JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE
(Autonomous)
B N ROAD, MYSURU- 570 025

DEPARTMENT OF CHEMISTRY

Syllabus

CHOICE BASED CREDIT SYSTEM

For B.Sc programmes

Physics, Chemistry, Mathematics
Chemistry, Zoology, Biotechnology
Chemistry, Botany, Zoology

2017-18

Programme - PCM

Scheme of Study for B.Sc. Chemistry under CBCS Scheme 2017-18

YR	SEM	COURSE CODE	TITLE OF THE PAPER	NO. OF CREDITS		LECTURE/PRACTICAL HOURS /WEEK		TOTAL TEACHING HOUIRS	
				THEORY	PRA	THEORY (Hrs)	PRA (Hrs)	THEORY (Hrs)	PRA (Hrs)
I	I	CMA24001	**ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS**	04	02	04	04	60	60
	II	CMB24001	**CHEMICAL ENERGETICS,EQUILIBRIA,& FUNCTIONAL GROUP ORGANIC CHEMISTRY**	04	02	04	04	60	60
II	III	CMC24001	**SOLUTIONS & ORGANIC CHEMISTRY**	04	02	04	04	60	60
	IV	CMD24001	**CO-ORDINATION CHEMISTRY & PHYSICAL CHEMISTRY**	04	02	04	04	60	60
III	V	**Choose any one(DSE)**							
		CME24001	**INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE**	04	1	04	03	60	45
		CME24401	**INDUSTRIAL CHEMICALS AND ENVIRONMENT**	04	1	04	03	60	45
	VI	**Choose any one(DSE)**							
		CMF24001	**ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLY NUCLEAR HYDROCARBONS AND UV,IR SPECTROSCOPY**	04	1	04	03	60	45
		CMF24201	**QUANTUM CHEMISTRY, SPECTOSCOPY AND PHOTOCHEMISTRY**	04	1	04	03	60	45
	V	**Choose any one(SEC)**							
		CME24201	**FUEL CHEMISTRY**	02	--	02	--	30	--
		CME24601	**BASIC ANALYTICAL CHEMISTRY**	02	--	02	--	30	--

Scheme of Assessment for B.Sc. Chemistry under CBCS Scheme 2017-18

Year	SEM	COURSE CODE	TITLE OF THE PAPER	CONTINUOUS ASSESSMENT					MAX MARKS			PERCENTAGE			DURATION OF EXAM	
				C1		C2		C 3	T H	PR	IA	T H	PR	IA	TH	PR
				T H	PR	T H	P R									
I	I	CMA24001	**ATOMIC STRUCTURE ,BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
	II	CMB24001	**CHEMICAL ENERGETICS,EQUILIBRIA, & FUNCTIONAL GROUP ORGANIC CHEMISTRY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
II	III	CMC24001	**SOLUTIONS & ORGANIC CHEMISTRY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
	IV	CMD24001	**CO-ORDINATION CHEMISTRY & PHYSICAL CHEMISTRY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
III	V	**Choose any one(DSE)**														
		CME24001	**INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
		CME24401	**INDUSTRIAL CHEMICALS AND ENVIRONMENT**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
	VI	**Choose any one(DSE)**														
		CMF24001	**ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLY NUCLEAR HYDROCARBONS AND UV, IR SPECTROSCOPY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
		CMF24201	**QUANTUM CHEMISTRY, SPECTOSCOPY AND PHOTOCHEMISTRY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
	V	**Choose any one(SEC)**														
		CME24201	**FUEL CHEMISTRY**	**15**	**--**	**15**	**--**	**50**	50	--	30	**70**	**---**	**30**	**2h**	**--**
		CME24601	**BASIC ANALYTICAL CHEMISTRY**	**15**	**--**	**15**	**--**	**50**	50	--	30	**70**	**---**	**30**	**2h**	**--**

Core papers – Chemistry (Credit: 06 each)

Sl. No	SEM	Course Code	Title of the paper	Total credits	
				Th	Pr
1	I	CMA24001	**ATOMIC STRUCTURE ,BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS**	04	02
2	II	CMB24001	**CHEMICAL ENERGETICS,EQUILIBRIA,&** FUNCTIONAL GROUP ORGANIC **CHEMISTRY**	04	02
3	III	CMC24001	**SOLUTIONS & ORGANIC CHEMISTRY**	04	02
4	IV	CMD24001	**CO-ORDINATION CHEMISTRY & PHYSICAL CHEMISTRY**	04	02

Discipline Specific Electives: DSE (Credit: 5 each)

Sl. No	SEM	Course Code	Title of the paper	Total credits	
				Th	Pr
	V	**Choose any one**			
1		CME24001	**INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE**	04	1
		CME24401	**INDUSTRIAL CHEMICALS AND ENVIRONMENT**	04	1
	VI	**Choose any one**			
2		CMF24001	**ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLY NUCLEAR HYDROCARBONS AND UV,IR SPECTROSCOPY**	04	1
		CMF24201	**QUANTUM CHEMISTRY, SPECTOSCOPY AND PHOTOCHEMISTRY**	04	1

Skill Enhancement Course: SEC (Credit: 02 each)

Sl. No	Course Code	Title of the paper	Total credits
			Th
	Choose any one		
1	CME24201	**FUEL CHEMISTRY**	02
	CME24601	**BASIC ANALYTICAL CHEMISTRY**	02

Programme - CZBt

Scheme of Study for B.Sc. Chemistry under CBCS Scheme 2017-18

YR	SEM	COURSE CODE	TITLE OF THE PAPER	NO. OF CREDITS		LECTURE/PRACTICAL HOURS /WEEK		TOTAL TEACHING HOUIRS	
				THEORY	PRA	THEORY (Hrs)	PRA (Hrs)	THEORY (Hrs)	PRA (Hrs)
I	I	CMA24005	**ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS**	04	02	04	04	60	60
	II	CMB24005	**CHEMICAL ENERGETICS,EQUILIBRIA,& FUNCTIONAL GROUP ORGANIC CHEMISTRY**	04	02	04	04	60	60
II	III	CMC24005	**SOLUTIONS & ORGANIC CHEMISTRY**	04	02	04	04	60	60
	IV	CMD24005	**CO-ORDINATION CHEMISTRY & PHYSICAL CHEMISTRY**	04	02	04	04	60	60
III	V	**Choose any one(DSE)**							
		CME24005	**INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE**	04	1	04	03	60	45
		CME24405	**INDUSTRIAL CHEMICALS AND ENVIRONMENT**	04	1	04	03	60	45
	VI	**Choose any one(DSE)**							
		CMF24005	**ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLY NUCLEAR HYDROCARBONS AND UV,IR SPECTROSCOPY**	04	1	04	03	60	45
		CMF24205	**QUANTUM CHEMISTRY, SPECTOSCOPY AND PHOTOCHEMISTRY**	04	1	04	03	60	45
	V	**Choose any one(SEC)**							
		CME24205	**FUEL CHEMISTRY**	02	--	02	--	30	--
		CME24605	**BASIC ANALYTICAL CHEMISTRY**	02	--	02	--	30	--

Scheme of Assessment for B.Sc. Chemistry under CBCS scheme 2017-18

Year	SEM	COURSE CODE	TITLE OF THE PAPER	CONTINUOUS ASSESSMENT					MAX MARKS			PERCENTAGE			DURATION OF EXAM	
				C1		C2		C 3	T H	PR	IA	T H	PR	IA	TH	PR
				T H	PR	T H	P R									
I	I	CMA24005	**ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
	II	CMB24005	**CHEMICAL ENERGETICS,EQUILIBRIA, & FUNCTIONAL GROUP ORGANIC CHEMISTRY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
II	III	CMC24005	**SOLUTIONS & ORGANIC CHEMISTRY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
	IV	CMD24005	**CO-ORDINATION CHEMISTRY & PHYSICAL CHEMISTRY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
III	V	**Choose any one(DSE)**														
		CME24005	**INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
		CME24405	**INDUSTRIAL CHEMICALS AND ENVIRONMENT**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
	VI	**Choose any one(DSE)**														
		CMF24005	**ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLY NUCLEAR HYDROCARBONS AND UV, IR SPECTROSCOPY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
		CMF24205	**QUANTUM CHEMISTRY, SPECTOSCOPY AND PHOTOCHEMISTRY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
	V	**Choose any one(SEC)**														
		CME24205	**FUEL CHEMISTRY**	**15**	**--**	**15**	**--**	**50**	50	--	30	**70**	**---**	**30**	**2h**	**--**
		CME24605	**BASIC ANALYTICAL CHEMISTRY**	**15**	**--**	**15**	**--**	**50**	50	--	30	**70**	**---**	**30**	**2h**	**--**

