K.J.SOMAIYA COLLEGE OF SCIENCE AND COMMERCE

AUTONOMOUS – Affiliated to University of Mumbai

Re-accredited "A' Grade by NAAC

Vidyanagar, Vidyavihar, Mumbai 400077

Syllabus for T.Y.B.Sc.

Program: B.Sc.

Course: Chemistry (6 Units)

Choice Based Credit System (CBCS)

From the academic year 2020–2021

Preamble of the Course

1. The curriculum frame work is designed around the choice based credit system (CBCS). This provides an opportunity for the students to choose courses from the prescribed courses comprising of following –

a) There are four Discipline specific courses (DSC), two discipline specific elective courses (DSEC) and two skill enhancement courses (SEC) per semester i.e. for semester 5 and semester 6.
b) Each DSC theory course is of 2 credits i.e.36 lectures; 3 lectures per course per week in every semester.
c) Each DSE theory course is of 2 credits i.e.36 lectures; 3 lectures per course per week in every semester.
d) Each DSC and DSE course will have practical equivalent to 1 credit each.

1. Core Courses (DSC):

Discipline Specific core courses (Four per semester - 2 credits for theory and 1 credit for practical):

a) A course which is required to be opted by a candidate as a core course.
b) The purpose of fixing core papers is to ensure that the institution follows a minimum common curriculum so as to adhere to common minimum standard with other universities/institutions.
c) The course designed under this category aims to cover the basics that a student is expected to imbibe in that particular discipline.

2. Elective Courses (DSE):

- **Discipline Specific Elective Course:(2 per semester- 2 credits for theory and 1 credit for practical):**

➢ Elective courses offered under the main discipline subject of study.

b. Dissertation/Project:

➢ An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, which is studied by a candidate with a support of a teacher.
➢ It involves application of knowledge in solving/analysing/exploring a real life/difficult problem.
➢ It should be of 6 credits.
➢ It can be given in lieu of DSE.

3. **Skill enhancement courses**: (SEC): (1 per semester- 2 credits)

- They are designed to provide skill based knowledge and contain both lab/hands on training/field work.
- The main purpose of these courses is to provide life skills in hands on mode to increase employability.

4. **Practical: One each with every DSC and DSE paper**

STRUCTURE OF SYLLABUS

Semester	College Paper Code	Name of the course	Credits for		Total credits
			Theory(T)	Practical's(P)	
V	20US5CHPC1(T) 20US5CHP1(P)	DSC I: Physical Chemistry	2	1	3
	20US5CHIC2(T) 20US5CHP1(P)	DSC II: Inorganic Chemistry	2	1	3
	20US5CHOC3(T) 20US5CHP3(P)	DSC III: Organic Chemistry	2	1	3
	20US5CHAC4(T) 20US5CHP4(P)	DSC IV: Analytical Chemistry	2	1	3
	20US5CHDRC5(T) 20US5CHP5 (P) OR 20US5CHERC5 20US5CHP5 (P)	DSE-I: Drugs (DRC) OR Essentials of Radiation Chemistry (ERC)	2	1	3
	20US5CHRMC6(T) 20US5CHP6 (P) OR 20US5CHENC6(T 20US5CHP6 (P)	DSE-II: Research methodology in Chemistry(RMC) OR Environmental Chemistry (ENC)	2	1	3
	20US5CHBSC7	SEC-I: Business skills for Chemists (BSC) OR Project work	2	-	2
	Total Credits				20

Semester	College Paper Code	Name of the course	Credits for		Total credits
			Theory (T)	Practical's (P)	
VI	20US6CHPC1(T) 20US6CHP1(P)	DSC I: Physical Chemistry	2	1	3
	20US6CHIC2(T) 20US6CHP2(P)	DSC II: Inorganic Chemistry	2	1	3
	20US6CHOC3(T) 20US6CHP3(P)	DSC III: Organic Chemistry	2	1	3
	20US6CHAC4(T) 20US6CHP4(P)	DSC IV: Analytical Chemistry	2	1	3
	20US6CHDYC5(T) 20US6CHP5(P) OR 20US6CHPSC5 20US6CHP5(P)	DSE-I: Dyes (DYC) OR Pesticides Chemistry(PSC)	2	1	3
	20US6CHPLC6(T) 20US6CHP6(P) OR 20US6CHINC6(T) 20US6CHP6(P)	DSE-II: Polymer (PLC) OR Industrial Chemistry (INC)	2	1	3
	20US6CHFCA7	SEC-I: Food/Cosmetics analysis (FCA) OR project work	2	-	2
	Total Credits				20

