
- To get an idea about environmental audit
- To know about the significance of ISO 14000 series in Environmental management.
- To study about waste management

Module 1: Environment Impact Assessment (18 Hrs)

Introduction: concept, objectives and goals. Origin and development of EIA. Relationship of EIA to sustainable development, EIA in project planning and Implementation - risk assessment and risk management, EIA report. Comparison of alternatives, EIS, EMP, public hearing, review, decision making and monitoring. Methodology of EIA - practices and guidelines in India. EIA case studies. Environmental Planning - principles, concepts and scope of environmental planning - Ecological aspects of EPM - Steps in environmental planning. Scope and types of Environmental audit - audit process - pre and post audit process - objectives and advantages of audit. Ecolabeling - Eco mark, environment management systems ISO 14000 series.

Module 2: Environment Laws and policies (9 Hrs)

Sustainable Development: Basic concepts, principles and measures for sustainable development. Brunt land commission report - our common future, Agenda 21, National policy statement, National Environment Policy - 2006. International Conventions - Stockholm Declaration, 1972, Ramsar Convention; World Heritage

Convention; Kyoto Protocol; Rio Summit (Earth Summit); Johannesburg Summit, 2002. Montreal Protocol. Biodiversity act 2002 and related rules: an overview of application in India. Convenction on International trade of endangered species. National Environmental Movement - Silent valley movement, Chipko movement, Narmada Movement, Appiko movement, Almatti dispute and Tehri dam movement.

Module 3: Remote Sensing and GIS (9 Hrs)

History, principle, concept and scope of remote sensing, Electromagnetic energy - Electromagnetic spectrum, Components, principles, stages of remote sensing. Platforms for remote sensing techniques. Sensors - types and resolution. Aerial photography - characteristics of aerial photographs and image interpretation. Satellite imagery - land sat imagery. Basics of GIS. Application of remote sensing and GIS into ground water exploration, mining of mineral resources and wet land conservation.

Module 4: Disaster Management (9 Hrs)

Various phases of disaster management - Mitigation, preparedness, response, and recovery. Scope of disaster management/emergency preparedness. Tools of disaster management - Emergency Management Information Systems - organizations related to disaster management. Disasters and Hazard Management: Human and ecological impacts; Risk assessment and Vulnerability analysis; National preparedness and adaptation strategies; Hazards, policies and Agencies; National and International Agencies in disaster management, NDMA, NIDM, State level disaster management authorities

Module 5: Waste Management (9 Hrs)

Solid wastes management - Solid wastes - Types, sources, disposal methods-incineration, and recycling, composting-composting methods - Windrow method. Vermicomposting. Pyrolisis, pulverization, gasification and sanitary landfill.

Hazardous waste management - characteristics of hazardous waste, categorization and its disposal methods.

Green Chemistry - Principles of Green Chemistry, Design of Green Synthesis, prevention of waste and byproducts, Atom Economy, prevention of chemical accidents, microwave assisted green synthesis.

References

[1]. Morgan. R.K., (2002). Environmental impact assessment, Kluwer publications, Massachussets

[2]. Dhara S.S., (1993). A text book on environmental chemistry and pollution control. S. Chand pulishers, New Delhi.

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SEMESTERS 3 & 4

CHE4P02 - ORGANIC CHEMISTRY PRACTICAL –I

Credits: 2 **Contact lab hours: 36+ 36=72**

1. Tests for elements: Nitrogen, Halogens and Sulphur (Green technique may also be adopted).
2. Tests for unsaturation.
3. Tests for aromatic character.
4. Study of the reactions of the following functional groups: alcohol, phenol, aldehyde, ketone, carboxylic acid, 1,2- dicarboxylic acid, ester, primary, secondary and tertiary amines, amide, nitro and halogen compounds, diamide, anilide, polynuclear hydrocarbons, reducing and non-reducing sugars.
5. Systematic analysis of the following organic compounds containing one functional group and characterization with its physical constant (solid and liquid) and a derivative :- alcohol, phenol, aldehyde, ketone, carboxylic acid, 1,2 dicarboxylic acid, ester, primary,secondary and tertiary amines, amide, nitro and halogen compounds, diamide, anilide, polynuclear hydrocarbons, reducing and non-reducing sugars.
   (Minimum 10 compounds to be analyzed, Chemistry of the reaction is necessary)

References

[1] A.I. Vogel, B.S. Furniss, Vogel's Textbook of Practical Organic Chemistry, Longman, 1989

[2] F.G. Mann and B. C. Saunders, Practical Organic Chemistry, 4th Edn., Pearson Education, 2009.

[3] V.K. Ahluwalia and S. Dhingra, Comprehensive Practical Organic Chemistry, Universities Press, 2004.

SEMESTERS 3 & 4

ENV4P02 PHYSICO CHEMICAL ANALYSIS OF SOIL AND EFFLUENT - I

Credits: 2 **Contact lab hours: 36+ 36=72**

1. Determination of soil moisture
2. Determination of soil PH
3. Determination of Total Organic Carbon in soil sample
4. Determination of nitrites in Effluent
5. Determination of phosphate in Effluent
6. Determination of BOD in Effluent
7. Analysis of sodium and potassium in water and soil sample

INSTRUMENTATION

1. High volume air sampler
2. Flame photometer
3. High performance liquid chromatograph

References

[1]. Grasshoff. K., Ehrhardt. M., and Kremling. K., (1999). Methods of Seawater Analysis. 3rdEdn. Wiley – VCH.