Core papers – Chemistry (Credit: 06 each)

Sl. No	SEM	Course Code	Title of the paper	Total credits	
				Th	Pr
1	I	CMA24005	**ATOMIC STRUCTURE ,BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS**	04	02
2	II	CMB24005	**CHEMICAL ENERGETICS, EQUILIBRIA &** FUNCTIONAL GROUP ORGANIC **CHEMISTRY**	04	02
3	III	CMC24005	**SOLUTIONS & ORGANIC CHEMISTRY**	04	02
4	IV	CMD24005	**CO-ORDINATION CHEMISTRY & PHYSICAL CHEMISTRY**	04	02

Discipline Specific Electives: DSE (Credit: 5 each)

Sl. No	SEM	Course Code	Title of the paper	Total credits	
				Th	Pr
	V	**Choose any one**			
1		CME24005	**INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE**	04	1
		CME24405	**INDUSTRIAL CHEMICALS AND ENVIRONMENT**	04	1
	VI	**Choose any one**			
2		CMF24005	**ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLY NUCLEAR HYDROCARBONS AND UV,IR SPECTROSCOPY**	04	1
		CMF24205	**QUANTUM CHEMISTRY, SPECTOSCOPY AND PHOTOCHEMISTRY**	04	1

Skill Enhancement Course: SEC (Credit: 02 each)

Sl. No	Course Code	Title of the paper	Total credits
			Th
	Choose any one		
1	CME24205	**FUEL CHEMISTRY**	02
	CME24605	**BASIC ANALYTICAL CHEMISTRY**	02

Programme - CBZ

Scheme of Study for B.Sc. Chemistry under CBCS Scheme 2017-18

YR	SEM	COURSE CODE	TITLE OF THE PAPER	NO. OF CREDITS		LECTURE/PRACTICAL HOURS /WEEK		TOTAL TEACHING HOUIRS	
				THEORY	PRA	THEORY (Hrs)	PRA (Hrs)	THEORY (Hrs)	PRA (Hrs)
I	I	CMA24008	**ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS**	04	02	04	04	60	60
	II	CMB24008	**CHEMICAL ENERGETICS,EQUILIBRIA,& FUNCTIONAL GROUP ORGANIC CHEMISTRY**	04	02	04	04	60	60
II	III	CMC24008	**SOLUTIONS & ORGANIC CHEMISTRY**	04	02	04	04	60	60
	IV	CMD24008	**CO-ORDINATION CHEMISTRY & PHYSICAL CHEMISTRY**	04	02	04	04	60	60
III	V	**Choose any one(DSE)**							
		CME24008	**INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE**	04	1	04	03	60	45
		CME24408	**INDUSTRIAL CHEMICALS AND ENVIRONMENT**	04	1	04	03	60	45
	VI	**Choose any one(DSE)**							
		CMF24008	**ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLY NUCLEAR HYDROCARBONS AND UV,IR SPECTROSCOPY**	04	1	04	03	60	45
		CMF24208	**QUANTUM CHEMISTRY, SPECTOSCOPY AND PHOTOCHEMISTRY**	04	1	04	03	60	45
	V	**Choose any one(SEC)**							
		CME24208	**FUEL CHEMISTRY**	02	--	02	--	30	--
		CME24608	**BASIC ANALYTICAL CHEMISTRY**	02	--	02	--	30	--

Scheme of Assessment for B.Sc. Chemistry under CBCS Scheme 2017-18

Year	SEM	COURSE CODE	TITLE OF THE PAPER	CONTINUOUS ASSESSMENT					MAX MARKS			PERCENTAGE			DURATION OF EXAM	
				C1		C2		C 3	T H	PR	IA	T H	PR	IA	TH	PR
				T H	PR	T H	P R									
I	I	CMA24008	**ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
	II	CMB24008	**CHEMICAL ENERGETICS,EQUILIBRIA, & FUNCTIONAL GROUP ORGANIC CHEMISTRY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
II	III	CMC24008	**SOLUTIONS & ORGANIC CHEMISTRY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
	IV	CMD24008	**CO-ORDINATION CHEMISTRY & PHYSICAL CHEMISTRY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
III	V	**Choose any one(DSE)**														
		CME24008	**INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
		CME24408	**INDUSTRIAL CHEMICALS AND ENVIRONMENT**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
	VI	**Choose any one(DSE)**														
		CMF24008	**ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLY NUCLEAR HYDROCARBONS AND UV, IR SPECTROSCOPY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
		CMF24208	**QUANTUM CHEMISTRY, SPECTOSCOPY AND PHOTOCHEMISTRY**	**10**	**5**	**10**	**5**	**70**	70	70	30	**50**	**20**	**30**	**3h**	**3h**
	V	**Choose any one(SEC)**														
		CME24208	**FUEL CHEMISTRY**	**15**	**--**	**15**	**--**	**50**	50	--	30	**70**	**---**	**30**	**2h**	**--**
		CME24608	**BASIC ANALYTICAL CHEMISTRY**	**15**	**--**	**15**	**--**	**50**	50	--	30	**70**	**---**	**30**	**2h**	**--**

Core papers – Chemistry (Credit: 06 each)

Sl. No	SEM	Course Code	Title of the paper	Total credits	
				Th	Pr
1	I	CMA24008	**ATOMIC STRUCTURE ,BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS**	04	02
2	II	CMB24008	**CHEMICAL ENERGETICS,EQUILIBRIA,&** FUNCTIONAL GROUP ORGANIC **CHEMISTRY**	04	02
3	III	CMC24008	**SOLUTIONS & ORGANIC CHEMISTRY**	04	02
4	IV	CMD24008	**CO-ORDINATION CHEMISTRY & PHYSICAL CHEMISTRY**	04	02

Discipline Specific Electives: DSE (Credit: 5 each)

Sl. No	SEM	Course Code	Title of the paper	Total credits	
				Th	Pr
	V	**Choose any one**			
1		CME24008	**INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE**	04	1
		CME24408	**INDUSTRIAL CHEMICALS AND ENVIRONMENT**	04	1
	VI	**Choose any one**			
2		CMF24008	**ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLY NUCLEAR HYDROCARBONS AND UV,IR SPECTROSCOPY**	04	1
		CMF24208	**QUANTUM CHEMISTRY, SPECTOSCOPY AND PHOTOCHEMISTRY**	04	1

Skill Enhancement Course: SEC (Credit: 02 each)

Sl. No	Course Code	Title of the paper	Total credits
			Th
	Choose any one		
1	CME24208	**FUEL CHEMISTRY**	02
	CME24608	**BASIC ANALYTICAL CHEMISTRY**	02

SCHEME OF VALUATION FOR PRACTICAL EXAMINATION

- A candidate appearing for the first time should submit a duly signed and certified practical record
- Each candidate has to perform one experiment in the specified duration of three hours for ***FIFTY*** marks
- Practical record has to be valued for ***TEN*** marks by examiners at the time of examination
- IA for ***TEN*** marks in practical is awarded by continuous assessment in the lab

I. EVALUATION OF EXPERIMENTS:

Sl. no	Component	Marks
1	Procedure writing	05
2	Conducting experiment	40
3	Result	05
4	Viva-voce	10
5	Practical record	10
TOTAL		**70**

Programme Outcome for Bachelor of Science in Physics, Chemistry, Mathematics:

After completing the graduation in the Bachelor of Science the students are able to:

PO1. Demonstrate proficiency in Mathematics and the Mathematical concepts needed for a proper understanding of Physics.

PO2. Demonstrate the ability to justify and explain their thinking and/or approach.

PO3. Develop state-of-the-art laboratory skills and professional communication skills.

PO4. Apply the scientific method to design, execute, and analyze an experiment

PO5. Explain scientific procedure and experimental observations

PO6. Appreciate the role of chemistry in the society

PO7. Use this as a basis for ethical behaviour in issues facing chemists /drugs.

PO8. Understand chemistry as an integral part for addressing social, economic, and environmental problems.

PO9. Understand the value of Mathematical proof and

PO10. Demonstrate proficiency in writing and understanding proofs.

PO11. Apply mathematical problems and solutions in aspects of science and technology.

PO12. Gain experience to investigate the real world problems

PO13. Apply mathematical ideas and models to those problems.