Structure of syllabus: T. Y. B. Sc. Chemistry

Semester	Course No	Course Title	Course code	Credits	Hours	Periods (50min)	Unit/ Module	Lectures (50 MINUTES)
THEORY								
Core courses								
V	I	Physical	**20US5CHPC1**	2	30	36	1	12
							2	12
							3	12
	II	Inorganic	**20US5CHIC2**	2	30	36	1	12
							2	12
							3	12
	III	Organic	**20US5CHOC3**	2	30	36	1	12
							2	12
							3	12
	IV	Analytical	**20US5CHAC4**	2	30	36	1	12
							2	12
							3	12
Discipline Specific Electives								
DSE	I	Drugs	**20US5CHDRC5**	2	30	36	1	12
V							2	12
							3	12
	II	Research Methodology	**20US5CHRMC6**	2	30	36	1	12
							2	12
							3	12
	Optional I	Essential of radiation	**20US5CHERC**	2	30	36	1	12

	For DSE I	chemistry	**5**					
							2	12
							3	12
	Optional II For DSE II	Environmental chemistry	**20US5CHENC6**	2	30	36	1	12
							2	12
							3	12
Skill Enhancement Electives								
SEC **	I	Business Skills For chemist	**20US5CHBSC7**	2	30	36	1	12
V							2	12
							3	12

Semester	Course No	Course Title	Course code	Credits	Hours	Periods (50 min)	Unit/ Module	Lectures (50 MINUTES)
PRACTICALS								
CORE COURSES								
V	I	Physical Chemistry	**20US5CHP1**	1	2	2.4	-	-
	II	Inorganic Chemistry	**20US5CHP2**	1	2	2.4	-	-
	III	Organic	**20US5CHP3**	1	2	2.4	-	-
	IV	Analytical	**20US5CHP4**	1	2	2.4	-	-
Discipline Specific Electives								
V	I	Drugs	**20US5CHP5**	1	2	2.4	-	-
	II	Research Methodology	**20US5CHP6**	1	2	2.4	-	-

Structure of syllabus: T. Y. B. Sc. Chemistry

Semester	Course No	Course Title	Course code	Credits	Hours	Periods (50 min)	Unit/ Module	Lectures (50 MINUTES)
THEORY								
Core courses								
VI	I	Physical	**20US6CHPC1**	2	30	36	1	12
							2	12
							3	12
	II	Inorganic	**20US6CHIC2**	2	30	36	1	12
							2	12
							3	12
	III	Organic	**20US6CHOC3**	2	30	36	1	12
							2	12
							3	12
	IV	Analytical	**20US6CHAC4**	2	30	36	1	12
							2	12
							3	12
Discipline Specific Electives								
DSE	I	Dyes	**20US6CHDYC5**	2	30	36	1	12
VI							2	12
							3	12
	II	Polymers	**20US6CHPLC6**	2	30	36	1	12
							2	12
							3	12
	Optional I for DSE I	Pesticides Chemistry	**20US6CHPSC5**	2	30	36	1	12
							2	12
							3	12
	Optional	Industrial	**20US6CHINC6**	2	30	36	1	12

	II for DSE II	chemistry						
							2	12
							3	12
Skill Enhancement Electives								
SEC **	I	Food/Cosmetics analysis	**20US6CHFCA7**	2	30	36	1	12
							2	12
							3	12

Semester	**Course No**	**Course Title**	**Course code**	**Credits**	**Hours**	**Periods (50 min)**	**Unit/ Module**	**Lectures (50 MINUTES)**
PRACTICALS								
CORE COURSES								
VI	I	Physical Chemistry	**20US6CHP1**	1	2	2.4	-	-
	II	Inorganic Chemistry	**20US6CHP2**	1	2	2.4	-	-
	III	Organic	**20US6CHP3**	1	2	2.4	-	-
	IV	Analytical	**20US6CHP4**	1	2	2.4	-	-
Discipline Specific Electives								
VI	I	Dyes	**20US6CHP5**	1	2	2.4	-	-
	II	Polymers	**20US6CHP6**	1	2	2.4	-	-

