# LOCF CHEMISTRY

Learning Outcomes based Curriculum Framework (LOCF) for

(B.Sc. Honors in Chemistry)

**Undergraduate Programme** 

2021



Prepared by BoS (UG) Chemistry Tumkur University, Tumakuru

# Curriculum

### Name of the Degree Program: B.Sc (Honors) Chemistry

#### **Discipline Core: Chemistry Total Credits for the Program: 176**

#### Year of implementation: 2021-22

#### **Program Outcomes:**

#### By the end of the program the students will be able to:

- 1. PO. 1: To create enthusiasm among students for chemistry and its application in various fields of life.
- 2. **PO. 2:** To provide students with broad and balanced knowledge and understanding of key concepts in chemistry.
- 3. **PO. 3:** To develop in students a range of practical skills so that they can understand and assess risks and work safely measures to be followed in the laboratory.
- 4. **PO. 4:** To develop in students the ability to apply standard methodology to the solution of problems in chemistry.
- 5. **PO. 5:** To provide students with knowledge and skill towards employment or higher education in Analytical chemistry or multi-disciplinary areas involving chemistry.
- 6. **PO. 6:** To provide students with the ability to plan and carry out experiments independently and assess the significance of outcomes and to cater to the demands of chemical Industries of well-trained graduates.
- 7. **PO. 7:** To develop in students the ability to adapt and apply methodology to the solution of unfamiliar types of problems.
- 8. **PO. 8:** To instill critical awareness of advances at the forefront of chemical sciences, to prepare students effectively for professional employment or research degrees in chemical sciences and to develop an independent and responsible work ethics.

# Curriculum Structure for the Undergraduate Degree Program B.Sc (Honors) Chemistry

Total Credits for the Program: 176 Year of implementation: 2021-22 Name of the Degree Program: B. Sc (Honors) Discipline/Subject: Chemistry

#### **Program Articulation Matrix:**

This matrix lists only the core courses. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory, project, internships etc. Elective courses may be listed separately.

Semester	Title/Name of the	Program outcomes that the	Pre-	Pedagogy##	Assessments
	course	course addresses (not more	requisite		
		than 3 per course)	course(s)		
Ι	CHEDSC01: Analytical and Organic Chemistry- I	<ul> <li>The concepts of chemical analysis, accuracy, precision and statistical data treatment</li> <li>Understand the preparation of alkanes, alkenes and alkynes, their reactions, etc.</li> <li>Understand the mechanism of nucleophilic, electrophilic reactions.</li> </ul>	P.U.C with Chemistry	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHEDSC01P: Analytical and Organic Practicals- I	<ul> <li>handle the glassware, prepare and dilute the solutions and perform experiments with prepared reagents.</li> <li>determine the analyte through volumetric and gravimetric analysis and understand the chemistry involved in each method of analysis.</li> <li>Prepare organic compounds and calculation of percentage yield.</li> </ul>	-	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
Π	CHEDSC02: Inorganic and Physical Chemistry-I CHEDSC02P:	<ul> <li>The Bohr's theory of atomic structure and how it was developed</li> <li>Quantum numbers and their necessity in explaining the atomic structure</li> <li>The concept of unit cell, symmetry elements, Nernst distribution law.</li> <li>To prepare standard</li> </ul>	-	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	Inorganic and Physical Practicals- I	<ul> <li>To prepare standard solutions</li> <li>Techniques like precipitation, filtration, drying and ignition</li> </ul>		Desk work	Continuous Evaluation, Sem Exams

	1				I
		• Various titrimetric			
		techniques and gravimetric			
	CITED C CAA	methods	<b>D a a a</b>		
111	CHEDSC03: Analytical and	Will be updated once syllabus	DSC-1 and	Assignment	Internal Exams,
	Analytical and Organic Chemistry-	from state committee is received.	DSC-2	Desk work	Continuous
	II				Evaluation, Sem
	CHEDSC03P:				Exams
	Analytical and				
	<b>Organic Practicals-</b>				
	II	*****			
IV	CHEDSC04: Inorgania and	Will be updated once syllabus		Assignment	Internal Exams,
	Physical	from state committee is received.		Desk work	Continuous Evoluction Som
	Chemistry-II				Evaluation, Sem
	CHEDSC04P:				Exams
	Inorganic and				
	Physical Practicals-				
N/		Will be up doted array gallaburg	DCC 2 and	MOOC	Internal tests
v	CHEDSCUS: Selected topics in	will be updated once syllabus	DSC-3 and	MOOCS, Drohlam	Aggiggements, Quiz
	Inorganic	from state committee is received.	DSC-4	solving	Assignments, Quiz
	Chemistry			sorving	
	CHEDSC05P:				
	Inorganic				
	Chemistry				
	CHEDSC06.				
	Selected topics in				
	Organic Chemistry				
	CHEDSC06P:				
	Organic Chemistry				
VI	CHEDSC07.	Will be updated once syllabus		MOOCs	Internal tests
V I	Selected topics in	from state committee is received		Problem	Assignments Ouiz
	Physical Chemistry			solving	
	CHEDSC07P:			U	
	Physical Chemistry				
	CHEDSC08.				
	Spectroscopy				
	CHEDSC08P:				
	Analytical and				
	Industrial				
	Cnemistry Practical's				
VII	CHEDSC09:	Will be updated once syllabus	DSC-5.	MOOCs.	Internal tests.
	Analytical	from state committee is received.	DSC-6,	Problem	Assignments,
	Techniques=I		DSC-7 and	solving	Seminar, Debate,
	CHEDSC09P:		DSC-8	-	Quiz
	Analytical Chemistry.				
	Applied Chemical				
	Analysis.				
	CHEDSC10P:				
	Analytical Chemistry.				
	CHEDSCI1:				
	Enviornmental and Nanomaterial				
	Chemistry.				
VIII	CHEDSC12:	Will be updated once syllabus		Project work,	Internal tests,

r	1		1	1
	Analytical	from state committee is received.	Industrial Visit	Assignments,
	Techniques-II			Seminar, Debate,
	CHEDSC13:			Ouiz
	Separation and			X
	Electroanalytical			
	Techniques.			
	CHEDSC14:			
	Analysis of food and			
	pharmaceuticals			

### Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/ course projects/ problem or project based learning/ case studies/self study like seminar, term paper or MOOCs. Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning).

#### This matrix lists only the open elective courses (OEC)

Open elective courses (OEC) are offered for students who have not opted Chemistry as a major course. One OEC has to be opted per semester in the first four semesters. Two types of OEC's are offered- progressive OEC and non-progressive OEC (NPR). Progressive OECs [OEC(PR)] are meant for those students who opt to study chemistry as their OEC in all the four semesters. The courses offered for progressive OECs are practical oriented and the courses are fixed for each semester. The students are expected to take the course in the order OEC(PR)-I to OEC(PR)-IV respectively in semester I to IV. Non-progressive OECs are designed for those students who wish to opt chemistry as OEC in any one of the semester/s. The student may opt any one of the OEC(NPR)-I to OEC(NPR)-VI in any one of the first to four semesters. These courses are non-practical oriented. OECs credit pattern/s is given in the course at a glance table.

#### **OEC(PR)** pattern:

L	Τ	Р	Cr
2	-	2	3

3

Cr

3

#### **OEC(NPR)** pattern:

Semester	Title/Name of the	Program outcomes that the	Pre-requisite	Pedagogy##	Assessments
	course	course addresses (not more			
		than 3 per course)			
I to IV	CHEOEC01: General Chemistry-I	<ul> <li>Importance and scope of Chemistry</li> <li>Elements in periodic table; physical and chemical characteristics, periodicity.</li> <li>Basic of organic molecules, structure, bonding, reactivity and</li> </ul>	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHEOEC01P: General Chemistry Practicals-I	<ul> <li>reaction mechanisms.</li> <li>how to handle the glassware, prepare and dilute solutions and perform the experiments with prepared reagents</li> <li>The students will be able to determine the analyte through volumetric and gravimetric analysis and understand the</li> </ul>	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

-		r			-
	CHEOEC08: General Chemistry-II	<ul> <li>chemistry involved in each method of analysis.</li> <li>The students will be able to determine the melting and boiling points of the organic compounds/liquids and detect the elements present.</li> <li>Prediction of structure/geometry of difference melearles</li> </ul>	Science discipline in	Assignment Desk work	Internal Exams, Continuous
		<ul> <li>Calculation of lattice energies</li> <li>Concept of second and third law of thermodynamics and prediction of spontaneity of a process</li> </ul>	F UC/10+2		Exams
I to IV	CHEOEC08P: General Chemistry Practicals-II	<ul> <li>Techniques like precipitation, filtration, drying and ignition.</li> <li>Various titrimetric techniques and gravimetric methods</li> <li>Determination of enthalpy</li> </ul>	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHEOEC02: Chemistry of Water	<ul> <li>Physical and chemical properties of water</li> <li>Understand the water quality parameters</li> <li>Water pollution and its treatment methods.</li> </ul>	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHEOEC03: Chemistry of Elements	<ul> <li>The arrangement of elements in the periodic table</li> <li>physical and chemical properties of elements</li> <li>periodicity</li> </ul>	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHEOEC04: Industrial Chemistry	<ul> <li>Structure and uses of dyes</li> <li>Classification of drugs and its importance</li> <li>Use and harmful effects of cosmetics.</li> </ul>	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHEOEC05: Chemistry of Food Nutrition and Preservation	<ul> <li>Understand the human physiological system and food science</li> <li>Nutrition and its importance</li> <li>Food preservation and its utility.</li> </ul>	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHEOEC06: Chemistry in Daily Life	<ul> <li>Classification of carbohydrates</li> <li>Correlate enzyme with drug action</li> <li>Biological importance of lipids.</li> </ul>	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHEOEC07: Molecules of Life	<ul> <li>Classification of carbohydrates</li> <li>Correlate enzyme with drug action</li> <li>Biological importance of lipids.</li> </ul>	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

#### This matrix lists only the skill enhancement courses (SEC)

Skill enhancement courses (SEC) may be opted by any students who have or have not elected Chemistry as a major course. One SEC has to be opted per semester in the first to sixth semesters. Some of the

courses offered are practical oriented. These courses are meant to enhance the basic skills of students in performing chemistry experiments. SECs have the following credit pattern (total 2 credits).