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SEMESTERS 3 & 4

ENV4P03 PHYSICO CHEMICAL ANALYSIS OF SOIL AND EFFLUENT - II

Credits: 2 **Contact lab hours: 36+ 36=72**

1. Determination of COD in Effluent
2. Determination of chloride in soil sample.
3. Determination of nitrates in soil sample
4. Determination of phosphates in soil sample
5. Determination of iron in soil sample.
6. Determination of iron in water sample.
7. Determination of sulphate in soil sample (gravimetry)

INSTRUMENTATION

1. High volume air sampler
2. Atomic absorption spectroscope
3. Gas Liquid chromatograph

References

[9]. Grasshoff. K., Ehrhardt. M., and Kremling. K., (1999). Methods of Seawater Analysis. 3rdEdn. Wiley – VCH.

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SEMESTER 5

CHE5COR05 – INORGANIC CHEMISTRY- III
(COORDINATION CHEMISTRY& BIOINORGANIC CHEMISTRY)

Credits - 3 **Contact lecture hours : 54**

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.
- To understand the important analytical and instrumental tools used for practicing chemistry
- To apply these skills in the analysis of experimental data in chemistry practical

Module 1: Chemistry of d and f block Elements (9 Hrs)

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

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

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

Module 2: Coordination Chemistry (18 Hrs)

Coordination complex-define complex and ligands, 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, spectrochemical series-classification of ligand into strong field and weak field, inner orbital and outer orbital complexes. Crystal field theory, splitting of d-orbitals in octahedral, tetrahedral and square-planar complexes – low spin and high spin complexes, strong and weak field ligands, CFSE, 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(Cr, Fe, Ni &Cu).

Reactivity of metal complexes-Labile and inert complexes, ligand substitution reactions –$S_N^1$and S_N^2 substitution reactions of square planar complexes – Trans effect.

Module 3: Data Analysis **(9 Hrs)**

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.

Module 4: Metal carbonyls and metal clusters **(9 Hrs)**

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). Metal-halide cluster, Quadruple bond – structure of$[Re_2CI_8]^{2-}$.

Module 5: Bioinorganic Chemistry **(9 Hrs)**

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

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[2] B.R. Puri, L.R. Sharma, K.C. Kalia, Principles of Inorganic Chemistry, 31st Edn., Milestone Publishers, New Delhi, 2013.

[3] G.L. Meissler, D.A Tarr, Inorganic Chemistry, Pearson Education, 2004.

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SEMESTER 5

CHE5COR06- ORGANIC CHEMISTRY-III

(NATURAL PRODUCTS)

Credits: 3 **Contact lecture hours: 54**

Aim

To give an outline of Natural products and biomolecules and the applications of organic chemistry in various spheres of chemical sciences.

Objectives

- To learn in detail the chemistry of carbohydrates.
- To learn in detail the chemistry of amino acids, proteins and nucleic acids.
- To understand the structure and functions of enzymes, proteins and nucleic acids. To study the fundamentals of terpenoids, alkaloids, vitamins, lipids and steroids, Green Fluorescent Proteins
- To develop basic skills required for crystallisation, distillation, solvent extraction, TLC and column chromatography.

Module 1: Natural products - I (Carbohydrates) (18 Hrs)

Monosaccharides:-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.

Polysaccharides:- Structure and properties of starch and cellulose. (Elementary idea). Industrial applications of cellulose.

Module 2: Natural products –II (Terpenoids, steroids, alkaloids, vitamins and lipids) (18 Hrs)

2.1 Terpenoids : classification, isoprene rule. Essential oils, isolation of essential oils, Structure elucidation of citral and geraniol. Natural rubber – structure, vulcanization and its advantages.

2.2 Steroids: Introduction – Diels hydrocarbon- Structure and functions of cholesterol, Biosynthesis of cholesterol, Elementary idea of HDL, LDL and Vitamin D. Biological functions of steroid hormones.

2.3 Alkaloids: Classification, general methods of isolation, structure elucidation of nicotine.

2.4 Vitamins: Classification-structure (elucidation not required) and deficiency diseases of vitamin A, C, B_1, B_2, B_6.

2.5 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.

Module 3: Natural Products –III (Amino acids, proteins, nucleic acids and enzymes) (18 Hrs)

3.1 Amino acids:- classification, Zwitter ion. Preparation of amino acids- Strecker amino acid synthesis. Peptides- structure and bonding. Solution phase peptide synthesis and solid phase peptide synthesis.

3.2 Proteins:- 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.

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

3.4 Green Fluorescent Proteins (elementary idea).

3.5 Enzymes:-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, Pearson Education, 1973.

[2] I.L. Finar, Organic Chemistry – Volume II, Pearson Education, 1956.

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SEMESTER 5

CHE5COR07 – PHYSICAL CHEMISTRY- I

(STATES OF MATTER AND SURFACE CHEMISTRY)

Credits: 2 **Contact lecture hours - 36**

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 understand the symmetry of crystals
- To study defects in crystals
- To study adsorption.