**** Skill enhancement courses may have theory or may have only practical component.**

Evaluation pattern

Evaluation pattern: Theory

For each core course I, II, III, IV and DSE I and II and SEC

External (60 M) + Internal (40 M)

SEC I and II

External: End Semester Examination

Paper Pattern: T. Y. B.Sc. Semester V/VI

External : 60 Marks **Duration: 2 hrs**

Question No.	Module	Marks (with option)	Marks (Without option)
Q1	I	5 M X 5 Q = 25 M	5 M X 4 Q = 20 M
Q2	II	5 M X 5 Q = 25 M	5 M X 4 Q = 20 M
Q3	III	5 M X 5 Q = 25 M	5 M X 4 Q = 20 M

Each question will have sub questions a, b, c, d, e out of which any 4 should be answered. Internal: 40 Marks:

- **20 marks – MCQ type test using ICT technique**
- **20 marks – assignment/workshop/Project/industrial visit**

Evaluation pattern: Practical

Practical Evaluation: 50 Marks practical examination at the end of each semester per paper.

Core Course I (Paper I) Semester V

Course Title: Physical Chemistry

Course Code: 20US5CHPC1

Course Credit- 2 (Teaching: 30 hrs/ 36 L)

After completion of this course a student should be able to

CO1: understand the concepts of Thermodynamics and chemical Kinetics.

CO2: Recognize the different types of electrochemical cells and their applications..

CO3: Awareness about Nuclear Chemistry and Reactions.

Module I: Chemical Thermodynamics and Chemical Kinetics

Learning Objectives

The module is intended to introduce

- Different concepts like Gibb's and Helmholtz's free energy, chemical potential and their significance.
- To understand the basic theories and effect of temperature on rate of chemical reactions.
- Calculation of different and kinetic parameters using numerical.
- Fundamental principles of radioactivity and Nuclear fission for power generation

Learning Outcome

A student will

- Understand the concepts like free energy and chemical potential in thermodynamics in detail.
- Apply the kinetic theories through chemical reactions.
- Solve different numerical based on the concepts of thermodynamics and kinetics.

1.1 Chemical Thermodynamics 8L

1.1.1 Gibbs free energy and Helmholtz free energy, variation of Gibbs free energy with temperature and pressure, Gibbs-Helmholtz equation.

1.1.2 Physical equilibria involving pure substances, Clapeyron equation and variation of vapour pressure with temperature, Clausius- Clapeyron equation and its application. Partial molal properties, partial molal volume and chemical potential, Gibbs- Duhem equation.

1.1.3 Variation of chemical potential with temperature and pressure, fugacity, activity and their relationship with chemical potential, activity and activity coefficient

1.2 Chemical Kinetics 4L

1.2.1 Effect of temperature on rate of a reaction, temperature coefficient, Arrhenius equation, energy of activation and its experimental determination (Numericals expected)

1.2.2 Collision theory of reaction rates, application of collision theory to 1) Biomolecular reaction and 2) Unimolecular reaction, Lindemann theory (derivation expected), merits and drawbacks of collision theory.

1.2.3 Activated complex theory of bimolecular reactions, expression for rate constant of bimolecular reactions (derivation not expected), comparison of collision theory and activated complex theory.

Module II: Electrochemical Cells and Their Applications

Learning Objectives

The module is intended to introduce

- Different types of Electrochemical Concentration cells
- Applications of EMF Measurements
- Concepts of Decomposition potential and Over voltage.

Learning Outcome

A student will

- Differentiate between Chemical and concentration cells
- Classify different types of Concentration cells.
- Understand the Applications of EMF Measurements.
- Recognize the concepts of Decomposition potential and Over voltage

2. 1 Electrochemical Cells and Their Applications 12L

2.1.1 Lewis concept of activity and activity coefficient, ionic strength of a solution, Debye-Huckel limiting law (derivation not expected)

2.1.2 Classification of cells: Comparison between chemical and concentration cell 1)Concentration cells with and without transference (derivation of expression for concentration cell EMF are expected), 2) Chemical cells without transference. Origin of liquid-liquid junction potential and its elimination using a salt bridge.