## SEC pattern (Practical oriented)

L	Т	Р	Cr
1	-	2	2

## SEC pattern (Non Practical Oriented)

L	Τ	Р	Cr
2	-	I	2

Semester	Title/Name of the	Program outcomes	Pre-requisite	Pedagogy##	Assessments
	course	that the course			
		addresses (not more			
		than 3 per course)			
I-VI	CHESEC01: General Biochemistry	<ul> <li>Structure and properties of proteins</li> <li>Biological significance of DNA and RNA.</li> <li>Composition and functions of blood.</li> </ul>	Science (biology as one of the subject) discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHESEC01P: Lab-General Biochemistry Practicals-I	<ul> <li>Understand the qualitative analysis of biomolecules</li> <li>Estimation of biomolecules</li> <li>Isolation and separation of biomolecules.</li> </ul>	Science (biology as one of the subject) discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHESEC02: Separation and Chromatographic Techniques	<ul> <li>Separate different compounds using solvent extraction methods.</li> <li>Principles and types of chromatography</li> <li>Learn different applications of chromatography</li> </ul>	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHESEC02P: Lab- Separation and Chromatographic Techniques	• Separation of solid- solid mixture, binary mixture, non-volatile liquids and solids.	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHESEC03: Titrimetric methods	• Enhance the knowledge and skills in different titrimetric methods.	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	CHESEC03P: Lab- Titrimetric methods	<ul> <li>Learn the handling of glasswares and equipments</li> <li>Volumetric, conductometric and</li> </ul>	Science discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

	potentiometry titrations.			
CHESEC04: Biofertilizers	<ul> <li>Identify the different forms of biofertilizers and their uses</li> <li>Green manuring and organic fertilizers</li> </ul>	Student should have studied science (biology as one of the subject) discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
CHESEC05: Fermentation science and Technology	<ul> <li>Employ the process for maintenance and preservation of microorganisms</li> <li>Various aspects of fermentation technologies.</li> </ul>	Science (biology as one of the subject) discipline in PUC/10+2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

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# **Course Structure at a Glance**

(L: Lecture [1h = 1 credit (Cr)]; T: Tutorial; P: Practicals (2h = 1 credit)

# Core Courses (DSC)

Code	Name of the course	Type of course	Semester	L	Т	P	Credits
CHEDSC01	Analytical and Organic Chemistry-I	Core	Ι	4	-	4	6
CHEDSC02	Inorganic and Physical Chemistry-I	Core	II	4	-	4	6

# **Open Elective Courses (OEC)**

Code	Name of the course	Type of course	Semester	L	Т	Р	Credits
CHEOEC01	General Chemistry-I	Open elective	Ι	2	-	2	3
CHEOEC08	General Chemistry-II	Open elective	II	2	-	2	3
CHEOEC02	Chemistry of Water	Open elective	I - IV	3	-	-	3
CHEOEC03	Chemistry of Elements	Open elective	I - IV	3	-	-	3
CHEOEC04	Industrial Chemistry	Open elective	I - IV	3	-	-	3
CHEOEC05	Chemistry of Food, Nutrition and Preservation	Open elective	I - IV	3	-	-	3
CHEOEC06	Chemistry in Daily life	Open elective	I - IV	3	-	-	3
CHEOEC07	Molecules of Life	Open elective	I - IV	3	-	-	3

(PR)-Progressive, (NPR)-Non progressive

# Skill Enhancement Courses (SEC)

Code	Name of the course	Type of course	Semester	L	Т	Р	Credits
CHESEC01	General Biochemistry	Skill Enhancement	I - VI	1	-	2	2
CHESEC02	Separation and Chromatographic Techniques	Skill Enhancement	I - VI	1	-	2	2
CHESEC03	Titrimetric Methods	Skill Enhancement	I - VI	1	-	2	2
CHESEC04	Biofertilizers	Skill Enhancement	I - VI	2	-	-	2
CHESEC05	Fermentation Science and Technology	Skill Enhancement	I - VI	2	-	-	2

# **DISCIPLINE CORE COURSES (DSC)**

There are 2 courses in first year. These courses have the following credit pattern (total 6 credits).

L	Т	Р	Cr
4	-	4	6

# CHEDSC01: ANALYTICAL AND ORGANIC CHEMISTRY-I

#### Unit-I

#### LANGUAGE OF ANALYTICAL CHEMISTRY

Definitions of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Choice of an analytical method–accuracy, precision, sensitivity, selectivity, method validation. Figures of merit of analytical methods and limit of detection (LOD), Limit of quantification (LOQ), linear dynamic range (working range).

Errors and treatment of analytical data: limitations of analytical methods–Errors: determinate and indeterminate errors, absolute error, relative error, minimization of errors. Statistical treatment of finite samples–mean, median, range, standard deviation and variance. External standard calibration– regression equation (least squares method), correlation coefficient ( $R^2$ ).

Numerical problems (errors, mean, median, standard deviation).

Basic laboratory practices, calibration of glassware (pipette, burette and volumetric flask), sampling (solids and liquids), weighing, drying, dissolving, Acid treatment, Rules of work in analytical laboratory, general rule for performing quantitative determinations (volumetric and gravimetric), safety in chemical laboratory, rules of fire prevention and accidents, first aid. Precautions to be taken while handling toxic chemicals, concentrated/fuming acids and organic solvents.

# Unit-II

#### TITRIMETRIC ANALYSIS

Basic principle of titrimetric analysis. Classification, preparation and dilution of reagents/solutions. normality, molarity and mole fraction, percentage (for solids and liquids). Use of  $N_1V_1 = N_2V_2$  formula, preparation of ppm level solutions from source materials (salts), conversion factors (volume and weight). Numerical problems (normality, molarity, mole fraction, ppm and percentage).

#### Acid-base titrimetry

Indicators and its type, titrations of strong acid vs strong base, weak acid vs strong base and weak base vs strong acid titrations. Quantitative applications–selecting and standardizing a titrant, inorganic analysis– alkalinity, acidity.

#### **Complexometric titrimetry**

Indicators for EDTA titrations-theory of metal ion indicators, titration methods employing EDTA-direct, back, displacement and indirect determinations, application-determination of hardness of water.

#### **Redox titrimetry**

Balancing redox equations (ion-electron, oxidation number method), calculation of the equilibrium

15h

60h 15h constant of redox reactions, titration curves (potentiometry), theory of redox indicators, calculation of standard potentials using Nernst equation. Applications.

#### **Precipitation titrimetry**

Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate-Volhard's and Mohr's methods and their differences.

### Gravimetric Analysis

Requisites of precipitation, mechanism of precipitation, Factors influencing precipitation, Coprecipitation, post-precipitation. Advantages of organic reagents over inorganic reagents, reagents used in gravimetry [Mg<sup>2+</sup> using 8-hydroxy quinoline (oxine) and Ni<sup>2+</sup> using dimethyl glyoxime (DMG)].

Numerical problems (acid-base, redox, complexometric titrations and gravimetry).

### Unit-III

15h

Classification and nomenclature of organic compounds (till bifunctional groups), hybridization, types (sp,  $sp^2$ ,  $sp^3$ ), shapes of organic molecules, Influence of hybridization on bond properties (w.r.t. acidic character, bond length and bond strength).

### Nature of bonding in Organic molecules

Types of chemical bonding, formation of covalent bond, localized and delocalized, conjugation and cross conjugation, electronic displacements: inductive effect, electromeric effect, resonance and hyper conjugation, explanation with examples.

Strengths of organic acid and bases: comparative study with emphasis on factors affecting pKa and pKb values.

Relative strengths of aliphatic and aromatic carboxylic acids-acetic acid and chloroacetic acid, acetic acid and propionic acid, acetic acid and benzoic acid. Steric effect- relative stability of trans and cis-2-butene.

Comparative strengths of amines: CH<sub>3</sub>NH<sub>2</sub>, (CH<sub>3</sub>)<sub>2</sub>NH, (CH<sub>3</sub>)<sub>3</sub>N; NH<sub>3</sub>, C<sub>6</sub>H<sub>5</sub>NH<sub>2</sub>.

# Fundamentsls of organic reaction mechanisms

Notations used to represent electron movements and directions of reactions-curly arrows, formal charges. Types of bonds breaking- homolytic and heterolytic. Types of reagents-electrophiles, nucleophilicity and basicity. Types of organic reactions-substitution, addition, elimination, rearrangement and pericyclic reactions, explanation with examples.

# CHEMISTRY OF ALIPHATIC HYDROCARBONS

#### A. Carbon-Carbon sigma bonds

Chemistry of alkanes: Introduction, natural sources, preparation – by catalytic hydrogenation of alkenes and alkynes, by Wurtz reaction, by Kolbe's electrolysis, from Grignard reagents. Wurtz-Fittig reaction for alkyl arenes. Free radical substitutions–chlorination of  $CH_4$ , and  $C_3H_8$  and its mechanism. Ease of substitution and stability of methyl, 1°, 2° and 3° alkyl free radicals to be discussed.

#### **B.**Carbon-carbon $\pi$ bonds

Formation of alkenes and alkynes by elimination reaction. Mechanism of E1, E2, E1cb reaction. Saytzeff

and Hofmann eliminations. Addition of HBr to alkene- mechanism of addition of HBr to propene (Markonikoff's and anti-Markonikoff's rules with examples), Addition of halogens to alkenescarbocation and halonium ion mechanism. Stereospecificity of halogen addition. Ozonolysis, mechanism of ozonolysis of propene, Significance. Regioselectivity and relative rates of addition. Hydrogenation, hydration, hydroxylation and epoxidation of alkenes, explanation with examples, 1,2 and 1,4- addition reactions in conjugated dienes. Diels-Alder reaction, allylic and benzylic bromination and mechanism in propene, 1-butene, 1-toluene and ethylbenzene.

#### Unit-IV

15h

Nucleophilic substitution at saturated carbon. Mechanisms of  $S_N^{-1}$ ,  $S_N^{-2}$  and  $S_N^{-1}$  reactions with suitable examples. Energy profile diagrams, Stereochemistry and factors effecting  $S_N^{-1}$  and  $S_N^{-2}$  reactions.

### Aromaticity

Introduction and characteristics of aromatic hydrocarbons. Concept of resonance, aromaticity, Huckel rule, anti-aromaticity explanation with examples. aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples (benzene, benzenoids, cyclopropyl carbocation, tropylium cation, cyclopentadienyl anion, furan, pyrrole and pyridine). Preparations of i) benzene (a) from acetylene (b) by decarboxylation of benzoic acid, ii) naphthalene from (a) 3–phenyl-1-butene (b)  $\alpha$ -tetralone, iii) anthracene from 1,4-naphthaguinone.

Aromatic electrophilic substitution reactions, mechanisms, halogenation, nitration, sulphonation, Friedel-Crafts alkylation and acylation, chloromethylation, Gatterman-Koch reaction with their mechanism.

Activating and deactivating groups. Orientation influence, ortho-para ratio.

Side chain oxidation of toluene and cumene. Nitration and sulphonation of naphthalene with an account on stability of products.