Module 1: Gases (12 Hrs)

Kinetic molecular model of gases: pressure of an ideal gas, derivation of gas laws, Maxwell's distribution of velocities – molecular velocities (average, root mean square and most probable velocities- no derivation). Collision diameter, mean free path, viscosity of gases – temperature and pressure dependence. Relation between mean free path and coefficient of viscosity (no derivation). 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).

Module 2: Liquids **(3 Hrs)**

Intermolecular forces in liquids (qualitative idea only)- viscosity, determination of viscosity- the viscometer method- surface tension – surface energy, refractive index, physical properties and chemical constitution of liquids. Unusual behaviour of water.

Module 3: Solid state **(15 Hrs)**

The nature of the solid state- anisotropy- the law of constancy of interfacial angles, symmetry in crystal systems- elements of symmetry– centre of symmetry, plane of symmetry, proper and improper axes of symmetry, law of rational indices - Miller indices. Seven crystal systems and Fourteen Bravais lattices and crystallographic point groups. 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.

Module 4: Surface chemistry **(6 Hrs)**

Adsorption – types, adsorption of gases by solids – factors influencing adsorption – Freundlich adsorption isotherm – Langmuir adsorption isotherm (derivation). The BET theory (no derivation) – use of BET equation for the determination of surface area. Colloids- stability of colloids, origin of charge on colloidal particles, electrical double layer, zeta potential.

References

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[5] A. McQuarrie, J.D. Simon, Physical Chemistry – A molecular Approach, Viva Books Pvt. Ltd., 1998.

Further reading

[1] A.R. West, Solid State Chemistry and its applications, John Wiley, 2014.

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[3] P.W. Atkins, The elements of Physical chemistry, 8th Edn., Oxford University Press, 2006.

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SEMESTER 5

CHE5COR08- PHYSICAL CHEMISTRY- II

(QUANTUM MECHANICS, SPECTROSCOPY AND PHOTOCHEMISTRY)

Credits: 3 **Contact lecture hours: 54**

Aim

To understand the fundamentals of quantum mechanics and its applications, molecular spectroscopy and photochemistry.

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

Module 1: Quantum mechanics (18 Hrs)

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.

Module 2: Molecular spectroscopy- I (18 Hrs)

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

Rotational spectrum(microvave spectroscopy): diatomic molecules, energy levels of a rigid rotator, selection rules, nature of rotational spectrum, determination of bond length.

Vibrational spectrum(IR spectroscopy): the simple harmonic oscillator – energy levels, force constant, selection rulesum, nature of vibrational spectrum. 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.

Molecular Symmetry - 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

Module 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 (1H 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

Module 4: Photochemistry (3 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.

References

[1] K.L. Kapoor, A Textbook of Physical chemistry, Volume 4, Macmillan India Ltd., 2006.

[2] Mc Quarrie, J.D. Simon, Physical Chemistry – A molecular Approach, Viva Books Pvt. Ltd., 1997.

[3] I.N. Levine, Physical Chemistry, Tata Mc Graw Hill, 2009.

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[8] K.K. Sharma, L.R Sharma, A text book of Physical Chemistry, Vikas Publishing house, 2006.

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SEMESTER 5

CHOICE BASED COURSE - I

(Any one course to be opted from the following courses)

CHE5CBP01: CHEMISTRY IN EVERYDAY LIFE

Credits: 4 **Contact lecture hours: 72**

Aim

To learn chemistry as an intergral part of everyday life.

Objectives

- To study the general information about the food we eat, the cloths we wear and the cosmetcis we apply.
- To learn about the pros and cons of using processed food stuff, which is in vogue today.

Module 1: Chemicals in food and beverages and Nutrition (18 Hrs)

1.1 Principles of food preservation: Maintenance of anaerobic condition - high temperature and low temperature storage, drying. Functional food additives, food laws. Food colours - permitted and non – permitted- Toxicology. Flavours – natural and synthetic- Toxicology . Important chemical ingredients/ taste makers used in packed food - soft drinks - and its health hazards. Chemicals in food production. Artificial sweeteners.

1.2 Adulteration, Adulterants in milk, ghee, oil, coffee powder, tea, asafoetida, chilli powder, pulses and turmeric powder - identification. Food spoilage: Risk factors associated with food borne illness. Spoilage of milk, canned food, fruits and vegetables. Elementary idea of antioxidants.

1.3 Measurement of Energy Value of food, Calorific value, caloric requirement, Kilocalorie. Basal metabolic rate (BMR):- Significance, Condition, factors, measurement.

Module 2: House hold materials (18 Hrs)

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

2.2 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.

2.3 Cosmetics:- Introduction, classification – bathing oils, face creams, skin products, perfumes, dental cosmetics, hair dyes, shaving cream, shampoo, talcum powder, tooth paste, deodorants, lipstick –ingredients. General formulation of each type. Harmful chemicals in cosmetics. Toxicology of cosmetics.

Module 3: Plastics, Paper and Dyes (9 Hrs)

3.1 Plastics in everyday life. Brief idea of polymerization- Thermoplastic and thermosetting polymers. Use of PET, HDPE, PVC, LDPE, PP, ABS. Recycling of plastics. Biodegradable plastics. Environmental hazards of plastics.