2.1.3 Faradaic and Non-Faradaic processes. Batteries and Superconductors.

2.1.4 Polarization, concentration polarization and its elimination, Decomposition potential, experimental determination of decomposition potential, factors affecting decomposition potential (nature of electrolyte, nature of electrodes and temperature), overvoltage, experimental determination of overvoltage, Tafel's theory and Tafel's equation for hydrogen overvoltage, simultaneous deposition of metal. Corrosion and its prevention.

Module III: Nuclear Chemistry

Learning Objectives

The module is intended

- To describe the detection and measurement of nuclear radiation using GM counter and scintillation counter
- To determine half-life of radioactive elements
- To illustrate the working of a nuclear power and breeder reactor .

Learning Outcome

A student will be able to

- Illustrate the principle and working of detectors used for detection and measurement of nuclear radiations
- Solve numerical problems on determination of half-life, decay constants, Q value, threshold energy
- Explain the important terms and factors controlling fission reaction while designing a nuclear reactor.

3.1 Nuclear Chemistry

3.1 Types of nuclear radiations and their characteristics, behaviour of ion-pairs in electric field, detection and measurement of nuclear radiations using – G.M counter and scintillation counter.

3.2 Kinetics of radioactive decay, units of radioactivity (Curie, Becquerel, Rutherford).

3.3 Radioactive equilibrium (secular and transient), determination of radioactive constants for radio- elements having 1) Moderate half-life 2) Long half-life 3) Extremely long or short half-life.

3.4 Use of radioisotopes as tracers in: 1) Chemical investigations-reaction mechanism 2) Age determination - dating by tritium content and by carbon-14.

3.5 Nuclear Reactions: nuclear transmutation, artificial radioactivity (suitable examples using different projectiles are expected), Q-value of nuclear reaction, threshold energy.

3.6 Fissile and fertile materials, nuclear fission, chain reactions, factors controlling fission Process (multiplication factor and critical size or mass of fissionable material), nuclear power reactor and breeder reactor.

Reference books:

1.Puri B.R., Sharma L.R., Pathania, M.S., Principles of Physical Chemistry, 23rd edition) New Delhi, Shoban Lal, Nagin Chand & Co., (1993)
2.Negi A. S and Anand S.C., A Text Book of Physical Chemistry ,Eastern Wiley Pvt.Ltd., 2nd edition (1986).
3.Kapoor K.L., A Text Book of Physical Chemistry , Macmillan Publishers India Limited, (2006)-
4 volumes
4.Glasstone S., Text book of Physical Chemistry,D. Van Nostrand company, inc; 2nd edition (1946)
5.Castellan G.W., Physical Chemistry, 3rdEdn., NarosaPublishing House, (2004).
6.Moore W.J.,Physical Chemistry,Longman Publishing Group; 5th edition (1998)
7. Maron S. H. and PruttonC.F., Principles of Physical Chemistry, London Collier-Macmillan, 4th edition(1969)
8.Atkin's Physical Chemistry, Atkins P.W., PaulaJ. D., KeelerJ., Oxofrd University Press,11th edition (2017)
9.PrasadR.K., Quantum Chemistry, PrasadR.K., New Age International Publishers, 4th edition (2010)
10. Introductory Quantum Chemistry, A.K. Chandra, Tata Mc Graw Hill, 4th edition (1994).

Course Title: Physical Chemistry Practicals

Course Code: 20US5CHP1

Course Credit-1

Learning Objectives

The course is intended to introduce

- Rate constants, effect of temperature on rate constants, energy of activation for the acid catalysed reactions like hydrolysis of methyl acetate
- Determination of radius of a molecule by viscosity measurements
- Determination of formal redox potential and to determine the amount of metal in the given solution potentiometrically.
- Determination of acidic and basic dissociation constants of amino acid and to calculate isoelectric point.

Learning Outcome

A student will understand

- The effect of temperature on rate constants and determination of energy of activation.
- The method of determination of radius of a molecule by viscosity measurements.
- Experimental determination of standard reduction potential and to determine the amount of metal in the given solution potentiometrically.
- The concept of isoelctric point, acidic and basic dissociation constants through pH metric determination.

1.**Chemical Kinetics** -

To determine the energy of activation for the acid catalysed hydrolysis of methyl acetate.

2.**Viscosity** –

To determine the radius of a glycerol molecule by viscosity measurements.