Aromatic nucleophilic substitution reaction:  $S_NAr$  and benzyne mechanism with suitable examples. Polycyclic arenes as carcinogens–definition of carcinogen, name and structure of benzo[a]anthracene and benzo[a]pyrene

- 1. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J.D.Barnes and M.J.K. Thomas, Third Indian Reprint, Pearson Education Pvt. Ltd. 6<sup>th</sup> edition (2007).
- 2. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, Saunders College Publishing, New York, 8<sup>th</sup> edition (2005).
- 3. Analytical Chemistry, G.D. Christian, Wiley, 6<sup>th</sup> edition (2007).
- 4. Practical Volumetric Analysis, Peter A C McPherson, Royal Society of Chemistry, Cambridge, UK (2015).
- Organic Chemistry, R. T. Morrison, R. N. Boyd, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education) 7<sup>th</sup> edition (2010).
- 6. Organic Chemistry (Volume I), I. L. Finar, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education) (2002).
- 7. Fundamentals of Organic Chemistry, J. E. McMurry, Cengage Learning India Edition, 7th edition (2013).
- 8. Organic Reaction mechanism, V. K. AhIuwalia, K. Parashar ,Narosa Publishers, 4<sup>th</sup> edition (2018).
- 9. Organic Chemistry, S. M. Mukherji, S. P. Singh, R. K. Kapoor, New Age International Publishers Pvt. Ltd

(2018).

- 10. A Guide book to Mechanism in Organic Chemistry, Peter Sykes. Pearson, 6<sup>th</sup> edition (2003).
- 11. Principles of Inorganic Chemistry, B. R. Puri, L.R Sharma, K.C. Kalia, Vishal Publishing Co, 33<sup>rd</sup> edition (2020).
- 12. Instrumental Methods of Chemical Analysis, Gurdeep R Chatwal, Sham K Anand, Himalaya Publishing House (2016).
- College Chemistry-Vol-1, L. Indira and G.R. Chatwal, Himalaya Publishing House, New Delhi, 1<sup>st</sup> edition (2013).

#### CHEDSC01P: ANALYTICAL AND ORGANIC CHEMISTRY PRACTICALS-I 4h/week

### PART-A ANALYTICAL CHEMISTRY

- 1. Calibration of glassware, pipette, burette and volumetric flask.
- 2. Determination of sodium carbonate and sodium bicarbonate in a mixture.
- 3. Determination of alkali present in soaps/detergents.
- 4. Determination of iron(II) using potassium dichromate.
- 5. Determination of oxalic acid using potassium permanganate solution.
- 6. Standardization of EDTA solution and determination of hardness of water
- 7. Determination of  $Fe^{2+}$  as  $Fe_2O_3$ .
- 8. Determination of  $Ni^{2+}$  as  $Ni(DMG)_2$  complex.

#### PART-B ORGANIC CHEMISTRY

- 1. Purification of organic compounds by recrystallization.
- 2. Preparation of acetanilide from aniline using Zn/acetic acid (Green method).
- 3. Synthesis of p-nitro acetanilide from acetanilide using nitrating mixture.
- 4. Preparation of p-bromoacetanilide from acetanilide.
- 5. Hydrolysis of methyl m-nitrobenzoate to m-nitrobenzoic acid.
- 6. Synthesis of diazoaminobenzene from aniline.
- 7. Preparation, recrystallization of meta-dinitrobenzene from nitrobenzene
- 8. Preparation, recrystallization of tri-bromophenol from phenol.

- 1. Vogel's Quantitative Chemical Analysis, J. A. Mendham, Pearson 6<sup>th</sup> edition (2009).
- 2. Vogel's Qualitative Inorganic Analysis, G. Svehala, Sivasankar, Pearson (2012).
- 3. Chemistry for Degree Students B.Sc First Year, R. L. Madan, S Chand Publishing Company, New Delhi (2010).
- 4. Practical Organic Chemistry, F. G. Mann, B.C. Saunders, Pearson Education Limited, 4<sup>th</sup> edition (2011).

# CHEDSC02: INORGANIC AND PHYSICAL CHEMISTRY-I (THEORY) 60h Unit-I 15h

Bohr's theory of hydrogen atom: Its assumptions and limitations, expressions for radius and energy of hydrogen atom and hydrogen atom like ions (no derivations), explanation of atomic spectrum of hydrogen atom (occurrence of different series in spectrum), numerical problems on calculation of wave numbers of spectral lines.

#### Wave mechanics

Need for a new approach to atomic structure, de Broglie hypothesis (statement and equation), Heisenberg's uncertainty principle (statement and equation) and its significance, numerical problems on de' Broglie equation and Heisenberg's uncertainty principle. Concept of orbits and orbitals. Time independent Schrödinger's wave equation (cartesian coordinate only, no derivation)–one dimensional and three dimensional equations, significance of Schrödinger's wave equation.

Wave functions: characteristics of well behaved wave functions (few simple examples should be discussed), significance of  $\psi$  and  $\psi^2$  (or  $\psi\psi^*$ ) (probabilistic approach), normalized and orthogonal wave functions, normalization condition. Quantum numbers and their significances. Time independent Schrodinger wave equation for hydrogen atom and its solution (R,  $\theta$  and  $\varphi$  equations) (in Cartesian and polar coordinates; only expressions, no derivations). Radial and angular wave functions for hydrogen atom, spherical harmonics. Radial and angular distribution curves: Shapes of *s*, *p*, *d* and *f* orbitals, radial distribution functions (probability diagrams) for 1s, 2s, 2p, 3s, 3p and 3d orbitals (only graphical representation), radial and angular nodes, nodal planes.

Rules for filling up of electrons in various orbitals: Hund's rule of maximum multiplicity, Pauli's Exclusion Principle, Aufbau'sprinciple, Variation of orbital energy with atomic number, stability of half filled and completely filled orbitals, concept of exchange energy, anomalous electronic configurations (Cr and Cu). Electronic configuration of elements (up to Z = 30).

#### Unit-II

#### 15h

Review of the modern periodic table (with respect to classification of elements based on outer electronic configuration)

Periodicity in *s* and *p*-block elements, trends in the periodic properties. Applications in predicting and explaining chemical behaviour with respect to a) electronic configuration b) effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table, c) the atomic radii–the concept of various radii–ionic radii, covalent radii (octahedral and tetrahedral), van der Waal radii with examples; variation of the atomic radii across the period and down the groups, d) ionization enthalpy, successive ionization enthalpies and factors affecting ionization enthalpy, e) the electron affinity of atoms–definition, illustration, variation of the values along the periodic table and explanation of the trends, f) electronegativity (E.N)–the concept of electronegativity and its difference from electron affinity; E.N scale, the postulation of arithmetic and geometric mean in the determination of E.N values, ionic characters of bonds and the E.N. difference, other E.N. scales–the Mulliken, Allred–Rochow scales (problems). Variation of electronegativity with bond order, partial charge and

hybridization. Group electronegativity. Sanderson's electron density ratio. Diagonal relationship between beryllium and aluminium. Comparative study of elements of alkali and alkaline earth metals.

Trends in the chemistry of the compounds of groups 13 to 17 (hydrides, carbides, oxides and halides) are to be discussed.

# Unit-III

# GASEOUS STATE

Elementary aspects of kinetic theory of gases, Ideal and real gases. Boyle's temperature (derivation not required), Molecular velocity, collision frequency, collision diameter, Collision cross section, collision number and mean free path and coefficient of viscosity, calculation of  $\sigma$  and  $\sigma$ , variation of viscosity with temperature and pressure.

Maxwell's Boltzmann distribution law of molecular velocities (Most probable, average and root mean square velocities). Relation between RMS, average and most probable velocity and average kinetic energies. (Mathematical derivation not required; numerical problems), law of equipartition of energy.

### **Behaviour of real gases**

Deviation from ideal gas behaviour. Compressibility factor (Z) and its variation with pressure for different gases. Causes of deviation from ideal behaviour, van der Waals equation of state (no derivation) and application in explaining real gas behaviour. Critical phenomena–Andrews isotherms of  $CO_2$ , critical constants and their calculation from van der Waals equation, continuity of states, law of corresponding states. Numerical problems.

# LIQUID STATE

#### **Surface Tension**

Definition and its determination using stalagmometer, effect of temperature and solute on surface tension.

#### Viscosity

Definition, coefficient of viscosity. Determination of viscosity of a liquid using Ostwald viscometer. Effect of temperature, size, weight, shape of molecules and intermolecular forces.

#### Refraction

Specific and molar refraction- definition and advantages. Determination of refractive index by Abbes Refractometer.

Additive and constitutive properties.

# Parachor

Definition: Atomic and structure parachor, elucidation of structure of benzene and benzoquinone, viscosity and molecular structure, molar refraction and chemical constitution. Numerical Problems.

#### Unit-IV

# LIQUID CRYSTALS

Explanation, classification with examples-smetic, nematic, cholesteric, dics shaped and polymeric. Structures of nematic and cholesteric phases-molecular arrangements in nematic and cholesteric liquid crystals. Applications of liquid crystals in LCDs and thermal sensing.

15h

### SOLIDS

#### Forms of solids

Crystalline and non-crystalline solids [comparison with examples (glasses briefly explain)], unit cell and space lattice, anisotropy of crystals, size and shape of crystals.

Laws of crystallography: law of constancy of interfacial angles, law of rational indices, law of symmetry (symmetry elements), types of crystal systems, Bravais lattice types and identification of lattice planes.

Miller indices and its calculation, X–ray diffraction by crystals: Bragg's law and derivation of Bragg's equation, single crystal and powder diffraction methods (Structures of NaCl, KCl by rotation method). Defects in crystals: stoichiometric (Frenkel and Schotky) and non-stoichiometric defects (color centres qualitative treatment only). Numerical problems (no. of atoms in a unit cell, Bragg's law).

#### **Distribution Law**

Nernst Distribution Law: statement and its derivation, distribution constant, factors affecting distribution constant, validity of distribution law, modification of distribution law when molecules undergo a) association b) dissociation. Application of distribution law in solvent extraction. Derivation for simple and multiple extraction. Principle of distribution law in Parkes process of desilverisation of lead. Numerical problems.