3.2 News print paper, writing paper, paper boards, cardboards. Organic materials, wood, cotton, jute and coir. International recycling codes, and symbols for identification.

3.3 Natural and synthetic dyes (basic idea only).

Module 4: Drugs (9 Hrs)

Chemotherapy:- Drugs and their classification, Drug-target interactions. Enzymes as drug targets, Receptors as drug targets. Therapeutic action of different classes of drugs- antipyretics, antihistamines, antacids, tranquilizers, analgesics, sedatives, antibiotics, antimicrobials, antifertility drugs. Antiseptics and disinfectants.

Module 5: Chemistry and Agriculture (9 Hrs)

5.1 Fertilizers:- natural, synthetic, mixed fertilizers. NPK fertilizers. Excessive use of fertilizers and its impact on the environment. Bio fertilizers– types. Nitrogen fixation- symbiotics and non symbiotics using mycorrhiza. Plant growth hormones.

5.2 Pesticides:- Classification-insecticides, herbicides, fungicides. Excessive use of pesticides– environmental hazards. Biopesticides.

Module 6: Water Treatment and Waste Management (9 Hrs)

6.1 Water sources – specifications for water, impurities in water, characteristics imparted by impurities. Hardness – disadvantages of hard water in domestic and industrial use. Softening methods- lime soda, zeolite and ion exchange methods.

6.2 Methods of purification of water- removal of micro organisms- Desalination of brackish water- electro dialysis, reverse osmosis- Importance of dissolved oxygen, BOD & COD. Sewage treatment process - small scale and large scale process. Primary, secondary and tertiary treatment.

6.3 Solid waste disposal methods - sanitary landfills, composting, vermicomposting and biogas production. e-waste management.

References

[1] T.P. Coultate, Food- The Chemistry of its components. Royal Society of Chemistry, London, 2000.

[2] Shashi Chowls,Engineering Chemistry, 15th Edn., Danpat Rai Publication.

[3] B.K. Sharma. Industrial Chemistry, GOEL Publishing House, 1997.

[4] CNR Rao- Understanding chemistry, Universities Press, Hyderabad, 1999.

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[16] A.G.Murugesan, C.Rajakumari, Environmental Science and Biotechnology: Theory and techniques, MJP Publishers, 2006.

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SEMESTER 5

CHE5CBP02: DAIRY SCIENCE

Credits: 4 **Contact lecture hours: 72**

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

Module 1: Composition of Milk **(12 Hrs)**

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.

Module 2: Processing of Milk **(12 Hrs)**

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.

Module 3: Major Milk Products **(12 Hrs)**

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.

Module 4: Special Milk (12 Hrs)

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.

Module 5: Fermented and Other Milk Products (24 Hrs)

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.

Visit to a pasteurization 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.

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[6] Sukumar De, Outlines of Dairy technology.

SEMESTER 5

CHE5CBP03: FOOD SCIENCE

Credits: 4 **Contact lecture hours: 72**

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

Module 1: Food Adulteration (18 Hrs)

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.

Module 2: Food Poisons (9 Hrs)

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

Module 3: Food Additives (18 Hrs)

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.

Module 4: Beverages **(9 Hrs)**

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

Module 5: Edible Oils **(18 Hrs)**

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

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.

SEMESTER 5

CHE5CBP04: FORENSIC SCIENCE

Credits: 4 **Contact lecture hours: 72**

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).

Module 1: Poisons (12 Hrs)

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.

Module 2: Crime Detection (12 Hrs)

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.

Module 3: Forgery and Counterfeiting (12 Hrs)

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.

Module 4: Tracks and Traces **(18 Hrs)**

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.

Module 5: Medical Aspects **(18 Hrs)**

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.

References:

[1] T.H.James, Forensic Sciences, Stanley Thornes Ltd.

[2] Richard, Criminalistics - An Introduction to Forensic Science (College Version), 8th Edn., Sofestein, Printice Hall.

SEMESTER 5

CHE5CBP05: ENVIRONMENTAL CHEMISTRY

Credits: 4 **Contact lecture hours: 72**

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

Module 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.

Module 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, NOx, SO_2, O_3, PAN, CN, pesticides, carcinogenic substances.

Module 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.

Module 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.

Module 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.

Module 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.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.

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[12] James W. Moore and S.Ramamoorthy, Organic chemicals in natural waters

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SEMESTER 5

CHE5CBP06: NANOSCIENCE AND NANOTECHNOLOGY

Credits: 4 **Contact lecture hours: 72**

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-dimensiona 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?

Module 1: .Nanomaterials **(18 Hrs)**

Historical landmarks- terminology-scales-top-down and bottom-up paths in nanoscience- Feynman's hypothesis-low dimensional solids-nanoparticlesfullerene- its discovery-production-contribution to nanotechnology-unusuaproperties of fullerene. Nanotubes:carbon nanotubes- architectural characteristics-synthesis- properties.

Module 2: Nanoscience **(18 Hrs)**

Its social, economic and ethical perspectives- responsible development of nanotechnology- existing laws and regulations- regulatoryagencies-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 ofnanotechnology.