Program Specific Outcome:

Bachelor of Science in Physics, Chemistry, Mathematics

After completing the graduation in Physics, Chemistry, Mathematics the students are able to:

PSO1. Find career opportunities

PSO2. Develop competence to write competitive examinations.

PSO3. Develop proficiency in the analysis of complex physical problems

PSO4. Use of mathematical or other appropriate techniques to solve problems.

PSO5. Apply appropriate techniques for the qualitative and quantitative analysis of chemicals laboratories and in industries.

PSO6. Create a hypothesis and appreciate how it relates to broader theories.

PSO7. Demonstrate skills in the use of Computers.

Programme Outcome for Bachelor of Science in Chemistry, Zoology, Biotechnology:

After completing the graduation in the Bachelor of Science the students are able to:

PO1. Demonstrate the ability to justify, explain, and/or approach the concept both in written and oral forms

PO2. Demonstrate the ability to present clear, logical and succinct arguments

PO3. Develop state-of-the-art laboratory skills and professional communication skills.

PO4. Apply the scientific method to design, execute, and analyze an experiment.

PO5. Appreciate the central role of chemistry in the society and use this as a basis for ethical behaviour in issues facing chemists/drugs.

PO6. Understand Chemistry as an integral part for addressing social, economic, and environmental problems.

PO7. Identify the major groups of organisms with an emphasis on animals and plants.

PO8. Compare and contrast the characteristics of animals that differentiate themselves from other living and non-living creatures.

PO9. Give specific examples of physiological adaptations.

PO10. Design and develop solution to Biotechnology problems keeping in mind the safety measures for environment and society.

PO11. Support Biotechnology research activity with strong technical background knowledge.

Programme Specific Outcome for Bachelor of Science in Chemistry, Zoology, Biotechnology:

After completing the graduation in Chemistry, Zoology, Biotechnology the students are able to:

PSO1. Find jobs at all level of chemical, pharmaceutical, food products and life oriented material Industries

PSO2. Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.

PSO3. Recognize the relationship between different structures and functions at different levels.

PSO4. Characterize the biological, chemical and physical features of environments that Animals inhabit.

PSO5. Demonstrate effectively the applications of biochemical and biological sciences.

PSO6. Know and apply appropriate tools and techniques in biotechnological manipulation

PSO7. Understand his or her responsibilities in biotechnological practices.

Programme Outcome for Bachelor of Science in Chemistry, Botany, Zoology:

After completing the graduation in the Bachelor of Science the students are able to:

PO1. Demonstrate the ability to justify, explain, and/or approach the concept

PO2. Demonstrate the ability to present clear, logical and succinct arguments

PO3. Develop state-of-the-art laboratory skills and professional communication skills.

PO4. Apply the scientific method to design, execute, and analyze an experiment.

PO5. Appreciate the role and use of chemistry for ethical issues facing chemists/drugs.

PO6. Identify the taxonomic position of plants using required principles and methods.

PO7. Understand the impact of the plant diversity in societal and environmental context,

PO8. Use interdisciplinary approaches with quantitative skills to work on biological problems.

PO9. Understand Chemistry as an integral part for addressing social, economic, and environmental problems.

PO10. Identify the major groups of organisms with an emphasis on animals and plants.

Programme Specific Outcome
Bachelor of Science in Chemistry, Botany, Zoology

After completing the graduation in the Bachelor of Science the students are able to:

PSO1. Find jobs at all level of chemical, pharmaceutical, food products, life oriented material industries,

PSO2. Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.

PSO3. Explicate ecological interconnectedness of life

PSO4: Analyze the avenues and remedies for burning environmental issues

PSO5. Recognize the relationship between different structures and functions at different levels.

PSO6. Characterize the biological, chemical and physical features of environment of Animal inhabits.

CMA24001/ CMA24005/ CMA24008

SEMESTER I

ATOMIC STRUCTURE, BONDING GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Theory: 60 Lectures

Course outcome:

After completion of the course the student is able to:

CO1: Learn in detail with examples quantum mechanics
CO2: Understand the details of periodicity, periodic table and chemical bonding
CO3: Understand in detail with examples stereochemistry and aliphatic hydrocarbons
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CHEMISTRY-DSC 1:

Section A: Inorganic Chemistry-1 (30 Periods)

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogen wave functions (atomic orbitals) and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation) Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1*s* and 2*s* atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers *ml* and *ms* .Shapes of *s, p* and *d* atomic orbitals, nodal planes.Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number (*ms*).
Rules for filling electrons in various orbitals, Electronic configurations of the atoms Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Periodic Table and Periodicity:
Classification of elements into s, p, d, and f-blocks, cause of periodicity. Detailed discussion of the following periodic properties of elements with examples
1). Atomic radius: Covalent, ionic, Vander Waal's and crystal radii. Additive nature of covalent radii., Determination of ionic radii by Lande's method. Variation of covalent radii in a group and in a period- explanation for the observed trends. Comparison of the size of the atoms with the corresponding anions and cations, Variation of ionic radii in isoelectronic ions.

2). Ionization enthalpy: Successive ionization enthalpy, factors affecting ionization enthalpy, applications of ionization enthalpy. Variation in a group and in a period-explanation for the observed trends.
3). Electron gain enthalpy: Successive electron gain enthalpy variation of electron gain enthalpy in period and in a group- explanation for the observed trends.
4). Electronegativity: Variation of electronegativity in a group and in a period-explanation for the observed trends. Factors determining electro negativity (charge on the atom and hybridization). Pauling and Mullikan methods (problems to be worked out). Allred-Rochow scale of electronegativity.Applications of electronegetivity.

(14 Lectures)

Chemical Bonding and Molecular Structure
Ionic Bonding*:* General characteristics of ionic bonding. Energy considerations inionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.
Covalent bonding*:* VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonalbipyramidal and octahedral arrangements.

Concept of resonance and resonating structures of simple inorganic compounds
MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.Molecular orbital structures and bond orders of homo and hetero atomic molecules like H_2, He_2, He_2^+, N_2, O_2 HF, and CO, Prediction of magnetic properties of these species
Coordinate bond:Explanation by taking NH_3-BF_3 molecule as example.
Hydrogen bonding: Definition, inter and intra molecular Hydrogen bonding by taking HF, H_2O, and nitrophenols as examples. Anomalous properties like physical state, boiling point and solubility. Structure of ice Theories (or nature) of hydrogen bond (electrostatic approach, VBT and MOT treatments)

(16 Lectures)

Section B: Organic Chemistry-1 (30 Periods)

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Basic Concepts of Organic reaction mechanism:-
Homolytic and heterolytic cleavages, electrophiles and nucleophiles(their nature with examples). Meaning of the terms with their illustration to show the formation of Carbocations, Carbanions, Free radicals. Stability and structure of primary, secondary and tertiary carbocations, carbanions, free radicalsStrength of organic acids and

bases:Comparative study with emphasis on factors affectingK_aOR pK values.(acetic acid,propionic acid,Butanoic acid) & (Methylamine, ethylamine and aniline)

(8 Lectures)

Stereochemistry: Types of stereoisomers.

Optical isomerism;Definition, Elements of symmetry(Plane, centre and alternate axis) Chirality, Optical activity. Optical isomerism in lactic acid, tartaric acid and biphenyls.Racemisation, Resolution, methods of resolution(Chemical and biochemical) Walden Inversion, Assymmetric synthesis(Partial and Absolute) Diastereomers, R/S Nomenclature- CIP rules(upto 2 carbon atoms)Geometrical isomerism-Definition with examples, Geometrical isomerism in aldoximesand ketoximes. Determination of configuaration–Beckmann rearrangement.). E / Z Nomenclature (for upto two C=C systems).Conformations with respect to ethane, butane and cyclohexane.Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations.

(10 Lectures)

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: Preparation:Catalytic hydrogenation of alkenes, Wurtz reaction,Kolbe's synthesis, from Grignard reagent.Reactions: Free radical Substitution: Halogenation.

Alkenes: Preparation:Elimination reactions: Dehydration ofalcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); Reactions:cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Dienes: Types, relative stabilities of dienes, 1,3 Butadiene, 1,2 and 1,4-addition reactions with H_2 and HBr, Diel's Alder reaction with an example

Alkynes:Preparation:Acetylene from $CaC_2$and conversion intohigher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, Acidity of alkynes, addition of bromine, HCN, Aceticacid, water,oxidation with $KMnO_4$and ozonolysis

(12 Lectures)

Aromatic hydrocarbons; Aromaticity: Benzenoids and Hückel's rule

Preparation (Case benzene): from phenol, by decarboxylation of Carboxylic acids, from acetylene. **Reactions:** Electrophilic substitution: Mechanisms of nitration, halogenation andsulphonation. Friedel-Craft's reaction (alkylation and acylation) Orientation-Orienting influence of o-p and m- directing groups

(8 Lectures)

Reference:

- Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
- Cotton, F.A., Wilkinson, G. &Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models inInorganic Chemistry, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. &Medhi, O.K. Inorganic Chemistry:Principles of Structure and Reactivity, Pearson Education India, 2006.
- Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).

- McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
- Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
- Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
- Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010
- R D Madan, Inorganic Chemistry

CHEMISTRY LAB: DSC 1 LAB:

ATOMIC STRUCTURE AND ORGANIC CHEMISTRY

(60 Lectures)

Section A: Inorganic Chemistry – Volumetric Analysis

1. Estimation of sodium hydroxide using HCl and sodium carbonate crystals
2. Estimation of oxalic acid $KmnO_4$.And Mohr's salt.
3. Estimation of Mohr's salt using $KmnO_4$. and oxalic acid crystals
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using NaS_2O_3.
6. Estimation of Hydrogen peroxide using $KmnO_4$ and Sodium oxalate crystals
7. Estimation of oxalic acid and Sulphuric acid present in a given mixture.
8. Estimation of oxalic acid using NaOH solution and PHP crystals.

Section B: Organic Chemistry:

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements).
2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)

a) Identify and separate the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography.

b) Identify and separate the sugars present in the given mixture by paper chromatography.

Reference:

- Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

CMB24001/ CMB24005/ CMB24008

SEMESTER-II

CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL GROUP ORGANIC CHEMISTRY

Theory: 60 Lectures

Course outcome:

After completion of the course the student is able to:

CO1: Learn the details of ionic equilibria and thermodynamics
CO2: Learn in detail with examples alkyl and aryl halides
CO3: Learn in detail with examples alcohols, phenols and carbonyl compounds

CHEMISTRY-DSC 2:

Section A: Physical Chemistry-1 (30 Lectures)

Chemical energetics
Laws of thermodynamics,Zeroth law of thermodynamics- statement
First law thermodynamics – statements, mathematical expressions internal energy and its significance.
Enthalpy; Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data.Variation of enthalpy of a reaction with temperature – Kirchhoff's equation
Second law of thermodynamics – spontaneous, non-spontaneous and equilibrium processes, different ways of stating second law – (clausius, spontaneity, entropy), heat engine, Carnot cycle and its efficiency(derivation). Concept of entropy and its significance in terms of randomness and probability
Free energy – Helmoltz and Gibb's free energy and their relationship, Giibb – Helmoltz's equation at constant pressure and volume(derivations). Thermodynamic criteria of equilibrium and spontaneity, variation of free energy with temperature and pressure.Clausius – Clapeyron'sequation(to be derived).Applications of integrated form of Clausius – Clapeyron equation and its applications. Van't Hoff's reaction isotherm and isochore equations.(derivation), Statement of third law of thermodynamics. (Numerical problems)
Statistical Thermodynamics: Introduction, types of statistics. Importance of each statistics.Expression for Bose-Einstein's Statistics (equation to be given) **(12 Lectures)**
Chemical Equilibrium:
Charecteristics of chemical equiulibrium,Law of mass action ,equilibrium constant,Freeenergy change in a chemical reaction.Thermodynamic derivation of the law of chemical equilibrium.Distinction between G and G^{o}, Le Chatelier'sprinciple.effect of change in concentration.and temperature. Application of law of mass action for the

formation of ammonia,dissociation of phosphorous pentachloride, Relationships between *Kp, Kc* and*Kx* for reactions involving ideal gases.

(6Lectures)

Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization,Arrhenius theory of electrolytic dissociation,merits and demerits,Kohlrausch's law of independent migration of ions and applications. Transport number by moving boundary method, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect.Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and effect of temperature on degree of hydrolysis ,pH for different salts.Buffersolutions.Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.Activity and activity co-efficients, definition and their relation, ionic strength and its calculation. Debye Huckel theory of strong electrolytes (relaxation time effect, electrophoteric effect and viscous effect). Debye-Huckel Onsager equation (no derivation),Debye-Huckel limiting equation for activity co-efficients (no derivation).Role of solvents in altering the strengths of acids and bases. **(12 Lectures)**

Section B: Organic Chemistry-2 (30 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkyl and Aryl Halides

Alkyl Halides: Nomenclature-Preparation: from alkenes and alcohols.Reactions- Types of Nucleophilic Substitution (SN^1, SN^2 andSN^i) reactions.Mechanisms, Energy profile diagram for SN^1 and SN^2 reactions.Reactions:,Elimination reactions-$E_1$and E_2, Mechanisms and hydrolysis

Aryl Halides: Preparation:(Chloro, bromo and iodo-benzene case): fromphenol,Sandmeyer & Gattermann reactions.Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OHgroup) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

(8 Lectures)

Alcohols, Phenols and Ethers

Alcohols: Preparation:Preparation of 1°, 2°and 3°alcohols: using Grignard reagent,Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (alk.KMnO4, acidic dichromate,).Oppeneauer oxidation, Interconversions among primary, secondary and tertiary alcohols.

Diols: Oxidation of diols. Pinacol-Pinacolone rearrangement.

Trihydric alcohols- Glycerol-Synthesis from propene, Reactions of glycerol with HI, oxalic acid, HNO_3 and dehydrating agent(P_2O_5or H_2SO_4).

Phenols: (Phenol case)Preparation:Cumenehydroperoxide method, from diazonium salts.Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Schotten – Baumann Reaction.Acidity of phenols.Effect of substitution on acidity of phenols.

Ethers: Nomenclature, Williamson ether synthesis, reactions of ethers-Cleavage .Ziesel's method of estimation .Epoxides:- Synthesis, Acid and Base catalyzed opening of epoxides.Crown ethers: Introduction and applications

Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde) Preparation: from acid chlorides and from alcohols.

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Mechanisms of Aldol Condensation, Cannizzaro's reaction, perkins reaction and , Benzoin condensation.

Illustrations of Clemensen reduction , Wolff Kishner reduction,.Meerwein-PondorffVerley reduction, Gattermann-Koch reaction and Baeyer-Villiger oxidation.

(14 Lectures)

Carboxylic acids and their derivatives ; Preparation: From Nitriles and by Arndt-Eiestert reaction Acidic and Alkaline hydrolysis of esters. Reactions: Hell – Vohlard–ZelinskyReaction..Acidity of carboxylic acids.Resonance structure of carboxylate ion and its stability. Effect of substitution on acidity of carboxylic acids

Carboxylic acid derivatives (aliphatic): Preparation of Acid chlorides, Anhydrides,Esters and Amides from acids.

Hydroxy acids:- Synthesis of Lactic, Tartaric and citric acids. Effect of heat on α,β,γ-hydroxyl acids **(8 Lectures**)

Reference:

- Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
- McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
- Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
- Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
- Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
- Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. General ChemistryCengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
- Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

CHEMISTRY LAB- DSC 2 LAB:

CHEMICAL ENERGETICS AND ORGANIC CHEMISTRY

60 Lectures

Section A: Physical Chemistry

Conductance

I. Determination of cell constant

II. Determination of equivalent conductance, degree of dissociation and

dissociation constant of a weak acid.

III. Perform the following conductometric titrations:
   i. Strong acid vs strong base
   ii. Weak acid vsstrong base

Potentiometry

Perform the following potentiometric titrations:
   i. Strong acid vs. strong base
   ii. Weak acid vs. strong base
   iii. Potassium dichromate vs. Mohr's salt

Colorimetric estimation of Cu^{2+} /Fe^{3+}

Determination of refractive index of the mixture

Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

b) PH titration of strong acid with strong base.

c) Determination of pKa of weak acid by potentiometric titration.

d) Preparation of buffer solutions:
   I. Sodium acetate-acetic acid.
   II. Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation ofquantitative yields to be done.
   (a) Bromination of Phenol/Aniline
   (b) Benzoylation of amines/phenols
   (c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone.
   (d) Preparation of acetanilide from aniline.
   (e) Preparation of p-bromo acetanilide
   (f) Preparation of benzoic acid from benzaldehyde by oxidation.