- 1. Concise Inorganic Chemistry: J. D. Lee, Wiley, 4<sup>th</sup> edition (2021).
- Fundamentals Concepts of Inorganic Chemistry, Vols. 1 and 2, Asim K. Das, CBS Publishers and Distributors, 2<sup>nd</sup> edition (2013).
- 3. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson, P. L. Gaus, Wiley. India, 3<sup>rd</sup> edition (1995).
- 4. Inorganic Chemistry, Catherine E. Housecroft, A.G. Sharpe, Pearson Prentice Hall, 2<sup>nd</sup> edition (2005).
- 5. Atkin's Physical Chemistry, Peter Atkins, Julio De Paula, Oxford University Press, 8<sup>th</sup> edition (2006).
- 6. Elements of Physical Chemistry, Samuel Glasstone, David Lewis, Palgrave Macmillan, 2<sup>nd</sup> edition (1963).
- 7. A Text book of Physical Chemistry, A. S. Negi, S. C. Anand, New Age International Publishers (2007).
- 8. Principles of Physical Chemistry, Puri, Sharma, Pathania, Vishal Publishing Co., 47<sup>th</sup> edition (2020).
- 9. A Text Book of Physical Chemistry P. L. Soni, O. P. Dharmarha and, U. N. Dash, Sultan Chand and Sons (2016).
- 10. Advanced Physical Chemistry, Gurdeep Raj, Krishna Prakashan Media Publishers (2020).

# CHEDSC02P: INORGANIC AND PHYSICAL CHEMISTRY PRACTICALS-I

#### PART-A: INORGANIC CHEMISTRY

#### Titrimetry

- 1. Determination of carbonate and hydroxide present in a mixture.
- 2. Determination of oxalic acid and sodium oxalate in a given mixture using standard KMnO<sub>4</sub>/NaOH solution.
- 3. Standardization of potassium permanganate solution and determination of nitrite in a water sample.
- 4. Standardization of silver nitrate and determination of chloride in a water sample (demonstration).
- 5. Determination of alkali content in antacids.
- 6. Determination of chlorine in bleaching powder using iodometric method. Gravimetry
- 7. Quantitative estimation of  $Ba^{2+}$  as  $BaSO_{4-}$
- 8. Quantitative estimation of  $Cu^{2+}$  as CuSCN.

### PART-B: PHYSICAL CHEMISTRY

- 1. Determination of density using specific gravity bottle and viscosity of liquids using Ostwald's viscometer (ethyl acetate, toluene, chlorobenzene or any other non-hazardous liquids).
- 2. Study of the variation of viscosity of sucrose solution with the concentration of a solute.
- 3. Determination of the density using specific gravity bottle and surface tension of liquids using Stalagmometer (ethyl acetate, toluene, chlorobenzene, any other non-hazardous liquids).
- 4. Study of variation of surface tension of detergent solution with concentration.
- 5. Determination of specific and molar refraction by Abbes Refractometer (ethyl acetate, methyl acetate, ethylene chloride).
- 6. Determination of the composition of liquid mixture by refractometry/viscometry method (toluene and alcohol, water and sucrose).
- 7. Determination of partition/distribution coefficient of i) acetic acid in between water and cyclohexane, ii) acetic acid in between water and butanol,
- 8. Determination of partition/distribution coefficient of i) benzoic acid in between water and toluene, ii) I<sub>2</sub> in between water and CCl<sub>4</sub>.

#### **Recommended Books/References:**

1. Vogel's text book of Practical Organic Chemistry, B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatehell, , Prentice Hall, 5th edition (1989).

2. Elementary Practical Organic Chemistry-Part-III: Quantitative Organic Analysis, Arthur I, Vogel, Pearson India (2011).

3. Laboratory manual of Organic Chemistry, B. B. Dey and M. V. Sitaraman, Laboratory manual of Organic Chemistry, B. B. Dey, M. V. Sitaraman, T. R. Govindachari, Allied Publishers, New Delhi (1996).

4. Practical Organic Chemistry, F. G. Mann, B.C. Saunders, Pearson Education Limited, 4<sup>th</sup> edition (2011).

5. Practical Volumetric Analysis, A. C. Peter, McPherson, Royal Society of Chemistry, Cambridge, UK (2015).

6. L. Rakesh Sharma, Practical Inorganic Chemistry (for undergraduate students), Evincepub publishing, 1<sup>st</sup> edition (2021).

#### **OPEN ELECTIVE COURSES** OEC(PR) pattern:

L	Т	Р	Cr
2	-	2	3

# **CHEOEC01: GENERAL CHEMISTRY-I**

### **INORGANIC CHEMISTRY**

#### **General Introduction**

Importance and scope of Chemistry. Historical approach to particulate nature of matter, laws of chemical combination, Dalton's atomic theory: concept of elements, atoms and molecules.

#### **Classification of elements**

Need for classification, early attempts at classification of elements (Dobereiner's Triads, Newland's Law of Octaves, Mendeleev's periodic table), Modern periodic law and the present form of periodic table, gradation in properties, valency, atomic number, metallic and non-metallic properties.

#### Group -1 and 2 Elements

General introduction, electronic configuration and general trends in physical and chemical properties of elements, anomalous properties of the first element of each group, diagonal relationship.

#### Group -13 to Group 18 Elements

General Introduction: Electronic configurations and general trends in physical and chemical properties of elements across the periods and down the groups.

#### **Redox Reactions**

Concept of oxidation and reduction, redox reactions, oxidation number, balancing redox reactions in terms of loss and gain of electron and change in oxidation numbers, applications of redox reactions.

#### **ORGANIC CHEMISTRY**

#### Introduction

Organic compounds: Classification, and nomenclature, hybridization, structure and shapes of ethane, ethene and ethyne.

#### **Electronic effects**

Inductive effect– definition, +I and –I effect with suitable examples. Resonance effect–definition, +R and –R effect with suitable examples. Electromeric effect–definition with examples. Hyperconjugation– definition, explanation for the stability of carbocations and alkenes by Hyperconjugation .

#### Strength of organic acids and bases

Comparative study with emphasis on inductive effect affecting  $pK_a$  values (Examples: aliphatic acids –acetic acid, mono, di and trichloro acetic acids; fluoro, chloro, bromo and iodo acetic acids; 2– chloro and 3-chloropropanoic acids).

#### **Basicity of amines**

Comparative study with emphasis on inductive and resonance effects affecting pK<sub>b</sub> values (examples:

30h

15h

Comparison of basicity of methyl amine, ammonia: methyl amine, dimethyl amine, tri methyl amine: and aniline, ammonia:

### **Bond cleavage**

Homolysis and heterolysis with examples. Electrophilic and nucleophilic reagents with examples.

Aromaticity–conditions for aromaticity, Huckel's rule (examples: cyclopentadienyl anion and benzenoids), aromaticity of pyrrole and pyridine.

#### Aliphatic Nucleophilic Substitution reactions

Definition, types, examples. Nucleophilic substitution reactions of alkyl halides with i) aqueous KOH, ii) ammonia, iii) sodium ethoxide, iv) AgCN, v) KNO<sub>2</sub>.

#### Addition reactions

Definition, types, examples. Addition to C=C multiple bonds involving electrophiles, nucleophiles. Markownikoff's rule and anti-Markownikoff's rule.

#### Additions to carbonyl compounds

Addition of water, alcohol, sodium bisulphite and HCN.

#### **Elimination reactions**

Definition, types, examples. Hofmann and Saytzeff eliminations.

#### Aromatic electrophilic substitution reactions

Definition, types, examples. Mechanism of nitration, halogenation, sulphonation, Friedel-Crafts alkylation and acylation.

- 1. Concise Inorganic Chemistry, J. D. Lee, Wiley, 5<sup>th</sup> edition (2008).
- 2. Concepts and Models of Inorganic Chemistry, B. E. Douglas, D.H. McDaniel, J.J. Alexander John Wiley and Sons, 3<sup>rd</sup> edition (1999).
- 3. Atkin's Physical Chemistry, P.W. Atkins, J. De Paula, Oxford University Press, 6<sup>th</sup> edition (2014).
- 4. Inorganic and Solid State Chemistry, G.E. Rodger, Cengage Learning, 3<sup>rd</sup> edition (2011).
- 5. College Chemistry-Vol-1, L. Indira and G.R. Chatwal, Himalya Publishing House, New Delhi.
- 6. Chemistry for Degree Students B.Sc. First Year, R L Madan, S Chand Publishing Company, New Delhi (2010).
- Inorganic Chemistry: Principles of Structure and Reactivity, J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Pearson Education India, 4<sup>th</sup> edition (2006).
- 8. Organic Chemistry, R.T. Morrison, R.N. Boyd, Pearson India Pvt. Ltd., 6<sup>th</sup> edition (2017).
- 9. Organic Chemistry, S.H. Pine, McGraw Hill, 5<sup>th</sup> edition (2007).
- 10. Organic Chemistry, F.A. Carey, Tata McGraw Hill, 7th edition (2008).
- 11. Organic Chemistry, J. Clayden, N. Greeves, S. Warren, Oxford University Press, 2<sup>nd</sup> edition (2012).
- 12. Advanced Organic Chemistry, Part A: Structure and mechanism, F.A. Carey, R. J. Sundberg, Springer Publisher, 5<sup>th</sup> edition (2008).

# CHEOEC01P: GENERAL CHEMISTRY PRACTICALS-I

2h/week

Equal weightage to be given to both inorganic and organic practicals.

#### **INORGANIC CHEMISTRY PRACTICALS**

#### Titrimetric Analysis

Conditions for volumetric analysis, terms involved, modes of expressing concentrations, equivalent masses of compounds, Normality, molarity and molality equations.

Preparation of commonly used standard solutions (primary and secondary standard).

Preparation of standard normal solutions (acids and bases-HCl, H<sub>2</sub>SO<sub>4</sub>, H<sub>2</sub>C<sub>2</sub>O<sub>4</sub>, NaOH, KOH).

Types of titrations (acid alkali, redox, iodometric).

Calibration and use of apparatus (pipette, burette).

Apparatus used in volumetric analysis (volumetric glassware, how to use a burette, pipette).

#### **Acid-Base Titrations**

- 1. Estimation of carbonate and bicarbonate present together in a mixture.
- 2. Estimation of strength of strong base using weak acid (oxalic acid)
- 3. Estimation of a given strong acid using strong base.
- 4. Estimation of Fe(II) using standardized potassium permanganate solution.
- 5. Estimation of Fe(II) using standardized potassium dichromate solution.
- 6. Estimation of oxalic acid using standardized potassium permanganate solution.
- 7. Estimation of the strength of strong acid (hydrochloric acid) using standard solution of sodium carbonate.
- 8. Estimation of free alkali present in different soaps/detergents.

#### **ORGANIC CHEMISTRY PRACTICALS**

- 1. Purification of organic solids by recrystallization (from water and alcohol) and determination of melting point.
- 2. Purification of organic liquids by distillation and determination of boiling point.
- 3. Detection of extra elements (N,S,Cl,Br,I) in organic compounds (containing up to two extra elements).
- 4. Preparation of meta-dinitrobenzene from nitrobenzene.
- 5. Preparation of tribromophenol by bromination of phenol.
- 6. Preparation of 2,4-dinitrophenylhydrazone from benzaldehyde.
- 7. Identification and separation of the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography.
- 8. Identification and separation of the sugars present in the given mixture by paper chromatography.