Module 3: Seeing the nanoworld (18 Hrs)

Fundamental particles-elctromagnetic radiation- its components- impact on matter- the Planck's equation- de Broglie relation- matterwave concept of radiation- concept of colour and vision- spectroscopic methods and radiation- elementary ideas of UV-visible, IR, NMR, XPES and UPES techniques. Xray techniques- SEM, TEM, STM, SPL, and SIMS - their use in the studies ofnanosystems.

Module 4: Applications of nanotechnology (18 Hrs)

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.

References:

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SEMESTER 5

CBCS PROJECT GUIDELINES - BSc CHEMISTRY PROGRAMME

PROJECT

The compulsory project work is a two credit course that can be carried out individually or as a group of three. However, the viva-voce examination on this will be conducted individually. The project completed as lab work under the guidance of a supervising teacher. It is to be submitted during the practical examination for external valuation.

TOPIC SELECTION

The choice is entirely personal with the help of a teacher from the area of interest or career prospects of students which can be done in the college library.

PROJECT WORK AND EXPERIENTIAL LEARNING

Project work is the best way to practice what you have learned. It provides an opportunity to investigate a problem by applying concepts in a scientific manner. It enables the application of conceptual knowledge in a practical situation and to learn the art of conducting a study in a systematic way and presenting its findings in a coherent report.

A MODEL PROJECT DESIGN

1. Selection of atopic
2. Pilot survey- a trial run
3. Significance
4. Review of literature
5. Coverage (Sample and period of study)
6. Data source
7. Methods of analysis, i.e., tools and techniques
8. Limitation of the study
9. Chapter outline
10. Result chapters
11. Conclusion

STRUCTURE OF THE PROJECT

1. Title page
2. Name of the candidate, name and designation of the supervising teacher
3. Declaration of the student
4. Content
5. Introduction
6. Objective
7. Materials and methods
8. Results and discussion
9. Conclusion
10. References

PROJECT GUIDELINES

Project can be done in about 18 hours and shall be of 10-15 pages in writing. Project reports shall be prepared and submitted to the department at the end of the sixth semester and are to be produced before the practical examiners. The valuation will be done in two stages.

Internal evaluation (the supervising teacher will assess the project and award marks).

External evaluation to be done by the practical examiners.

PROJECT EVALUATION

Sl. No.	Component	Internal marks	External marks
1	Report	8	32
2	Presentation	8	32
3	Viva-voce	4	16
	TOTAL	**20**	**80**

SEMESTER 6

CHE6COR09 - INORGANIC CHEMISTRY – IV
(ADVANCED INORGANIC CHEMISTRY)

Credits – 3 **Contact lecture hours: 54**

Aim

The aim of the course is to develop the interest to research and application field.

Objectives

To understand

- the method behind research
- the preparation and uses of inorganic polymers
- preparation and application of nano materials
- the chemistry of the compounds of p block elements
- thermal and chromatographic techniques

Module I: Research in Science **(9 Hrs)**

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.

Module 2: Inorganic polymers **(9 Hrs)**

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

Module 3: Nano materials **(9 Hrs)**

Nano materials – Introduction, General method of synthesis – chemical precipitation, mechano-chemical method, micro emulsion method, reduction technique, chemical vapour deposition and sol-gel method (brief study). Synthesis, Properties and applications of fullerenes and carbon nano tubes.

Module 4: Compounds of p block Elements **(9 Hrs)**

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).

Module 5: Organometallic Compounds **(9 Hrs)**

Definition, classification of organometallic compounds, , 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.

Module 6: Analytical Techniques **(9 Hrs)**

Thermo analytical methods: Principle of thermo gravimetry, differential thermal analysis, differential scanning calorimetry. 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 Rf-Values, significance of Rf 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.

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Further Reading

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SEMESTER 6

CHE6COR10 ORGANIC CHEMISTRY- IV

(ADVANCED ORGANIC CHEMISTRY)

Credit: 3 **Contact lecture hours: 54**

Aim

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

Objectives

To enable the students-

- To learn the chemistry of nitro compounds, amines, heterocyclics.
- To understand and study mechanism of reactions of nitro compounds and amines.
- To have an elementary idea of organic spectroscopy, photochemistry and pericyclic reactions.
- To identify organic compound using UV, IR and PMR spectroscopic techniques and elementary idea on green chemistry and.
- To give an outline of applied organic chemistry including chemotherapy, polymer chemistry, green chemistry, supramolecular chemistry and dyes.
- To develop basic skills required for crystallization, distillation, solvent extraction, TLC and column chromatography.

Module I: Organic compounds containing Nitrogen and Heterocyclic compounds (18 Hrs)

1.1 Nitro compounds (3Hrs**):-** nitromethane- tautomerism- Difference between alkyl nitrites and nitroalkanes. Reduction products of nitrobenzene in acidic, neutral and alkaline media- electrolytic reduction and selective reduction of poly nitro compounds- formation of charge transfer complexes.

1.2 Amines (5Hrs):- 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.

1.3 Diazonium salts (3Hrs):-Preparation, structure, synthetic applications of benzene diazonium chlorides, azo coupling-. Preparation and uses of Phenyl hydrazine. Diazomethane - preparation, structure and synthetic uses. Arndt Eistert synthesis-mechanism –Wolff rearrangement

1.4 Heterocyclic compounds (7Hrs)

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.