Reference :

- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
- Khosla, B. D.; Garg, V. C. &Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011)

CMC24001/ CMC24005/ CMC24008

SEMESTER-III
SOLUTIONS AND ORGANIC CHEMISTRY

Theory: 60 Lectures

Course outcome:

After completion of the course the student is able to:

CO1: Understand the classification and characteristics of solutions
CO2: Understand the details of electrochemistry
CO3: Understand in detail organometallic compounds and biomolecules
CO4: Understand in detail the concept of carbohydrates

CHEMISTRY-DSC -3

Theory: 60 Lectures

Section A: Physical Chemistry-2 (30 Lectures)

Solutions

Concentrations-different ways of expression, solutions of gases in gases,Henry's law,Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions.Lever rule.Azeotropes. Chemical potential of ideal and non ideal solution: Gibbs Duhem-Morgules equation. Entropy change of mixing for an ideal solution

Liquid mixtures:

Classification of binary mixtures into partially miscible, completely miscible and immiscible pairs of liquids. Principle of steam distillation Raoult's law, Critical solution temperature, partially miscible liquids: phenol water system, triethyl-amine water system and nicotine water system, Binary mixtures of completely miscible liquids, vapour pressure – composition diagrams and vapour pressure – temperature diagram. Classification into types- obeying Raoult's law (type I), positive deviation (type II),negative deviation (type III)from Raoult's law.Principles of fractional distillation, fractional distillation type I, type II and type III liquid mixtures, azeotropic mixtures. Binary mixtures of completely miscible liquids, principles of steam distillation – applications.(to be briefed)

Colligative properties

Introduction: vapour pressure, variation of vapour pressure with temperature(explanation with graph). Definition of boiling point and freezing point.Effect of dissolution of solute, vapour pressure of the solvent, lowering of vapour pressure, Raoult's law – relation between relative lowering of vapour pressure and molar mass.Determination of molar mass of solute by dynamic method, problems.

Elevation of boiling point:– definition and its relation to lowering of vapour pressure and molar mass (to be derived). Ebullioscopic constant of the solvent and its relation to

the boiling point (only equation). Determination of molar mass of the solute by Walker-Lumsden's method,

Depression in freezing point:– definition. Relation to lowering of vapour pressure and molar mass (to be derived).Cryoscopic constant, its relation to the melting point (only equation). Determination of molar mass of non-volatile solute by Beckmann's method. Abnormal molecular weights – causes - vant Hoff's factor, evaluation of degree of dissociation and association.Problems pertaining to all the colligative properties

(12 Lectures)

Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium.Gibbs Phase Rule and its thermodynamic derivation. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, FeCl3-H2O and Na-K only).

(5 Lectures)

Conductance and Electrochemistry

Introduction, conductance (specific, equivalent and molar conductance – definition and SI unit), conductance cell and cell constant, determination of equivalent conductance by meter-bridge method, variation of Λ and k with dilution, ionic mobility, ionic conductance and their relationship. Kohlrausch's law and its significance, transport number – definition and explanation, anomalous transport number, relationship between ionic conductance and transport number (to be derived). Determination of transport number by Hittorff's and moving boundary method (transport number of H+ using CdCl2 as supporting electrolyte) (Numerical problems to be worked out).

Application of conductance measurement:

a) Solubility and solubility product of sparingly soluble salt.
b) Ionic product of water
c) degree of ionization of weak electrolyte
   I. conductometric titration (strong acid Vs strong base, weak acid Vs strong base, strong acid Vs weak base, weak acid and weak base with examples)
   II. hydrolysis constant (taking aniline hydrochloride as an example)

Electromotive force:

Electrolytic and electro chemical cells,.Single electrode potential, sign of electrode potential (reduction potential to be adopted) convention of representing a cell, electrode reaction of a daniellcell.EMF and standard EMF of a cell, cell reaction, reversible and irreversible cells. Nernst equation (to be derived) and calculation of electrode potential, primary reference electrode – standard hydrogen electrode, secondary reference electrode – calomel and Ag - AgCl electrode – construction and working, electro-chemical series, equilibrium constant and free energy of a cell reaction, and its derivation, concentration cells with and without transference, EMF of concentration cells, liquid junction potential and salt bridge.Numerical problems on Nernst equation and EMF calculation.Fuel cells – working of H_2O_2 fuel cell and its importance.

Application of EMF measurements:

a)Determination of pH of a solution using quinhydrone electrode and glass electrode using dip type calomel electrode – principles and procedure.

b)Potentiometric titration – principle, location of end points in neutralization reactions (NaOH Vs HCl), Oxidation – reduction reactions ($K_2Cr_2O_7$ Vs FAS), precipitation reaction (KCl Vs $AgNO_3$) and complex reactions ($ZnSO_4$ Vs $K_3[Fe(CN)_6]$

(13 Lectures)

Section B:Organic Chemistry-2 (30 Lectures)

Organometallic compounds:-

Definition with example.Organo magnesium compounds (Grignard reagents) Formation ethyl magnesium bromide and its synthetic applications(synthesis of alcohols, acids, aldehydes, ketones and carboxylic acids)

Organo zinc compounds:- Preparation of diethyl zinc and its applications

Organolithium Compounds:- Preparation and synthetic applications of LDA

Amines and Diazonium Salts

Amines:-Definition, classification with example. Synthesis by Gabriel phthalimide method, reduction of amides.Separation of amine mixture by Hinsberg's method. Distinction tests for 1°,2°, 3° amines (acetylation and Hoffmann's exhaustive methylation). Action of nitrous acid on different amines(Both aliphatic and aromatic 1°,2°, 3° amines), basicity of amines, effect of substituent on basicity of aliphatic and aromatic amines. Hoffmann-Martius rearrangement.

Diazonium Compounds: Preparation, mechanism of preparation and synthetic applications of benzene diazonium chloride. Conversion to phenol, halobenzene, phenyl hydrazine and coupling reaction.

(10Lectures)

Amino Acids, Peptides and Proteins:

Preparation of Amino Acids: Strecker synthesis using Gabriel's Phthalimidesynthesis.Zwitterion, Isoelectric point and Electrophoresis.

Reactions of Amino acids: ester of –COOH group, acetylation of NH_2group,complexation with Cu^{2+} ions,

Elementary account of Primary, Secondary, Structure of proteins. Peptides(Amides)Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and Carbobenzoxy carbonyl) **(4 Lectures)**

Carbohydrates: Definition and importance, classification based on composition with examples-reducing and non-reducing sugars. Monosaccharides:- Glucose- reactions of glucose (with H_2N-OH, HCN, $C_6H_5NHNH_2$, Br_2 water, Conc.HNO_3, reductions with HI/red P , Methanol(dry HCl), acetic anhydride and reduction reactions. Mutarotation. Structural elucidation of glucose and fructose :- open chain structure, ring structure-Fisher and Haworth structure. Determination of ring size by methylation method. Fischer and Haworth structures of fructose, galactose and mannose Interconversions reactions-1) Ascending (Killiani's synthesis) 2) Descending (Wohl's degradation) 3) Aldose to Ketose 4) Ketose to Aldose 5) Epimerization

Disaccharides:- structural elucidation of sucrose, structural formulae of maltose and lactose (Haworth structure).Polysaccharides:- Partial structural formulae of starch and Cellulose. **(8 Lectures)**

Alkaloids:- definition, classification based on heterocyclic rings-isolation, synthesis and structural elucidation of nicotine .Structure of Morphine, Atropine, Cocaine & physiological importance of alkaloids.

Vitamins:- Definition, classification, structural elucidation and synthesis of vit-A, Synthesis of vit-C, Sources & importance of Vitamin-B, calciferol, E ,D & K

Hormones:- definition, classification, synthesis and functions of adrenaline and thyroxine.

Terpenes:- definition, isoprene rule, Classification, isolation (Solvent extraction and Steam distillation), structural elucidation of citral and it's synthesis, structural formulae of α-terpeneol, Camphor and menthol. **(8 Lectures)**

Reference:

- Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
- Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
- Mahan, B.H. University Chemistry, 3rd Ed. Narosa (1998).
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- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7thEd., W. H. Freeman.
- Berg, J.M., Tymoczko, J.L. &Stryer, L. Biochemistry, W.H. Freeman, 2002.

- Puri & Sharma,A Textbook of Chemistry

CHEMISTRY LAB-DSC 3 LAB:
SOLUTIONS AND ORGANIC, CHEMISTRY

60 Lectures

Section A: Physical Chemistry

Section A: Physical Chemistry
Thermo chemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of Transition temperature of the given salt hydrate.
5. Determination of enthalpy of hydration of copper sulphate.
6. Determination of CST OF phenol water system
7. Determination of % of NaCl

Section B: Organic Chemistry

I Systematic Qualitative Organic Analysis of Organic Compounds possessingmonofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

II

1. Separation of amino acids by paper chromatography
2. Determination of the concentration of glycine solution by formylation method.
3. Titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.