- 1. J. A. Mendham, Vogel's *Quantitative Chemical Analysis*, Pearson, 6<sup>th</sup> edition (2009).
- 2. G. Svehala, I.B, Sivasankar, Vogel's Qualitative Inorganic Analysis, Pearson India, 7<sup>th</sup> edition (2012).
- 3. Chemistry for Degree Students B.Sc. First Year, R L Madan, S Chand Publishing Company, New Delhi (2010).

- 4. Vogel' text book of Practical Organic Chemistry, B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatehell, 5<sup>th</sup> edition (2016).
- 5. Elementary Practical Organic Chemistry, Part-III: Quantitative Organic Analysis, A. I. Vogel., Pearson education, 2<sup>nd</sup> edition (2010).
- Laboratory manual of Organic Chemistry, B. B. Dey, M. V. Sitaraman, Laboratory manual of Organic Chemistry, B. B. Dey, M. V. Sitaraman, T. R. Govindachari, Allied Publishers, New Delhi, (1996).
- 7. F. G. Mann, Saunders, Practical Organic Chemistry, Pearson education, 4<sup>th</sup> edition (2011).

# **CHEOEC08: GENERAL CHEMISTRY-II**

#### **INORGANIC CHEMISTRY**

#### **Chemical Bonding and Molecular Structure**

Valence electrons, formation of an ionic bond (examples: NaCl, KCl, MgCl<sub>2</sub>), factors favouring the formation of ionic bond, general characteristics of ionic compounds.

Lattice energy-definition, factors affecting lattice energy.

Definitions of bond moment and dipole moment by taking H<sub>2</sub>, HCl, H<sub>2</sub>O and CO<sub>2</sub> as examples.

Formation of covalent bond (examples:  $O_2$ ,  $H_2$ ,  $N_2$ ) and coordinate bond (dative bond) (examples:  $NH_4^+$ ,  $H_3O^+$ ).

Valence Bond Theory (VBT) –assumptions,  $\sigma$  and  $\pi$  bonds (using H<sub>2</sub>, HF, O<sub>2</sub> and N<sub>2</sub> molecules as examples), limitations.

Shapes of molecules on the basis of VSEPR Theory–calculation of total number of electron pairs, number of bond pairs, number of lone pairs and predicting the shapes of the molecules (examples: BeCl<sub>2</sub>, BCl<sub>3</sub>, H<sub>2</sub>O, NH<sub>3</sub>, PCl<sub>5</sub>, SF<sub>6</sub>, SF<sub>4</sub>, XeF<sub>4</sub>).

Metallic bond-definition, free electron model, semiconductors and insulators.

#### General principles of metallurgy

Modes of occurrence of elements in nature, minerals, ores; steps involved in the extraction of metals– concentration, reduction (chemical and electrolytic methods), Ellingham diagrams–definition and application in metallurgy for reduction of metal oxides using C, CO and Al as reducing agents.

Electrolytic or oxidative refining, parting process (separating Ag from Au), vapour phase refining– Mond's process (Ni), zone refining (ultrapure metals for semiconductor technology).

#### PHYSICAL CHEMISTRY

# Second Law of thermodynamics

#### **Review of I law of thermodynamics**

Statement and limitations of I law (need for II law of thermodynamics). Different ways of stating II law of thermodynamics with respect to its spontaneity. Spontaneous and non-spontaneous processes. Concept of entropy and its significance. Physical significance of entropy in terms of disorderness and unavailable energy.

#### Heat engine

Carnot's cycle and derivation of the expression for its efficiency. Numerical problems on efficiency. II law in terms of efficiency. Change in entropy of universe in reversible and irreversible processes. Entropy as a measure of spontaneity. Calculation of entropy changes in reversible-isothermal and reversible-adiabatic processes (including phase changes and phase transitions). Numerical problems on calculation of entropy change for various processes. Limitations of entropy as a measure of spontaneity.

#### Gibbs free energy

Work function, chemical potential, definition and relationship between free

**4h** tals-

15h

energy and work function. Criteria for equilibrium and spontaneous processes – problems. Gibb's-Helmholtz equation (derivation-differential form). Rate of change of free energy with respect to temperature and pressure. Temperature coefficient (mention only), derivation of van't Hoff isotherm,  $\Delta G^{o}$ = -RTln(K<sub>p</sub>), van't Hoff reaction isochore (derivation), Clausius-Clapeyron equation (derivation) and its applications in the determination of  $\Delta T_{b}$  and  $\Delta T_{f}$  (derivation not required). Numerical problems on the above equations.

#### Third law of thermodynamics

4h

Qualitative treatment of Nernst heat theorem and III law of thermodynamics (statement only). Elementary concept of residual entropy. Procedure for calculation of absolute entropy (by taking an example of a substance which exists as a solid at zero Kelvin, exists in two crystalline forms in the solid state, transforms to liquid at a certain temperature and is finally a gas at the temperature at which its entropy is required).

- 1. Concise Inorganic Chemistry, J.D. Lee, Wiley, 5<sup>th</sup> edition (2016).
- Concepts and Models of Inorganic Chemistry, B. E. Douglas, D. H. McDaniel, J. J. Alexander, John Wiley and Sons, 3<sup>rd</sup> edition (1999).
- 3. Physical Chemistry P.W. Atkins, J. DePaula, , Oxford University Press, 10<sup>th</sup> edition (2014).
- 4. Inorganic and Solid State Chemistry, G. E. Rodger, Cengage Learning (2002).
- 5. College Chemistry-Vol-III, L. Indira, G. R. Chatwal, Himalya Publishing House, New Delhi (2013).
- 6. Selected topics in Inorganic Chemistry, Wahid U Malik, G.D. Tuli, R. D. Madan, S Chand Publisher (2010).
- 7. Principles of Inorganic Chemistry, B. R. Puri, L. R. Sharma and M. S. Pathania, Vishal publishing co., 47<sup>th</sup> edition (2020).
- A text book of physical chemistry (Vol. 2) –Thermodynamics and Chemical Equilibrium, K. L. Kapoor, McGraw Hill Education (India) Pvt. Ltd., 6<sup>th</sup> edition (2019).
- 9. Advanced Physical Chemistry, Gurdeep, Chatwal, Krishna's publication, 4<sup>th</sup> edition (2016).
- 10. Physical Chemistry, G. M. Barrow, Tata McGraw-Hill, 6<sup>th</sup> edition (2007).
- 11. Chemistry for Degree students: B. Sc., Second year, R. L. Madan, S. Chand publication (2019).
- 12. Physical Chemistry A Molecular Approach, Donald A McQuarrie, John D. Simon, Viva Books Private Limited (2019).

# CHEOEC08P: GENERAL CHEMISTRY PRACTICALS-II

*Equal weightage to be given to both inorganic and physical practicals.* 

#### **INORGANIC CHEMISTRY PRACTICALS**

- 1. Determination of the amount of manganese in pyrolusite ore.
- 2. Determination of the amount of calcium in limestone.
- 3. Determination of the amount of iron in haematite.
- 4. Determination of the amount of nickel as nickel dimethyl glyoximate by gravimetric method.
- 5. Determination of the amount of magnesium as magnesium oxinate by gravimetric method.
- 6. Determination of the amount of calcium present in the given solution by complexometric titration using EDTA.
- 7. Determination of the amount of magnesium present in the given solution by complexometric titration using EDTA.
- 8. Determination of the amount of zinc present in the given solution by complexometric titration using EDTA.

#### PHYSICAL CHEMISTRY PRACTICALS

- 1. Determination of heat capacity of calorimeter for different volumes.
- 2. Determination of enthalpy of neutralization of HCl with NaOH.
- 3. Determination of enthalpy of ionization of acetic acid.
- 4. Determination of enthalpy of solution of KNO<sub>3</sub>
- 5. Determination of enthalpy of solution of NH<sub>4</sub>Cl.
- 6. Determination of enthalpy of hydration of copper(II) sulphate.
- 7. Determination of enthalpy of reaction for the decomposition of hydrogen peroxide.
- 8. Determination of enthalpy of interaction between acetone and chloroform.

#### **Recommended Books/References:**

- 1. Vogel's Quantitative Chemical Analysis J. A. I. Mendham, Pearson, 6<sup>th</sup> edition (2009).
- 2. Chemistry for Degree Students B.Sc. First Year, R. L. Madan, S Chand Publishing Company, New Delhi (2010).

3. Experimental Physical Chemistry, V. D. Athawale, P. Mathur, New Age International Publishers, 1<sup>st</sup> edition (2001).

 Advanced Practical Physical Chemistry, J. B. Yadav, Krishna's Education publishers, Krishna Prakashan Media (2015).

2h/week

# **OEC (NPR) PATTERN:**

L	Τ	Р	Cr
3	-	-	3

# **CHEOEC02: CHEMISTRY OF WATER**

#### Introduction

Formation, structure, reaction with metals and nonmetals. Anomalous properties of water.

# Water resources and properties

Water resources (oceans, rivers, lakes and wet lands), the hydrologic cycle and types of water. Unpolluted vs polluted water, complexation in natural water and waste water, Aquatic biochemical processes. Over exploitation of surface and ground water resources, water quality parameters-standards in India. Physical properties of domestic water-color, odour, pH, turbidity, hardness.

# Water Harvesting and Conservation

Water Harvesting Techniques- Micro-catchments -Design of small water harvesting structures - Farm ponds-percolation tanks-yield from a catchment, rain water harvesting-various techniques related to rural and urban area

# Water Pollution

Origin of waste water, types of water pollutants of their sources and effects. Major pollutants such as pathogens, organic wastes and chemical pollutants; their harmful effects and prevention. Sample collection and preservation. Environmental and public health significance and measurement of colour, turbidity, total solids, acidity, alkalinity, hardness chloride, residual chlorine, chlorine demand, DO, BOD and COD. Heavy metal pollution-public health significance of Pb, Cd, Hg, As.

# Waste water treatment

Waste water characteristics, effluent standards, terminology in waste water treatment. Treatment of domestic waste water-preliminary treatment.

Primary treatment: sedimentation, equalization, neutralization.

Secondary treatment: Aerated lagoons, trickling filters, activated sludge process, oxidation ditch, oxidation pond and anaerobic digestion. Sludge treatment and disposal.

Tertiary treatment: evaporation, ion-exchange, adsorption, electrodialysis, electrolytic recovery and reverse osmosis. Advanced waste water treatment: nutrient removal-nitrogen and phosphorus removal, solids removal. Waste water disposal and reuse: industrial waste water and its treatment.