Module 2: Structure elucidation using spectral data (12 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 and 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)

Module 3: Pericyclic Reactions and Organic photochemical reactions (6 Hrs)

3.1 Pericyclic reactions:-Classification- electrocyclic, cycloaddition (Diels Alder reaction and its stereochemical aspects) and sigmatropic reactions. Claisen rearrangement

3.2 Photochemical reactions:-Introduction- Photochemical versus Thermal reactions, Jablonski diagram, Norrish reactions of acyclic ketones. Patterno-Buchi reaction, Photo-Fries rearrangement.

Module 4: Applied Organic Chemistry (18 Hrs)

4.1 Chemotherapy (3 Hrs)

Drugs: Introduction, Elementary idea of the structure and mode of action of the following drugs:- Sulphanilamide, Ampicillin, Chloramphenicol, Chloroquine, Paracetamol and Analgin.

Drugs in cancer therapy- Chlorambucil. Application of nanomaterials in medicine.

4.2 Synthetic Polymers (5 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. Plastic identification codes, Biodegradable polymers: PGA, PLA and PHBV. Synthetic rubbers –SBR and Nitrile rubber. Polymerization reactions-Types of polymerization-free radical, cationic and anionic polymerizations - including mechanism.

4.3 Green Chemistry (2Hrs)

Introduction-need of green chemistry-twelve principles of green chemistry, atom economy, microwave and ultrasound assisted green synthesis (elementary idea only), green solvents.

4.4 Supramolecular Chemistry (2Hrs)

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

4.5 Soaps, Detergents and cosmetics (2 Hrs)

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

4.6 Dyes (4 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 Fluorescein 4) Vat dye - indigo 5) Anthraquinone dye - alizarin.

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SEMESTER 6

CHE6COR11 - PHYSICAL CHEMISTRY – III
(THERMODYNAMICS AND KINETICS)

Credits : 3 **Contact lecture hours: 54**

Aim

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

Objectives

- To study the laws of thermodynamics
- To derive Gibbs-Helmholtz, Clausius-Clapeyron, Gibbs-Duhem equations
- To derive the relation between Kp, Kc and Kx
- 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 catalysis.

Module 1: Thermodynamics (18 Hrs)

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, Cp and Cv relation in ideal gas systems, change in thermodynamic properties of an ideal gas during (i) isothermal/adiabatic, reversible/irreversible processes. Joule-Thomson experiment, Joule-Thomson coefficient JT , inversion temperature.

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.

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.

Module 2: Chemical Equilibrium and Phase Equilibria (18 Hrs)

Chemical equilibrium: conditions for chemical equilibrium, relation between Kc and Kx – Kp , van't Hoff reaction isotherm. Temperature dependence of Kp – van't Hoff equation.

The phase equilibria: Phase rule, derivation of the phase rule, equilibrium between phases – conditions. One component system – water system, sulphur system. Two component systems – solid-liquid equilibrium – simple eutectic, thermal analysis, 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. Nernst distribution law, thermodynamic derivation, applications of distribution law.

Module 3: Kinetics (18Hrs)

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

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

Kinetics of complex (composite) reactions: Opposing reactions, consecutive reactions, and parallel (simultaneous) reactions. Chain reactions – steady state treatment, hydrogen bromine reaction.

Catalysis: Homogeneous catalysis, enzyme catalysis – Michaelis - Menten equation (no derivation needed). Heterogeneous catalysis – surface catalysis, uni and bi molecular reactions on surface. Elementary idea about autocatalysis.

References

[1] R.P. Rastogi, R.R. Misra, An Introduction to Chemical Thermodynamics, 6th Edn., Vikas Pub. Pvt. Ltd. 2003.

[2] P. Atkins and J Paula, The elements of Physical chemistry, W. H. Freeman, 2009

[3] K.K. Sharma, L.K. Sharma, A Textbook of Physical Chemistry, 4th Edn.,Vikas publishing House, 2009.

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Further reading

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SEMESTER 6

CHE6COR12 - PHYSICAL CHEMISTRY – IV
(SOLUTION CHEMISTRY AND ELECTROCHEMISTRY)

Credit: 3 **Contact lecture hours: 54**

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.

Module 1: Solutions **(18 Hrs)**

Introduction- Binary liquid solutions – Raoult's law- ideal and non-ideal solutions- Gmix, Vmix, and Smix 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.

Module 2: Ionic Equilibria (3Hrs)

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.

Module 3: pH and theory of indicators (3Hrs)

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.

Module 4: Electrical Conductance (15 Hrs)

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

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

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

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

Module 5: Electromotive force (15 Hrs)

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 G, H and S 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.

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SEMESTER 6

CHOICE BASED COURSE - II

(Any one course to be opted from the following courses)

CHE6CBP01: POLYMER CHEMISTRY

Credits: 3 **Contact lecture hours: 72**

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

Module 1: Introduction to Polymers (9Hrs)

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.

Module 2: Physical Properties and Reactions of Polymers (18Hrs)

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.

Module 3: Polymerisation Techniques and Processing (9 Hrs)

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

Module 4: Chemistry of Commercial Polymers (9Hrs)

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.