3.**Potentiometry** –

To determine the amount of Fe(II) in the given solution by titration with a standard K2Cr2O7 solution and hence to find the formal redox potential of Fe3+/Fe2+

4.**pH –Metry** –

To determine acidic and basic dissociation constants of amino acid and to calculate isoelectric point

CHEMISTRY SEM VI

Course I (Paper I) Semester VI
Course Title: Physical Chemistry
Course Credit- 2 (Teaching: 30 hrs/ 36 L)
Course Code: 20US6CHPC1

After completion of this course a student should be able to

CO1: Understand the principles of molecular spectroscopy.

CO2: Learn colligative properties of dilute solutions. Understand phase rule and its applications to one and two component systems.

CO3: Understand basics of quantum chemistry. Familiarize the potential applications in electrochemistry.

Module IV: Molecular Spectroscopy 12L

Learning Objective

- The module is intended to introduce the principles of three key spectroscopic methods- Rotational, Infra-Red and Raman spectroscopies.

Learning outcome

A student will

- Acquire basic knowledge of the interaction of radiation with matter and will be able to use the quantum mechanics principles to understand molecular spectra. The student will recognize the relationship between molecular spectra and molecular properties.

Molecular Spectroscopy 12L

4.1 Dipole moment: Dipole moment, polarization of a bond, bond moment, dipole moment and molecular structure.

4.2 Rotational Spectrum: Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of inter nuclear distance and isotopic shift

4.3 Vibrational (IR) spectrum: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum

4.4 Vibration-Rotation spectrum of diatomic molecules, vibrating rotor, energy levels, selection rule, nature of spectrum, R and P branches, anharmonic oscillator: energy levels, selection rule, fundamental band, overtones. Introduction to infrared spectra of simple molecules like H_2O and CO_2.

4.5 Raman Spectroscopy: scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum, Stoke's lines, anti-Stoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion (example of CO_2 molecule).

Module V: Colligative Properties of Dilute Solutions and phase Rule 12L

Learning Objective:

The module is intended to introduce

- The concepts of colligative properties lowering of vapour pressure, elevation of boiling point, depression in freezing point and osmotic pressure.
- Relation between the colligative property and calculations of different parameters
- Phase rule and it's applications to one and two component systems.

Learning Outcome:

A student will be able to

- Understand the relation between colligative property and molar mass of the non-volatile solute.
- Solve numerical problems on determination of molar mass of the non-volatile solutes.
- Apply phase rule to understand behaviour of one and two component systems.

Colligative Properties of Dilute Solutions and phase Rule

5.1 Colligative Properties of Dilute Solutions 7L

5.1.1 Dilute solutions, colligative properties, Raoult's law, relative lowering of vapour pressure.

5.1.2 Elevation in boiling point of a solution, thermodynamic derivation relating elevation in boiling point of a solution and the molar mass of a non-volatile solute.

5.1.3 Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and the molar mass of a non-volatile solute.

5.1.4 Osmotic pressure, van't Hoff's equation for osmotic pressure (derivation is expected) and determination of molar mass of the solute. Abnormal molar masses of solutes and van't Hoff factor (calculation of Degree of Association and Degree of Dissociation.)

5.2 Phase Rule 5 L

5.2.1 Gibb's phase rule and terms involved in the equation

5.2.2 Application of phase rule to ONE component systems: Water system

5.2.3 Application of phase rule to TWO component systems, condensed systems, condensed phase rule, eutectic systems (Lead – Silver system), desilverisation of lead.

5.2.4 Introduction to THREE component systems , triangular plots.

Module VI: Quantum Chemistry and Nuclear Magnetic Resonance Spectroscopy 12L

Learning Objective

This module is intended

- To introduce basic concepts of quantum mechanics, operators, eigen function and eigen value.
- To familiarize the principles of Nuclear Magnetic Spectroscopy.

Learning Outcome

A student will be able to

- compare between classical mechanics and quantum mechanics.
- understand and analyse different operators.
- learn eigen function and eigen value.
- explain the terms and basic principles of NMR spectroscopy
- illustrate the principle and working of NMR Spectrometer

6.1 Quantum Chemistry 8L

6.1.1 Why quantum mechanics? Comparison between classical mechanics and quantum mechanics.

6.1.2 Progressive and standing waves, boundary conditions, Schrodinger's time independent wave equation, interpretation and properties of wave function.