# **Recommended Books/References:**

1. Concise Inorganic Chemistry, J. D. Lee, Blackwell Science, London, 5<sup>th</sup> edition (2010).

2. Principles of Inorganic Chemistry, B. R. Puri, L. R. Sharma, K. C. Kalia, Vishal Publishers, 33rd edition (2020).

3. Environmental Chemistry, A. K. De, New Age International Ltd, 1<sup>st</sup> edition (2016).

15h

#### 15h

45h 15h

- 4. Environmental Science, T. G. Miller Jr., Brooks/Cole Publisher, Meerut, 13th edition (2009).
- 5. Fundamentals of Ecology, E. P. Odum, W.B. Saunders Co., Philadelphia, 3<sup>rd</sup> edition (1971).
- 6. Environmental chemistry, S. E. Manahan, CRC Press, 10<sup>th</sup> edition (2017).
- 7. Environmental chemistry, Sharma and Kaur, Pragathi Praksahan (2010).
- 8. Environmental Pollution: Monitoring and control, S.M. Khopker, New Age International (2007).
- 9. Environmental chemistry, C. Baird, M. Cann, W. H. Freeman publication, 5<sup>th</sup> edition (2012).
- 10. Fundamental Concepts of Environmental Chemistry, G. S. Sodhi, Narosa Publishers, 3<sup>rd</sup> edition, (2009).
- 11. Principles of instrumental analysis, D. A. Skoog, Sauns College Publishing (London), 6<sup>th</sup> edition (2007).
- 12. Basic concepts of analytical chemistry, S. M. Khopkar, New Age International Pvt. Ltd, 2<sup>nd</sup> edition (2004).

# **CHEOEC03: CHEMISTRY OF ELEMENTS**

#### **Periodic Table**

Modern periodic law, classification of elements into s,p,d and f blocks. Review of periodic propertiessize of atoms and ions, variation of atomic radius, variation of ionic radii in isoelectronic ions, periodic trend in ionic radii, electron affinity, electronegativity, differences in the behaviour of the periodic elements, comparative study of groups.

#### General study of s block elements

Elements of group-I alkali metals, general properties-size of atoms and ions, density, melting point, boiling point, ionization energy, compounds of alkali metal oxides, oxides of alkali metals, carbonates of alkali metals, halides of alkali metals, differences between Li and other groups.

#### Alkaline earth metals: general properties

Size of atoms and ions, density, melting point, boiling point, ionization energy, compounds of alkaline earth metals, oxides of alkaline earth metals, carbonates of alkaline earth metals, halides of alkaline earth metals, differences between beryllium and other elements of group 2.

#### General study of p block elements

#### **Elements of group-16-oxygen family**

General properties: ionisation energy, electron affinity, electronegativity, chemical properties; hydrides of group 16 elements, difference between oxygen and the other elements of group 16.

#### **Elements of group 17 (halogens)**

General properties: size of atoms, ions, ionisation energy, electron affinity, electronegativity, oxidation state, oxidising nature, compounds of halogens. Hydrogen halides, differences between fluorine and other halogens.

#### General study of *d* block elements

Transition elements: General properties of transition elements-electronic configuration, atomic and ionic radii, ionisation energies, redox potentials, variable oxidations states, formation of complexes, colour of transition metal compounds, magnetic properties, catalytic properties, formation of interstitial compounds-comparison of 3d series with 4d and 5d series.

#### General study of f block elements

General properties of f-block elements-electronic configuration, atomic and ionic sizes (Lanthanide contraction), oxidation states, magnetic properties, colour (spectral properties), formation of complexes. Comparison of d-block and f-block elements (oxidation states, complex formation, magnetic properties. Ionic exchange method of separation of lanthanides (ion exchange method).

#### Noble gases (Elements of group 18)

Occurrence, discovery of noble gases (Ar, He, Ne, Kr, Xe, Rn), isolation of noble gases from liquid air

7h

8h

45h

# 7h

7h

#### 8h

and natural gases; applications of noble gases, compounds of noble gases; fluorides of Xe (XeF<sub>2</sub>, XeF<sub>4</sub>, XeF<sub>6</sub>), oxides of xenon (XeO<sub>3</sub>, XeO<sub>4</sub>) (properties).

- 1. College chemistry, Vol. I, L. Indira, G. R. Chatwal, Himalaya Publishing House, New Delhi, 1<sup>st</sup> edition (2013).
- 2. Essential Chemistry III, for BSc III Semester, Vinod kumar B, M Ashwathanarayanappa, Surabhi Books, 1<sup>st</sup> edition.
- 3. Concise Inorganic Chemistry, J. D. Lee, Blackwell Science, London, 5<sup>th</sup> edition (2010).
- 4. Principles of Inorganic Chemistry, B. R. Puri, L. R. Sharma, K. C. Kalia, Shoban Lal Nagin Chand and Co., New Delhi (2005).
- 5. Advanced Inorganic Chemistry, Satyaprakash, G. D. Tuli, S. K. Basu, R. D. Madan, Vol. II, 5<sup>th</sup> edition, S. Chand & company, New Delhi (2000).

# **CHEOEC04: INDUSTRIAL CHEMISTRY**

#### Synthetic dyes

Introduction –definition, conditions, classification based on application, chromophores, auxochromesdefinition, examples. Structure and uses of the following dyes i) methyl orange ii) congo red iii) malachite green iv) phenolphthalein v) alizarin vi) indigo.

#### Drugs

Definition, chemotherapy- definition, classification of drugs with examples. i) antipyretics, ii) analgesics, iii) antibacterial drugs, iv) antimalarial drugs, v) antibiotics vi) antiseptics vii) hypnotics [structure and uses of i) paracetamol ii) sulphanilamide iii) aspirin, iv) chloroquine, v) dettol (major component only), vi) pencillin-V, vii) barbituric acid].

#### Pesticides

Introduction, classification, structure and uses of i) DDT ii) gammaxene iii) chloranil. Advantages and harmful effects of pesticides.

#### Cosmetics

Introduction, classification, ingredients and uses of the following i) talcum powder, ii) perfumes, iii) Deodorants, iv) vanishing creams, v) nail polish vi) lipstick. Harmful effects of cosmetics.

#### Glass

Introduction, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: i) soda lime glass, ii) lead glass, iii) safety glass, iv) borosilicate glass, v) coloured glass, vi) photosensitive glass.

#### Cements

Introduction, classification of cement, raw materials and their role. Manufacture of cement and the setting process (quick setting cement).

#### Ceramics

Importance of clays and feldspar. Ceramics: types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

#### Fertilizers

Definition, types of fertilizers (N-type, P-type, K-type and mixed fertilizers), examples for NP, PK, KN, NPK fertilizers. Preparation of urea, ammonium nitrate, calcium ammonium nitrate and calcium superphosphate.

#### **Surface coatings**

Objectives of surface coatings, preliminary treatment of surface, classification of surface coatings. Paints and pigments: composition and properties (brief mention of-oil paints, toners, fillers, thinners, enamels, emulsifying agents), eco-friendly paints and plastic paints.

#### Alloys

Classification of alloys, ferrous alloy with examples and their uses (ferrosilicon, ferrochrome, ferromanganese) and their uses. Non-ferrous alloys with examples and their uses [copper alloys (bronze,

#### 45h

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4h

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4h

# 4h

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4h

brass), tin alloys (solder), gold alloy (Karat gold for jewellary)]. Composition and properties of different types of Steels (stainless steel, Nickel steel, invar steel, chrome steel and manganese steel).

## Propellants

Introduction to rocket propellants and their classification (solid, liquid, gaseous and hybrid propellants) with examples.

## Food preservation

Definition, objectives and principles of food preservation. Different methods of food preservation. Preserved Products (jam, jelly, sauces, pickles, squashes: composition, storage, uses and their nutritional aspects).

#### **Recommended Books/References:**

- 1. Introduction to Industrial chemistry, Howard L. White, Wiley Interscience Publisher, 1<sup>st</sup> edition (1986).
- 2. Industrial chemistry, Vols I and II, B.K. Sharma, Krishna Prakashan Media Pvt. Ltd., (2016).
- 3. Engineering chemistry, B. K Sharma, Krishna Prakashan Media Pvt. Ltd., (2014).
- Engineering chemistry, R. Gopalan, D. Venkapayya, S. Nagarajan. Vikas publications, New Delhi, 4<sup>th</sup> edition (2018).
- 5. Engineering chemistry, P.C. Jain, M. Jain. Dhanpath Rai and Sons, Delhi, 17th edition (2015).
- 6. Riegel's Handbook of Industrial Chemistry, J. A. Kent, Springer, 10<sup>th</sup> edition (2003).
- 7. Introduction to ceramics, W. D. Kingery, H. K. Bowen, D. R. Uhlmann, Wiley Publishers, 2<sup>nd</sup> edition (1976).
- 8. Industrial Chemistry, E. Stocchi, Vol-I, Ellis Horwood Ltd, UK (1990).

3h

# CHEOEC05: CHEMISTRY OF FOOD, NUTRITION AND PRESERVATION 45h

#### Unit-I

Basics of human physiological system and food science: digestive system: structure and functions of G.I. tract, Process of digestion and absorption of food, structure and functions of liver, gall bladder and pancreas. Basic concept on food, nutrition and nutrients (nutrition, malnutrition and health:scope of nutrition). Classification of food, classification of nutrients.

#### Unit-II

#### Nutrition

Dietary fibers (composition, properties and minerals and trace elements (biochemical and physiological role of Na<sup>+</sup>, K<sup>+</sup>, Mg<sup>2+</sup> and Ca<sup>2+</sup> ions.

#### Vitamins

Definition, classification, common sources and deficiency manifestations of water soluble vitamins, coenzyme functions of B-complex vitamins, fat soluble vitamins- sources, chemical name and deficiency symptoms, Hypervitaminosis. Water (requirement, water balance), basic idea about community nutrition (objective, importance of various programmes).

#### Unit-III

#### Food preservation

Definition, objectives and principles of food preservation. Different methods of food preservation. Preserved products: jam, jelly, Marmalade, sauces, pickles, Squashes, syrupstypes, composition and manufacture, selection, cost, storage, uses and nutritional aspects, Food Standards: ISI, Agmark, FPO, MPO, PFA, FSSAI.