Module 5: Advances in Polymers (9Hrs)

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

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[2] V.R Gowariker, N.V. Viswanathan, and J. Sreedhar, Polymer Science, Wiley Eastern Ltd., New Delhi, 2006.

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SEMESTER 6

CHE6CBP02: NANOCHEMISTRY AND NANOTECHNOLOGY

Credits: 3 **Contact lecture hours: 72**

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

Module 1: History **(12Hrs)**

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.

Module 2: Characterization of nanomaterials **(15Hrs)**

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).

Module 3: Electrical and optical properties of nanomaterials (15Hrs)

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

Module 4: Applications of nanomaterials (12Hrs)

Nanocrystals- immunogold labeling- applications in medical diagnosis- nanobased drug delivery- applications in biotechnology- nanosensors- self-assembly, nanosensor based on quantum size effects- nanobiosensors- nanomedicines- destructive applications of nanomaterials- nanomaterials in war.

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, 2001.

[7] C. P. Poole Jr and F J Owens, Introduction to nanotechnology, Wiley India Pvt. Ltd. 2009.

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[9] G.L Hornyak, J.Dutta, H.F Tibbals, A.K Rao, Introduction to Nanoscience, CRC Press, 2008.

SEMESTER 6

CHE6CBP03: INDUSTRIAL CHEMISTRY

Credits: 3 **Contact lecture hours: 72**

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.

Module 1: Industrial Requirements (18 hours)

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.

Module 2: Petrochemical Industries (18 hours)

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.

Module 3: Fertilizers and Speciality Chemicals (9 hours)

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.

Module 4: Oils, Soaps and Detergents (9 hours)

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, gamexane, malathion, parathion.

References:

[1] B.K Sharma, Industrial chemistry, Goel publishing House, Meerut, 2003.

[2] C.E Drydens, Outlines of Chemical Technology, 3rd Edn., (Edited and Revised by M. Gopal Rao and M. Sittig) Eastwest press, NewDelhi, 1997.

[3] R.V Shreve, Chemical Process Industries, 5th Ed., Mc Graw Hill Pub., 1984.

[4] H. Steines, Introduction to Petrochemicals, Pergaman Press, 1961.

SEMESTER 6

CHE6CBP04: ENVIRONMENTAL CHEMISTRY

Credits: 3 **Contact lecture hours: 72**

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

Module 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.

Module 2: Chemical toxicology (10 Hrs)

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

Module 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.

Module 4: Water pollution **(17 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, 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.

Module 5: Lithosphere **(12 Hrs)**

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, 3rd Edn., New age International Pvt. Ltd. 1996.

[2] G.T. Tyler, Living in the Environment, Tomson Brooke/Cole, 2003.

[3] N. Manivasakam, Physico-chemical examination of water, sewage and industrial effluents, Pragathi prakashan, 2009.

[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, 2004.

[6] B. B. Kebbekus and S. Mitra, Enveronmental chemical analysis, Blacke Academic & Professional, 1998.

[7] S.S.Dara, A Textbook of Environmental chemistry and pollution control, S.Chand & Company Ltd, 2014.

[8] R.A. Malaviya, Environmental Pollution and its control under international law, Rawat Publication, 1997.

[9] Pramod Singh, Environmental pollution management. Anmol Pub, 1985.

[10] G. K. Ghosh, Environmental pollution – A scientific study. APH Publishing Corporation, New Delhi, 1992.

[11] Nelson L. Numerow, Industrial water pollution. R.E. Krieger Publishing Company, 1978.

[12] James W. Moore and S.Ramamoorthy, Organic chemicals in natural waters, Springer science+ Business media, NewYork, 1984.

[13] Hutzinger, Aquatic pollutants, Van Lelyveld and Zoeteman, New York, 1977

[14] F. Kreith, Handbook of Solid waste management, Mc Graw Hill Inc, 1994.

[15] Peter O' Neil, Environmental Chemistry, Blackie Academic and Professional, London, 2004.

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[17] V K Ahluwalia, Environmental Chemistry, Ane Books Pvt Ltd, New Delhi, 2012.

SEMESTER 6

CHE6CBP05: SOIL AND AGRICULTURAL CHEMISTRY

Credits: 3 **Contact lecture hours: 72**

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

Module 1: Origin of Soil **(9 Hrs)**

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.

Module 2: Physical Properties of Soil **(9 Hrs)**

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.

Module 3: Chemistry Aspects of Soil (9 Hrs)

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.

Module 4: Plant Nutrients (18 Hrs)

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.

Module 5: Pesticides, Fungicides and Herbicides (9 Hrs)

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.

References:

[1] T. D. Biswas, and S. K. Mukeherjee, Textbook of Soil Science, 1987.

[2] A.J. Daji, A Textbook of Soil Science, Asia Publishing House, Madras, 1970.

[3] S.L Tisdale, W.L Nelson, and J.D. Beaton, Soil Fertility and Fertilizers, Macmillian Publishing Company, New York, 1990.

[4] P.R Hesse, A Textbook of Soil Chemical Analysis, John Murray, New York, 1971.

[5] K.H Buchel, Chemistry of Pesticides, John Wiley & Sons, New York, 1983.