6. Differentiation between a reducing and a nonreducing sugar.

Reference:

- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
- Khosla, B. D.; Garg, V. C. &Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Ahluwalia, V.K. &Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

CMD24001/ CMD24005/ CMD24008

SEMESTER-IV

COORDINATION CHEMISTRY AND PHYSICAL CHEMISTRY

Theory: 60 Lectures

Course outcome:

After completion of the course the student is able to:

CO1: Understand in depth transition elements and coordination chemistry
CO2: Learn the details of kinetic theory of gases and chemical kinetics
CO3: Learn in detail the properties of solids, liquids and gases

CHEMISTRY-DSC 4

Chemistry of transition elements:

Position in the periodic table, electronic configuration, general characteristics-atomic and ionic radii, ionization energy, variable oxidation states, (Latimer diagrams) spectral properties, redox potentials, colour and magnetic properties, catalytic activity, complex formation and interstitial compounds formation (3d, 4d and 5d series).

Chemistry of inner transition elements: Lanthanides: Electronic configuration and position in the periodic table, oxidation states, spectral properties, colour and magnetic properties, complex formation and ionic radii, lanthanide contraction – cause & its consequences and solvent extraction method.

General survey of actinides – comparison with lanthanides, transuranic elements. Action of ion exchange resins – cation exchange and anion exchange resins, exchange of inorganic ions, ion exchange capacity, separation of lanthanides by ion- exchange method. Comparison of d and f block elements.

(12 Lectures)

Coordination Chemistry

Ligands, classification of ligands and chelation, nomenclature of co-ordination compounds, physical methods in the study of complexes – change in conductance, colour and pH.Stability of complexes – stability constant, a brief outline of thermodynamic stability of metal complexes, factors affecting the stability of complexes.Polynuclear complexes, inner metallic complexes.Sidwick-EAN rule

Isomerism in co-ordination complexes: Stereo-isomerism – Geometrical and optical isomerism exhibited by co-ordination compounds of co-ordination number 4 and 6.

Metal-ligand bonding in transition metal complexes:

Valence bond theroy: Salient features, formation of octahedral complexes on the basis of VBT, outer and inner orbital octahedral complexes- $[Fe(CN)_6]^{4-}$, $[Fe(CN)_6]^{3}$-, $[Co(CN)_6]^{3-}$, [CoF6]3- $[Cr(H_2O)_6]^{3+}$ and $[Fe(H_2O)_6]^{2+.}$ Formation of tetrahedral and square planner complexes on the basis of VBT – $[Ni(CN)4]^{2-}$, $[Cu(NH3)]^{2+}$, $[Zn(NH3)4]^{2+}$and $[Ni(CO)_4]$, limitations of VBT.

Crystal field theory: Important features of crystal field theory, crystal field splitting of d-orbitals in tetrahedral, octahedral and square planar complexes, crystal field stabilization energy (CFSE), factors affecting the magnitude of Δo, (nature of ligand, oxidation state of the metal ion, size of the orbitals, geometry of the complex), high spin

(HS) and low spin (LS) complexesSpectrochemical series, magnetic properties of metal complexes based on crystal field theory-[Co(NH3)6]3+, [CoF6]3-, [Fe(CN)6]4-, [Fe(CN)6]3- and [Ni(CN)4]2-. Magnetic susceptibility, measurement of magnetic moment by Gouy's method.Tetragonal distortion of octahedral geometry.Jahn-Teller distortion.Applications of complex formation in biological systems

(18 Lectures)

Section B: Physical Chemistry-3 **(30 Lectures)**

Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation.Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation.Andrews isotherms of CO2.

Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.

Temperature dependence of these distributions.Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only)

(8 Lectures)

Liquids

Properties of liquids

Viscosity : Definition of co-efficient of viscosity, factors affecting viscosity – temperature, size, mass, shape of molecules, intermolecular forces, determination of viscosity of liquids by Ostwald's method.**.**

Surface tension : Definition, effect of temperature and solute on surface tension.Determination of surface tension of liquids using stalagmometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Parachor : Definition, sudgen equation, calculation of parachor and its application w.r.t. the elucidation of structures- of benzene, quinine and isocyanide ion(Numerical problems).

Polarization- induced, orientation and molar polarization – definitions, clausius-Mossotiz equation (no derivation) and its application. **(8 Lectures)**

Solids :

Introduction, laws of crystallography - law of constancy of interfacial angles, law of rational indices- weiss and miller indices. Unit cell, Space lattices and lattice planes, seven crystal systems, lattice planes in cubic crystals (Simple cubic, body centered cubic and face centered cubic).

Elements of symmetry – plane, axis and centre, elements of symmetry in cubic system, types of lattices, Bragg's equation and its derivation. X-ray diffraction and determination of crystal structure of rock salt by rotating crystal method. Application of X-ray studies – distance between lattice planes, density of crystals, determination of Avogadro number. (Numerical problems) Defects in crystals.

Liquid crystals:
Mesomorphic state – definition, classification of liquid crystals smectic and nematic with examples, molecular arrangement in the two types and uses. Nano materials – definition, properties and application **(8 Lectures)**

Chemical Kinetics:
The concept of reaction rates.Effect of temperature, pressure, catalyst and other factors on reaction rates.Order and molecularity of a reaction.Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants).Half–life of a reaction. General methods for determination of order of a reaction (Differential method, integration, halflife period and isolation methods) Concept of activation energy and its calculation from Arrhenius equation.
Theories of Reaction Rates: Collision theory based on hard sphere model and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only). **(6Lectures)**

Reference:

- Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
- Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. General ChemistryCengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
- Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

- Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley.
- Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press.
- Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd.
- Rodgers, G.E. Inorganic & Solid State Chemistry,Cengage Learning India Ltd., 2008.
- R D Madan,Textbook of Chemistry
- Madan, Malik Tuli,Comprehensive Chemistry
- Satyaprakash, Text book of Chemistry

CHEMISTRY LAB-DSC 4 LAB:
COORDINATION CHEMISTRY AND PHYSICAL CHEMISTRY

60 Lectures

Section A: Inorganic Chemistry

Semi-micro qualitative analysis (using H2S or other methods) of mixtures - not more than four ionic species (two anions and two cations, excluding insoluble salts) out of the following:

Cations : NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Na^+, K^+

Anions : CO_3^{2-} , S^{2-}, SO^{2-}, $S_2O_3^{2-}$, NO_3^-, CH_3COO^-, Cl^-, Br^-, I^-, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, C_2O4^{2-}, F^-

(Spot tests should be carried out wherever feasible)

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.
2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
3. Estimation of total hardness of a given sample of water by complexometric titration.

Section B: Physical Chemistry

I. Surface tension measurement (use of organic solvents excluded).

a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

b) Study of the variation of surface tension of a detergent solution with concentration.

II. Viscosity measurement (use of organic solvents excluded)

a. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

b. Study of the variation of viscosity of an aqueous solution with concentration of solute.

III Determination molecular weight of the given non volatile solute by Walker Lumbsden method.

(III) Chemical Kinetics

Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
   a. Acid hydrolysis of methyl acetate with hydrochloric acid.
   b. Saponification of ethyl acetate.
   c. Kinetics of rate of decomposition of H_2O_2catalysed by $FeCl_3$

Reference:

- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
- Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
- Khosla, B. D.; Garg, V. C. &Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

CME24001/ CME24005/ CME24008

DSE-1A **SEMESTER-V**

INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

Theory: 60 Lectures

Course outcome:

After completion of the course the student is able to:

CO1: Identify in detail with examples inorganic polymers and Non aqueous solvents
CO2: Understand the details of silicate industry and batteries
CO3: Learn in detail about alloys catalysis and explosives

CHEMISTRY-DSE:

Silicate Industries

Glass: Rawmaterials, Glassy state and its properties, classification (silicate and non-silicate glasses).Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics:Important clays and feldspar, ceramic, their types and manufacture. Hightechnology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cement: Classification of cement, ingredients and their role, Manufacture of cementand the setting process, quick setting cements.

Abrasives: Definition, classification with examples – hardness, manufacture and applications of carborundum, alundum and tungsten carbide.

Refractories: Definition, properties, classification with examples. Different steps involved in the manufacture of refractories. Applications of refractories.