#### **Recommended Books/References:**

- 1. The Chemical Analysis of Foods, H. E. Cox, David Pearson, Chemical Publishing Co Inc., U.S (1962).
- 2. Foods: Facts and Principles. N. Shakuntala Many, S. Swamy, New Age International, 4<sup>th</sup>edition (1998).
- 3. Nutrition Science, B. Srilakshmi, New Age International Publication, 6<sup>th</sup> edition (2016).
- 4. Food Additives: Characteristics, Detection and Estimation. S. N. Mahindru, Aph Publishing Corporation, New Delhi (2008).
- 5. A Handbook of Foods and Nutritional Biochemistry, Nandal Urvanshi, Agrobios (India) Publisher (2013).
- 6. Fennema's Food Chemistry, S. Damodaran, K. L. Parkin, O. R. Fennema, CRC Press, 4th edition, (2008).
- 7. Food Facts and Principal, N. Shakuntala Manay, M. Shadaksharaswamy, New International (P) Ltd. Publishers, New Delhi (2011).

#### 15h

#### 15h

# CHEOEC06: CHEMISTRY IN DAILY LIFE UNIT-I

#### **Dairy Products**

Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk. Beverages:analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, determination of methyl alcohol in alcoholic beverages.

#### Food additives, adulterants and contaminants

Definition, objectives and principles of food additives, adulterants and contaminants. Different types of food additives (benzoates, propionates, sorbates, disulphites), artificial sweeteners (aspartame, saccharin, dulcin, sucralose, and sodium cyclamate), flavors [vanillin, alkyl esters (fruit flavors) and monosodium glutamate].

#### Artificial food colorants

Coal tar dyes and non-permitted colors and metallic salts. Analysis of pesticide residues in food.

#### UNIT-II

#### Vitamins

Classification and nomenclature. Sources, deficiency diseases, and structures of vitamin A1, vitamin B1, vitamin C, vitamin D, vitamin E and vitamin K1.

#### Oils and fats

Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. Halphen test.

#### Soaps & Detergents

Definition, classification, manufacturing of soaps and detergents, composition and uses.

#### UNIT-III

#### **Chemical and Renewable Energy Sources**

Principles and applications of primary and secondary batteries and fuel cells. Basics of solar energy, future energy storer.

#### Polymers

Basic concept of polymers, classification and characteristics of polymers. Applications of polymers as plastics in electronic, automobile components, medical fields, and aerospace materials. Problems of plastic waste management. Strategies for the development of environment-friendly polymers.

#### **Recommended Books/References:**

1. Introduction to Industrial Chemistry, B. K. Sharma, Krishna Prakashan Media P. Ltd., (2016).

- 2. Medicinal Chemistry, Ashtoush Kar, New Age International Publishers, 7th edition (2018).
- 3. The chemical analysis of Foods, H. E. Cox, David Pearson, Chemical Publishing Co Inc., U.S (1962).
- 4. Foods: Facts and Principles, N. Shakuntala Many and S. Swamy, New Age International, 4<sup>th</sup>edition (1998).
- 5. Physical Chemistry, Paul Atkins, J. de Paula, Oxford University Press, 7<sup>th</sup> edition (2002).
- 6. Handbook on Fertilizer Technology, FAI, Swaminathan and Goswamy, 6<sup>th</sup> edition (2001).
- 7. Organic Chemistry, I. L. Finar, Vols. 1 & 2, Pearson Education India, 6<sup>th</sup> edition (2002).
- 8. Polymer Science and Technology, Joel Fried, Pearson Prentice Hall, 3<sup>rd</sup> edition (2014).

15h

# **CHEOEC07: MOLECULES OF LIFE**

#### UNIT-I

#### Carbohydrates

Classification of carbohydrates, reducing and non-reducing sugars, general properties of glucose and fructose, their open chain structures. Epimers, mutarotation and anomers.

Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

#### Amino Acids, Peptides and Proteins

Classification of amino acids, zwitterion structure and isoelectric point. Overview of primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of peptides.

#### UNIT-II

#### Enzymes and correlation with drug action

Mechanism of enzyme action, factors affecting enzyme action, co-enzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity).

Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and non competitive inhibition including allosteric inhibition).

#### **Drug** action

Receptor theory, structure–activity relationships of drug molecules, binding role of -OH group,  $-NH_2$  group, double bond and aromatic ring.

#### Lipids

Introduction to lipids, classification, biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

#### UNIT-III

#### Nucleic Acids

Components of nucleic acids: Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, nucleosides and nucleotides (nomenclature), Structure of polynucleotides, structure of DNA (Watson-Crick model) and RNA (types of RNA), genetic code, biological roles of DNA and RNA: replication, transcription and translation.

#### **Concept of Energy in Biosystems**

Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of carbohydrate: glycolysis, fermentation, Krebs cycle. Overview of catabolic pathways of fats and proteins. Interrelationships in the metabolic pathways of proteins, fats and carbohydrates.

15h

- 1. Organic Chemistry, Morrison Boyd, Bhattacharjee, Pearson Education India, 7<sup>th</sup> edition (2010).
- 2. Organic Chemistry, (Volume 1), I. L. Finar, Pearson Education India, 6<sup>th</sup> edition (2002).
- 3. Organic Chemistry (Volume 2), Stereochemistry and chemistry of natural products, I. L. Finar, Pearson Education India, 5<sup>th</sup> edition (2002).
- 4. Lehninger's Principles of Biochemistry, D. L. Nelson, M. M. Cox, W H Freeman and Co., 7th edition (2017).
- 5. Biochemistry, J. M. Berg, J. L.Tymoczko, L.W.H. Stryer Freeman publishers, 5<sup>th</sup> edition (2002).

# **SKILL ENHANCEMENT COURSES**

# SEC PATTERN (PRACTICAL ORIENTED) SEC PATTERN (NON PRACTICAL ORIENTED)

L	Т	Р	Cr
1	-	2	2

# **CHESEC01: GENERAL BIOCHEMISTRY**

Structure, properties and functions of carbohydrates, lipids and proteins.

# Carbohydrates

Biological importance of carbohydrates, classification, structure, properties, chemical reactions, isolation and characterization of polysaccharides.

# **Proteins (Amino acids)**

Structure, classification, properties and functions, peptides and polypeptides biological importance; Isolation and characterization of proteins, denaturation of proteins.

# Enzymes

Classification and nomenclature, prosthetic groups, cofactors, properties of enzymes as catalysts, specific activity, turn over number and catalytic center activity, Isolation of enzymes from different sources.

# Lipids

Classification, biological importance of triglycerides and phosphoglycerides and cholesterol; saponification, saponification number, iodine number. Lipid membrane, lipoproteins, functions and biochemical functions of steroid hormones.

# Structure of DNA (Watson-Crick Model) and RNA types

tRNA, rRNA and mRNA, genetic code, biological roles of DNA and RNA.

# Blood

Composition and functions of blood. Blood collection and preservation of samples. Estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

# Urine

Collection and preservation of samples, composition and estimation of constituents of normal and pathologicalurine.

# **Recommended Books/References:**

- 1. Tool of Biochemistry, T. G. Cooper, Wiley-Interscience, 1<sup>st</sup> edition (1977).
- 2. Textbook of Biochemistry with Clinical Correlations, T. M. Devlin, Wiley-Liss, 7th edition (2010)).
- 3. Biochemistry, J. M. Berg, J. L. Tymoczko, L. Stryer, W. H. Freeman and Co. Ltd, 5<sup>th</sup> edition (2002).
- 4. Textbook of Biochemistry and Human Biology, G. P. Talwar, M. Srivastava, PHI Learning publisher,  $3^{rd}$ edition (2002).
- 5. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, Albert L. Lehninger, W. H. Freeman and Company, 6<sup>th</sup> edition (2013).

L	Т	Р	Cr
2	-	-	2



3h

3h

3h

2h

#### 2h

## **CHESEC01P:** GENERAL BIOCHEMISTRY PRACTICALS IDENTIFICATION AND ESTIMATION OF THE FOLLOWING:

- 1. Qualitative analysis of carbohydrates (glucose, fructose, sucrose).
- 2. Qualitative analysis of lipids.
- 3. Determination of cholesterol using Liebermann- Burchard reaction.
- 4. Qualitative analysis of proteins.
- 5. Isolation of casein from milk.
- 6. Estimation of protein by the Biuret method.
- 7. Estimation of DNA by diphenylamine method.
- 8. Isolation of amylase from different sources.
- 9. Isolation of starch from potato.
- 10. Determination of saponification and iodine number of an oil or fat.
- 11. Preparation of osazone derivatives of carbohydrates (Glucose, fructose, sucrose)

#### **Recommended Books/References:**

- 1. Tool of Biochemistry, T. G. Cooper, Wiley-Interscience, 1<sup>st</sup> edition (1977).
- 2. Practical Biochemistry: Principles and Techniques, K. Wilson, J. Walker, Cambridge University Press (2009).
- 3. Practical Clinical Biochemistry, Vol. 1, H. Varley, A. H. Gowenlock, M. Bell, Heinemann, London, 5<sup>th</sup> edition (1980).
- 4. Laboratory Handbook of Chromatographic Methods, O. Mikes, R. A. Chalmers, D. Princeton publishers (1966).
- 5. An Introduction to Practical Biochemistry, D.T. Plummer, Tata McGraw Hill Education, 3<sup>rd</sup> edition (2006).
- 6. Laboratory manual in Biochemistry, J. Jayaraman, New Age International Private Limited (2011).

2h/week

# CHESEC02: SEPARATION AND CHROMATOGRAPHIC TECHNIQUES 15h

#### **Solvent Extraction**

Introduction, principle, techniques, factors affecting solvent extraction, batch extraction, continuous extraction and counter current extraction. Synergism, application-determination of iron.

#### Chromatography

Definitions (chromatography, elution, eluent, mobile phase, stationary phase, retention factor), types of chromatographic methods (explain the principles in brief), the chromatograph (elution time and volume), capacity factor, column efficiency and resolution, sample preparation.

#### **Paper Chromatography**

Principle, various modes of development, nature of the paper, detection of spots, retardation factors, factors that affect the reproducibility of  $R_f$  values (due to paper, solvent system, sample, development procedure), selection of solvent, quantitative analysis, applications.

#### Thin layer chromatography

Principle, stationary phase, adsorbents, liquid phase supports, plate preparation, mobile phase, sample application, development, saturation of chamber, detection of spot,  $R_f$  values (effect of adsorbent, solvent, solute, development process), quantitative analysis, applications.

#### **Column Chromatography**

Principle, columns, matrix materials, stationary phase, column packing, application of sample, column development and sample elution, detectors and fraction collectors, applications.