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SEMESTER 6

CHE6CBP06: PHARMACEUTICAL CHEMISTRY

Credits: 3 **Contact lecture hours: 72**

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

Module 1: Introduction (18 Hrs)

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, LD50 and ED50 therapeutic index, drug dosage.

Module 2:Designation of Drugs (9 Hrs)

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.

Module 3: Common Body Ailments (9 Hrs)

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.

Module 4: Health Promoting Medicines (18 Hrs)

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.

References

[1] J. Ghosh, Pharmaceutical chemistry, S. Chand and Company Ltd., New Delhi, 2006.

[2] Lakshmi S., Pharmaceutical chemistry, S. Chand & Sons, New Delhi, 1995.

[3] Ashutosh Kar, Medicinal chemistry, Wiley Eastern Ltd., New Delhi, 1993.

[4] D. William & T. Lemke, Foyes principles of medicinal chemistry, 5th Edn., BI publishers, 2005,

[5] Romas Nogrady, Medicinal chemistry, 2nd Edn., Oxford University, 2004.

SEMESTERS 5 & 6

PRACTICAL: CHE6P03 - VOLUMETRIC ANALYSIS

Credits : 2 **Contact lab hours: 54 + 54= 108**

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. Permanganometry

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

C. Dichrometry

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

D. 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.

E. 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, 2006.

[2] G.H Jeffery, J. Bassett, J. Mendham, R. C Denney, Vogel's Textbook of Quantitative Chemical Analysis 5th Edn, John Wiley & Sons.,1989.

[3] G. D. Christian, Analytical Chemistry, 6th Edn., John Wiley and Sons, 2004.

[4] R.D. Day, A.L. Underwood, Quantitative analysis,6th Edn., Prentice Hall of India Pvt. Ltd.,1991.

SEMESTERS 5 & 6

PRACTICAL: CHE6P04 – ORGANIC CHEMISTRY PRACTICAL-II

Credits :2 **Contact lab hours: 36+36= 72**

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) Crystallization – Any four compounds using ethyl acetate, ethanol, and water- Record the yield recovery.

c) Soxhlet extraction

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. Preparations

Single stage 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).
6) Acylation (Benzoylation of aniline, phenol, β -naphthol).
7) Esterification (benzoic acid).
8) Iodoform from acetone or ethyl methyl ketone.
9) Side chain oxidation (benzyl chloride to benzoic acid).
10) Claisen –Schmidt: Dibenzal acetone from benzaldehyde

The product to be recrystallized and purity checked by TLC and melting point.

References

[1] F.G. Mann and B.C. Saunders, 'Practical Organic Chemistry' 4th Edn., Pearson Education Ltd, 1960.

[2] A.I. Vogel, Vogel's Textbook of Practical Organic Chemistry, Including Qualitative Organic Analysis English Language Book Society Longman, 1978.

[3] V.K. Ahluwalia and S.Dhingra, Comprehensive Practical Organic Chemistry, Universities Press, 2004.

[4] Gem Mathew, Practical Organic Chemistry.

SEMESTERS 5 & 6

PRACTICAL: CHE6P05 – PHYSICAL CHEMISTRY PRACTICAL

Credits : 2 **Contact lab hours: 54 + 54= 108**

1) Viscosity – percentage composition of a mixture.
2) Heat of solution – KNO_3, NH_4Cl
3) Heat of neutralization strong acid with strong base.
4) Determination of equivalent conductance of an electrolyte
5) Conductometric titration – strong acid *vs.* strong base.
6) Determination of partition coefficient of non-volatile solute between two immiscible solvents. E.g. I_2 between CCl_4 and water.
7) Transition temperature of salt hydrates. (Sodium thiosulphate, sodium acetate)
8) Critical solution temperature. Phenol-water system
9) Determination of molecular weight by Rast's Method (using naphthalene, camphor or biphenyl as solvent and acetanilide, p-dichlorobenzene etc. as solute.)
10) Kinetics of simple reactions eg. Acid hydrolysis of methyl acetate.
11) Potentiometric titration – Fe^{2+} *vs.* $Cr_2O_7^{2-}$, I^- *vs.* MnO_4^-
12) Data analysis of kinetic experiments using spreadsheet program (determination of rate constant)
13) Determination of equivalence point of potentiometric and conductometric titrations using spreadsheet program.

References

[1] W.G. Palmer, Experimental physical chemistry, Cambridge University Press, 1941.

[2] J.B. Yadav: Advanced Practical Physical Chemistry, 9th Edn., Goel Publishing House, 1989.

[3] R.C. Das and B. Behra, Experimental Physical Chemistry, Tata McGraw hill, New Delhi, 1983.

[4] K.K. Sharma and DS Sharma, Introduction to Practical Chemistry, Vikas Publishing House, New Delhi, 1989.

SEMESTERS 5 & 6

PRACTICAL: CHE6P06 – GRAVIMETRIC ANALYSIS

Credit : 1 **Contact lab hours: 36**

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': 3rd Edn., ELBS and Longman, London, 1971.

[2] J.Bassett, R.C.Denney, G.H. Heffery and J Mendham,. 'Vogel's Textbook of quantitative Inorganic Analysis' John Wiley & Sons, 5th Edn., 1989.

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