Inorganic polymers:

Definition – examples, general properties, comparison with organic polymers, glass transition temperature Silicones: Definition, nomenclature, preparation (linear, cross-linked and cyclic). Factors affecting the nature of silicon polymers, properties (chemical and thermal stabilities(chemical properties) uses of silicon polymers, silicon fluids/oils – uses, silicon elastomers / rubbers, silicon resins (preparation and uses)

Phosphazenes: Definition, types, structures, preparation, properties and uses. Crystalline polymetaphosphates – Maddrell's and Kuroll's salts – properties and uses.Nature of bonding in phosphazenes.

Fluorocarbons: Definition, examples, preparation, properties and uses of Freon-12, Freon-22, PTFE and poly per fluorovinyl chloride.

Non-aqueous solvents:

Liquid ammonia- Reasons for the solvent properties, typical reactions- solubility of alkali metals; acid-base, precipitation, ammonolysis, Ionization of weak acids, advantages and disadvantages.

Liquid SO_2- Reasons for the solvent properties, typical reactions-acid-base, solvolysis, precipitation, amphoteric and redox reactions **(25 Lectures)**

Fertilizers:
Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate. **(5 Lectures)**

Surface Coatings:
Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings.Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

(10 Lectures)

Batteries:
Primary and secondary batteries, battery components and their role, Characteristics of Battery.Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery.Fuel cells, Solar cell and polymer cell.

(4 Lectures)

Alloys:
Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys.Properties and applications of steel. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.
Production of Ferro alloys: Ferro chrome and Ferro manganese.

(8 Lectures)

Catalysis:
General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples).Theories of catalysis, Auto catalyst.Industrial applications, Deactivation or regeneration of catalysts.Phase transfer catalysts, application of zeolites as catalysts.

(4 Lectures)

Chemical explosives:
Origin of explosive properties in organic compounds, Classification with examples, preparation and explosive properties of lead azide, PETN, cyclonite (RDX).Introduction to rocket propellants.

(4 Lectures)

Reference:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel'sHandbook of Industrial Chemistry, CBS Publishers, New Delhi.
- P. C. Jain & M. Jain: Engineering Chemistry,DhanpatRai& Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry,Vikas Publications, New Delhi.
- B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut

CHEMISTRY PRACTICAL – DSE 1A LAB:
INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

60 Lectures

Section A: Gravimetric estimations

1. Gravimetric estimation of Barium as barium sulphate.
2. Gravimetric estimation of Iron as Iron oxide
3. Gravimetric estimation of Copper as Copper thiocyanate
4. Gravimetric estimation of Nickel as nickeldimethylglyoximate
5. Gravimetric estimation of magnesium as Magnesiumhydroxyquenolate
6. Gravimetric estimation of Sulphate as barium sulphate
7. Gravimetric estimation of Manganese from pyrolusite ore

Section B: Volumetric estimations

1. Determination of Iodine value of edible oil
2. Determination saponification value of edible oil
3. Separation of Green leaf pigments by TLC
4. Determination of amount of acetic cid in a given wine sample
5. Determination of total acidity of vineger
6. Determination of vitamin C in orange juice.

Reference:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel'sHandbook of Industrial Chemistry, CBS Publishers, New Delhi.
- P. C. Jain, M. Jain: Engineering Chemistry,DhanpatRai& Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry,Vikas Publications, New Delhi.
- Sharma, B.K. & Gaur, H. Industrial Chemistry,Goel Publishing House, Meerut (1996).

CME24401/ CME24405/ CME24408

DSE:1B **SEMESTER V**

INDUSTRIAL CHEMICALS AND ENVIRONMENT

Theory: 60 Lectures

Course outcome:

After completion of the course the student is able to:

CO1: Understand in depth environment and energy
CO2: Specify the classification and characteristics of industrial gases metallurgy and inorganic chemicals

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

(10 Lectures)

Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology

(4 Lectures)

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution

Pollution by SO_2, CO_2 , CO, NO_x, H_2S and other foul smelling gases. Methods of estimation of CO, NO_x, SO_x and control procedures

Effects of air pollution on living organisms and vegetation.Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal.Control of particulates

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sourcesand nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems

Water purification methods: Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.

Industrial waste management, incineration of waste.Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water

(30 Lectures)

Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

(10 Lectures)

Biocatalysis

Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

(6 Lectures)

Reference:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: *Riegel's Handbook of Industrial Chemistry, CBS Publishers, NewDelhi.*
- *S. S. Dara: A Textbook of Engineering Chemistry*, S. Chand & Company Ltd.New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
- S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).

- G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
- A. Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).

CHEMISTRY PRACTICAL - DSE 1B, LAB: INDUSTRIAL CHEMICALS & ENVIRONMENT **60 Lectures**

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method.
7. Measurement of dissolved CO_2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Reference:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's*Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt. Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

CMF24001/ CMF24005/ CMF24008

DSE-1A SEMESTER-VI

ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLYNUCLEAR HYDROCARBONS AND UV, IR SPECTROSCOPY

Theory: 60 Lectures

Course outcome:

After completion of the course the student is able to:

CO1: Learn in depth metallurgy, organometallic compounds and bioinorganic chemistry
CO2: Understand in depth heteronuclear aromatic compounds, active methylene compounds
CO3: Learn in detail with examples spectroscopy

DSE-1A:

Section A: Inorganic Chemistry-4 (30 Lectures)

Metallurgy: Terms and principles involved in metallurgy, Ellingam'sdiagram,Types of metallurgy: Pyro metallurgy- extraction of Nickel by sulphide ore- generall metallurgy followed by Monds process (purification, Manganese from oxides ores- Reduction by the Alumino Thermite process- refininmg by electrolytic process.

Hydro metallurgy: Extraction of Gold from native ore by cyanide process, and refining by quartation process.

Electro metallurgy: Extraction of Lithium by fusion method Followed by electrolysis of lithium chloride.

Powder metallurgy: Importance, metal powder production &applications. Production of Tungsten powder.Principles of Electroplationg. **(10 Lectures)**

Organometallic Compounds

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene.. Preparation , properties , boding and appliations of alkyle and aryls of Li, Al, Hg,Sn and Ti.

Nature of M-CO bonding in carbonyls. Preparation, properties and structures of mono nuclear and binuclear metal carbonyls-Ni(CO)4, Cr(CO)6, Fe(CO)5, Mn2(CO)10, Co2(CO)8. Applications of EAN rule to mononuclear metalcarbonyls.

Behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies). **(10 Lectures)**

Chemistry of nonmetallics:

Boron : Boron hydrides – Diborane – preparation, properties, uses and structure Carbon: Fullerenes- Production, structure of C60 and C70. Diamond and Graphite-Properties and structure.

Silicon: Structure of silica. Silicates-types of silicates with examples.

Nitrogen: Preparation (any two methods), properties, uses, structure of hydrazine, hydroxyl amine and hydrazoic acid.

Sulphur: Preparation, properties, structures and applications of thionyl chloride, sulphuryl chloride and SF6.

Halogens: Preparation, properties and structure of bleaching powder.

Pseudo halogens: preparation, properties and structure of cyanogens, thiocyanogen, tellurocyanogen and oxocyanogen.(any one method of preparation and any three properties to be discussed). **(5 Lectures)**

Bio-Inorganic Chemistry

A brief introduction to bio-inorganic chemistry.Essential and trace elements in biological process. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Ca2+, Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, Enzymatic role of Iron in Hemoglobin and myoglobin, Magnesium in Chlorophyll, Cobalt in Vitamin B12.

Stabilization of protein structures and structural role (bones).

Biological functions and toxicity of Cr, Mn, Co, Ni, I, Hg, Mo, and Se. **(5 Lectures)**

Section B: Organic Chemistry-4 **(30 Lectures)**

Polynuclear and heteronuclear aromatic compounds:

Polynuclear Hydrocarbons: Resonance structures of Naphthalene, anthracene and Phenanthracene.

Structural elucidation of naphthalene. Reactions of naphthalene- oxidation, reduction and electrophilic substitution reactions

HetrocyclicCompounds:Definition, classification with examples, synthesis of Furan, thiophene, pyrrole, pyridine, indole (Fischer method), quinoline (Skrup's synthesis), isoquinoline, pyrimidine (one method each). Aromaticity and basicity of pyrrole and pyridine.Electrophillic substitution reactions of pyrrole and pyridine.