#### **Recommended Books/References:**

- 1. Principles and Practice of Analytical Chemistry, F.W. Fifield and D. Kealy, Wiley-Blackwell, 5th edition (2000).
- 2. Exploring Chemical Analysis, Daniel C Harris, WH Freeman publishers, 5<sup>th</sup> edition (2012).
- 3. Quantitative Chemical Analysis, Daniel C Harris, WH Freeman publishers, 9th edition (2015).
- 4. Analytical Chemistry Methods of Separation, R.V. Dilts, Van Nostrand publishers (1974).
- 5. Laboratory Handbook of Chromatographic and allied Methods, O. Mikes, R.A. Chalmers, Ellis Horwood Ltd. (1979).
- 6. Modern Analytical Chemistry, Alka L Gupta, Pragathi Praksahan, 3<sup>rd</sup> edition (2019).
- 7. Analytical Chemistry, Gary D Christian, John Wiley and Sons Inc, 5<sup>th</sup> edition (2001).
- 8. Instrumental Methods of Analysis, Gurdeep and Chatwal, Himalaya Publishing House, New Delhi (2011).

#### 3h

3h

3h

# 3h

# CHESEC02P: SEPARATION AND CHROMATOGRAPHIC TECHNIQUES-PRACTICALS

2h/week

- 1. Determination of R<sub>f</sub> value of amino acids using paper chromatography.
- 2. Separation and identification of monosaccharide present in a given mixture by paper chromatography.
- 3. Separation of  $Cu^{2+}$  and  $Cd^{2+}$  present in the mixture using ascending chromatography.
- 4. Separation of  $Co^{2+}$  and  $Ni^{2+}$  by thin layer chromatography.
- 5. Separation of mixture of ortho-nitroaniline and para-nitroaniline using column chromatography.
- 6. Separation of spinach leaves pigment using ascending chromatography and determination of R<sub>f</sub> value.
- 7. Separation of binary mixtures (discuss the types: acid-base, acid-neutral, base-neutral, acid-phenol, base-phenol, neutral-phenol); preliminary examinations.
- 8. Separation of solid-solid, solid -liquid, liquid-liquid mixtures (based on solubility).

- 1. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Adarsh Gulati, University Press (India) Limited (2005).
- 2. Advanced Practical Chemistry, Jagadamba Singh, R K P Singh, Jaya Singh, L.D.S. Yadav, I.R. Siddique-Jaya Shrivastava, Pragathi Prakashan, 9<sup>th</sup> edition (2019).

# **CHESEC03:** Titrimetric Methods

#### **Overview of Titrimetry**

Titrant and titrand, equivalence points and end points, titration curves, principles of different methods employed for titrations (volumetric, conductometric, potentiometric, thermometric titrations, pH metric).

#### **Volumetric titrations**

Principle of acid-base titrations (strong acid-strong base, weak acid-strong base and weak acid-weak base), double titrations, concept of indicators, properties of acid-base indicators, structures of some simple indicators (phenolphthalein, methyl orange).

#### **Complexation titrations**

Principle and applicability of EDTA titrations (direct titration of the analyte with EDTA), structure of EDTA, advantages of EDTA as a complexing titrant, an introduction to back titration and substitution titration, application- determination of water hardness. Redox titrations-general principle of redox titrations, use of reducing agents-ferrous ammonium sulphate, sodium thiosulphate, oxidizing agents-potassium permanganate, potassium dichromate (suitable examples should be considered), iodimetry Titration (direct and indirect method).

#### **Conductometric titrations**

Principle of conductometric titrations for acid-base reactions [SA vs SB (HCl vs NaOH), SA+WA vs SB (HCl+Acetic acid vs NaOH), dibasic acid vs base (oxalic acid vs NaOH)] and precipitation reactions  $[Li_2SO_4 \text{ vs } BaCl_2]$ , applications and advantages. Potentiometric titrations-Principle of potentiometric titrations [acid-base titration (HCl vs NaOH), redox titration (FAS vs KMnO<sub>4</sub>)], applications and advantages. A brief introduction to pH metric and thermometric titrations, their applications and advantages.

#### **Recommended Books/References:**

- 1. Modern Analytical Chemistry, David Harvey Douglas, McGraw-Hill Companies (1999).
- 2. Analytical Chemistry: Gary D. Christian, Wiley & Sons, 6<sup>th</sup> edition (2003).
- 3. Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, F. J. Holler, Brooks/Cole publishers, 9<sup>th</sup> edition (2013).
- Instrumental Methods of Analysis, H. H. Willard, L. L. Mirrit, J. A. Dean, Wadsworth Publishing Co Inc, 7<sup>th</sup> edition (1988).
- 5. Vogel's Textbook of Quantitative Inorganic Analysis, A.I. Vogel, Longman Sci. and Tech, 4<sup>th</sup> edition (1980).
- Chemical Instrumentation: A Systematic Approach, H. A. Strobel, Wiley-Interscience; 3<sup>rd</sup> edition (1989).
- 7. Principles of Instrumental Analysis, Douglas A. Skoog., F. James Holler, Stanley R. Crouch, Cengage Learning publishers, 6<sup>th</sup> edition (2014).
- 8. Quantitative Chemical Analysis, Daniel C. Harris, W. H. Freeman publishers, New York, 10<sup>th</sup> edition (2020).

### 15h

2h

#### 5h

#### 5h

# **CHESEC03P: TITRIMETRIC METHODS: PRACTICALS**

- 1. Calibration of glasswares
- 2. Preparation of standard solutions
- 3. Handling of instruments.

## Acid-base titrations

- 4. Estimation of carbonate and bicarbonate present together in a mixture.
- 5. Estimation of strength of strong base using weak acid (oxalic acid)
- 6. Estimation of a given strong acid using strong base.
- 7. Estimation of carbonate and hydroxide present in a mixture.
- 8. Estimation of oxalic acid and sodium oxalate in a given mixture using standard  $KMnO_4/NaOH$  solution.

# **Redox titrations**

- 9. Estimation of Fe(II) using standardized KMnO<sub>4</sub> solution.
- 10. Estimation of oxalic acid using standardized KMnO<sub>4</sub> solution.
- 11. Estimation of Fe(II) with K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> using internal (diphenylamine/anthranilic acid) indicator.

# Iodometric titration

12. Estimation of Cu (II) ions iodometrically using  $Na_2S_2O_3$ .

### **Conductometric titrations**

- 13. Determination of strength of strong acid by titrating it against strong base conductometrically.
- 14. Determination of strength of weak acid by titrating it against strong base conductometrically.

# Potentiometric titrations

15. Determination of strength of strong acid by titrating it against strong base potentiometrically.

16. Determination of amount of  $Fe^{2+}$  ion present in the given solution by titrating the given Mohr's salt solution against potassium dichromate potentiometrically.

#### **Recommended Books/References:**

- 1. J. Mendham, A. I. Vogel's Quantitative Chemical Analysis, Pearson, 6<sup>th</sup> edition (2009).
- 2. Chemistry for Degree Students B.Sc. First Year, R. L. Madan, S Chand Publishing Company, New Delhi (2013).
- 3. Chemistry for Degree Students B.Sc. Third Year (Physical chemistry), R. L. Madan, S Chand Publishing Company, New Delhi (2013).
- Experimental Physical Chemistry, V. D. Athawale, P. Mathur, New Age International Publishers, 1<sup>st</sup> edition (2001).
- Advanced Practical Physical Chemistry, J. B. Yadav Krishna's Education publishers, Krishna Prakashan Media (2015).

2h/week

# **CHESEC04: BIOFERTILIZERS**

#### Unit I

General account about the microbes used as biofertilizer: rhizobium-isolation, identification, mass multiplication. *Azospirillum:* isolation and mass multiplication- carrier-based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics-crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

#### Unit II

Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.

### Unit III

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield.

### Unit IV

Organic farming – Green manuring and organic fertilizers, recycling of bio- degradable municipal, agricultural and Industrial wastes – bio compost making methods, types and method of vermicomposting – field, application.

#### **Recommended Books/References:**

- 1. A Text book of Biotechnology, R.C. Dubey, S. Chand and Co, 4th revised edition (2006).
- 2. Outlines of Plant Biotechnology. John Jothi Prakash, Emkay Publication, 1<sup>st</sup> edition (2014).
- 3. Biotechnology, V. Kumaresan, Saras Publications, 6<sup>th</sup> format (2005).
- 4. The complete Technology Book on Biofertilizer and organic farming, NIIR Project Consultancy Services: NIIR Board, 2<sup>nd</sup> edition (2012).
- 5. T. V. Sathe, Vermiculture and Organic Farming. Daya publishers (2004).
- 6. Biofertilizers in Agriculture and Forestry, Subba Rao N.S. Medtech, 4<sup>th</sup> edition (2017).
- 7. S.C. Vayas, S. Vayas, H. A. Modi, Bio-fertilizers and organic Farming Akta Prakashan, Nadiad (1998).

#### 30h 9h

#### 7h ors

# 7h

# CHESEC05: FERMENTATION SCIENCE AND TECHNOLOGY

# Unit I

Preparation of microbial culture, preparation and sterilization of fermentation media. Isolation and improvement of industrially important microorganisms.

# Unit II

Maintenance and preservation of microorganisms, metabolic regulations and overproduction of metabolites.

# Unit III

Scope and opportunities of fermentation technology. Principles of fermentation: submerged, solid state, batch, fed-batch and continuous culture. Fermentative production of vinegar, alcohol (ethanol, wine, beer), acids (citric acid and gluconic acid), amino acids (lysine and glutamic acid) and antibiotics (penicillin and streptomycin).

# Unit IV

Microbial production of enzymes: amylase and protease. Bioproduct recovery.

# **Recommended Books/References:**

- 1 Industrial Microbiology: An Introduction, M. J. Waites, Blackwell Science, London, UK, 7th edition (2008).
- Prescott & Dunn's Industrial Microbiology, S.C. Prescott, C.G. G. Dunn Reed AVI Pub. Co., USA, 4<sup>th</sup> edition (1982).
- 3. Prescott & Dunn's Industrial microbiology, G. Reed. AVI Pub. Co., USA, 4th edition (2004).
- 4. Industrial Microbiology, L.E. JR Casida New Age International (P) Limited Publishers, 3<sup>rd</sup> edition (2015).
- Industrial Microbiology: An Introduction, M. J. Waites, N.L. Morgan, J. S. Rockey, G. Higton Blackwell Science, London, UK, 1<sup>st</sup> edition (2001).
- Microbiology, M. J. Pelczar E.C.S. Chan, N.R. Krieg Tata McGraw-Hill Publishing Company Ltd., 5<sup>th</sup> edition (2003).

# Submitted by BoS(UG) in Chemistry, Tumkur University

- 1. Dr. Shet Prakash M., Chairperson
- 2. Sri. M. Subbaiah, Member
- 3. Smt. M. B. Shylaja, Member
- 4. Dr. G. P. Somashekarappa, Member
- 5. Sri. M. S. Thippesh, Member
- 6. Dr. M. K. Shivananda, Member
- 7. Dr. B. Nirmala, Member
- 8. Dr. P. A. Suchetan, Member
- 9. Dr. T. N. Ramesh, Member

# 30h 8h

7h

8h