Uric acid- Structure, Synthesis. Conversion of uric to purine and caffeine

Dyes: Colour and Constitution, Witt's theory, Classification of dyes based on structures with examples, synthesis of Methyl orange, Bismark brown, indigo and malachite green, structural elucidation of alizarin and it's synthesis**.**

Drugs: Chemotherapy and chemotherapeutic agents, definition of drugs, types of drugs, antipyretics, analgesics, anaesthetics, sedatives, narcotics, antiseptics, antibacterials, antibiotics, antimalarials and sulpha drugs with examples. Synthesis of paracetamol, sulphanilamide, sulphaguanidine **(13 lectures)**

Active methylene compounds: Definition, Ethyl acetoacetate and diethyl malonatepreparation, Mechanism of Claisen condensation, keto-enoltautomerism and its evidence.Synthetic applications of EAA and DEM:- Synthesis of mono carboxylic acids, dicarboxylic acids-succinic acid, adipic acid, antipyrine,Barbituric acid, acetyl acetone, Crotonic acid and Cinnamic acid**.** **(4 lectures)**

Application of Spectroscopy to Simple Organic Molecules

Application of visible, ultraviolet and Infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, $\lambda_{max,}$ chromophore, auxochrome, bathochromic and hypsochromic shifts. Woodward rules for calculating λmax of conjugated dienes

IR-Spectroscopy: Introduction,functional group region and finger print region stretching frequency, Graphical representation of IR spectra of benzoic acid and methyl benzoate . Absorption frequencies of Simple functional groups

NMR Spectroscopy: Basic principles of proton magnetic resonance , nuclear magnetic spin quantum number I, influence of the magnetic field on the spin of nuclei, magnetic resonance-chemical shift (δ value), use of TMS as reference, nuclear shielding effects, equivalent and non-equivalent protons, spin-spin splitting.

NMR spectra of Simple organic molecules (like ethyl alcohol, ethane, propane, benzene, toluene, acetone, and methyl chloride) to be discussed.. **(13 Lectures)**

Reference:

- James E. Huheey, Ellen Keiter& Richard Keiter: Inorganic Chemistry:Principles of Structure and Reactivity, Pearson Publication.
- G.L. Miessler& Donald A. Tarr: Inorganic Chemistry, Pearson Publication.
- J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
- F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley & Sons.
- I.L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S.
- John R. Dyer: Applications of Absorption Spectroscopy of OrganicCompounds, Prentice Hall.
- R.M. Silverstein, G.C. Bassler& T.C. Morrill: Spectroscopic Identification ofOrganic Compounds, John Wiley & Sons.
- R.T. Morrison & R.N. Boyd: Organic Chemistry, Prentice Hall.
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- ArunBahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand

CHEMISTRY PRACTICAL – DSE 1A LAB

60 lectures

Section A: Inorganic Chemistry

1. Separation of mixtures by chromatography: Measure the Rf value in each case. (Combination of two ions to be given)
   Paper chromatographic separation of Fe^{3+}, $A1^{3+}$ and Cr^{3+} or Paper chromatographic separation of Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+}
2. Preparation of any two of the following complexes and measurement of their conductivity:

   (i) tetraamminecarbonatocobalt (III) nitrate
   (ii) tetraamminecopper (II) sulphate
   (iii) potassium trioxalatoferrate (III) trihydrate

Compare the conductance of the complexes with that of M/1000 solution of NaCl, $MgCl_2$ and $LiCl_3$.

Section B: Volumetric analysis

1. Estimation of iron in the given sample of Hematite by dichromate method
2. Estimation of % of calcium in lime stone by oxalate method
3. Estimation of manganese in the given sample of pyrolusite
4. Estimation of magnesium in the given sample of Dolomite by EDTA method
5. Determination of % purity of copper in tha given sample of copper wire
6. Determination of COD of water.
7. Estimation of available chlorine in bleaching powder
8. Estimation of total hardness of different samples of water using EDTA & $ZnSO_4$.

Reference:

- A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
- A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

CMF24201/ CMF24205/ CMF24208
DSE-1B

SEMESTER VI

QUANTUM CHEMISTRY, SPECTROSCOPY & PHOTOCHEMISTRY

Theory: 60 Lectures

COURSE OUTCOME:

After completion of the course the student is able to:

CO1: Identify the details of quantum chemistry
CO2: Learn the details of molecular spectroscopy
CO3: Understand the details of photochemistry

Quantum Chemistry

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.

Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.

Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

(24 Lectures)

Molecular Spectroscopy:

Interaction of electromagnetic radiation with molecules and various types of spectra; BornOppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals. **(24 Lectures)**

Photochemistry

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

(12 Lectures)

Reference:

- Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
- Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
- House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
- Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
- Kakkar, R. Atomic & Molecular Spectroscopy: Concepts & Applications, Cambridge University Press (2015).

DSE-1B LAB 60 Lectures

UV/Visible spectroscopy

I. Study the 200-500 nm absorbance spectra of KMnO4 and K2Cr2O7 (in 0.1 M H2SO4) and determine the λmax values. Calculate the energies of the two transitions in different units (J molecule-1, kJ mol-1 , cm -1, eV).

II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K2Cr2O7.

III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colourimetry

I. Verify Lambert-Beer's law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration

II. Determine the concentrations of KMnO4 and K2Cr2O7 in a mixture.

III. Study the kinetics of iodination of propanone in acidic medium
IV. Determine the amount of iron present in a sample using 1,10-phenathroline.
V. Determine the dissociation constant of an indicator (phenolphthalein).
VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.
VII. Analyse the given vibration-rotation spectrum of HCl(g)

Reference :

- Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- Khosla, B. D.; Garg, V. C & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

CME24201/ CME24205/ CME24208

V SEMESTER

SEC-1A FUEL CHEMISTRY

SKILL ENHANCEMENT COURSE-SEC

30 Lectures

Course outcome:

After completion of the course a student is able to:

CO1: Understand the characteristics of coal and lubricants with examples
CO2: Specify the characteristics of petroleum and petrochemical industries

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value

Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants.
Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Reference :

- Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
- Jain, P.C. & Jain, M. Engineering ChemistryDhanpatRai& Sons, Delhi.
- Sharma, B.K. & Gaur, H. Industrial Chemistry,Goel Publishing House, Meerut (1996).

CME24601/ CME24605/ CME24608

SEC-1B V SEMESTER

BASIC ANALYTICAL CHEMISTRY

30 Lectures

Course outcome:

After completion of the course a student is able to:

CO1: Understand in detail, the analysis of soil, water and food
CO2: Understand the details of chromatography

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

a. Determination of pH of soil samples.
b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminatingwater, water sampling methods, water purification methods.

a. Determination of pH, acidity and alkalinity of a water sample.
b. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processingand food preservations and adulteration.

a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
b. Analysis of preservatives and colouring matter.

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).
b. To compare paint samples by TLC method. **Ion-exchange:** Column, ion-exchange chromatography etc.

Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Analysis of cosmetics: Major and minor constituents and their function

a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Suggested Applications (Any one):

a. To study the use of phenolphthalein in trap cases.
b. To analyze arson accelerants.
c. To carry out analysis of gasoline.

Suggested Instrumental demonstrations:

a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.

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b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Reference:

- Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. *Instrumental Methods ofAnalysis*. 7thEd. Wadsworth Publishing Co. Ltd., Belmont, California, USA,1988.
- Skoog, D.A. Holler F.J. &Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of AnalyticalChemistry 6th Ed.,* Saunders College Publishing, Fort Worth (1992).
- Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
- Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
- Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
- Freifelder, D. *Physical Biochemistry 2ndEd.,* W.H. Freeman and Co., N.Y. USA (1982).
- Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (1977).
- Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7thEd.,* Prentice Hall.
- Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6thEd.,* Prentice Hall.
- Robinson, J.W. *Undergraduate Instrumental Analysis 5thEd.,* Marcel Dekker, Inc., New York (1995).

Pattern of question paper
I to VI semesters

Time :3.00hrs **Max marks: 70**

PART-A

I. Answer the following questions 1x10=10

a)
b)
c)
d)
e)
f)
g)
h)
i)
j)

PART-B

II Answer any three questions
(Questions carrying 4,4,2- 3,3,4- 6,4 and 5,5 marks may be given) 3x10=30

2)
3)
4)
5)

PART-C

III Answer any three questions
(Questions carrying 4,4,2- 3,3,4- 6,4 and 5,5 marks may be given) 3x10=30

6)
7)
8)
9)

Pattern of question paper for SEC

Time :2.30.00hrs **Max marks: 50**

PART-A

I. Answer the following questions 1x10=10

a)
b)
c)
d)
e)
f)
g)
h)
i)
j)

PART-B

II Answer any four questions
(Questions carrying 4,4,2- 3,3,4- 6,4 and 5,5 marks may be given) 4x10=40

2)
3)
4)
5)