6.1.3 Postulates of quantum mechanics, Concept of operators: definition, addition, subtraction, multiplication of operators. Commutative and non-commutative operators, Linear operators, Hamiltonian operator.

6.1.4 Eigen function and eigen value, eigen value equation

6.2. Nuclear Magnetic Resonance Spectroscopy 4L

6.2.1 Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession. Relaxation processes in NMR (Spin-spin relaxation and spin-lattice relaxation)

6.2.2 NMR Spectrometer, chemical shift, shielding and de-shielding of protons, low resolution NMR spectrum of methanol and ethanol, fine structure of NMR- nuclear spin-spin interaction with reference to methanol and ethanol.

Reference books:

1.Banwell C.N., McCash M.E, Fundamentals of Molecular Spectroscopy, McGraw Hill Education; Fourth edition (2017).

2.Puri B.R., Sharma L.R., Pathania, M.S., Principles of Physical Chemistry, 23rd edition) New Delhi, Shoban Lal, Nagin Chand & Co., (1993)

3.Negi A. S and Anand S.C., A Text Book of Physical Chemistry ,Eastern Wiley Pvt.Ltd., 2nd edition (1986).

4.Kapoor K.L., A Text Book of Physical Chemistry , Macmillan Publishers India Limited, (2006)- 4 volumes

5.Glasstone S., Text book of Physical Chemistry,D. Van Nostrand company, inc; 2nd edition (1946)

6.Castellan G.W., Physical Chemistry, 3rdEdn., NarosaPublishing House, (2004).

7.Moore W.J., Physical Chemistry,Longman Publishing Group; 5th edition (1998)

8. Maron S. H. and PruttonC.F., Principles of Physical Chemistry, London Collier-Macmillan, 4th edition(1969)

9.Atkin's Physical Chemistry, Atkins P.W., PaulaJ. D., KeelerJ., Oxofrd University Press, 11th edition (2017)

10.PrasadR.K., Quantum Chemistry, PrasadR.K., New Age International Publishers, 4th edition (2010)

11.Introductory Quantum Chemistry, A.K. Chandra, Tata Mc Graw Hill, 4th edition (1994).

Course Title: Physical Chemistry Practicals

Course Code: 20US6CHP1

`Course Credit-1

Learning Objectives

The course is intended to introduce

- Effect of an added electrolyte on the kinetics of the reaction.
- Partition coefficient method to determine equilibrium constant of a reaction
- Potentiometric titration method to determine the strength of the given strong acid.
- Conductometric titration method of mixture of acids and salt to determine the percentage composition.

Learning Outcome

A student will understand

- The effect of addition of electrolyte on the kinetics of the reaction.
- Partition coefficient method to determine equilibrium constant of a reaction.
- Potentiometric titration method.
- Conductometric titration method.

1.Chemical Kinetics –

To study the effect of an added electrolyte (KCl) on the kinetics of the reaction between potassium persulphate and potassium iodide.

2. Partition coefficient –

To determine the equilibrium constant for the reaction KI + I2→KI3 by partition coefficient method. (Partition coefficient of I2 between CCl4 and water is to be given)

3.Potentiometry –

To determine the strength of the given strong acid (HCl) by potentiometric titration using quinhydrone electrode (Calculation of pH from Ecell and the plot of (a) against V (b) pH against V graphs are expected).

4. Conductometry –

To estimate the concentration of sulphuric acid, acetic acid and copper sulphate in the given solution by conductometric titration method.

Core Course II (Paper II) Semester V

Course Title: Inorganic Chemistry
Course Code: 20US5CHIC2
Course Credit- 2 (Teaching: 30 hrs/ 36 L)

After completion of this course a student should be able to
CO1: understand the concept of molecular symmetry and chemical bonding.
CO2: Recognize the modern theories of bonding in coordination compound.
CO3: Learn about f- block elements.

Module I: Molecular Symmetry and Chemical bonding 12L

Learning Objectives

The module is intended to introduce

- Different symmetry elements, symmetry operations, concept of point group in molecule.
- Molecular orbital theory in simple polyatomic molecules.
- Band theory of metallic bonding.

Learning Outcome

A student will understand

- The basic concept in symmetry like symmetry elements, symmetry operations and point group.
- Molecular orbital approach for bonding in simple polyatomic molecules and drawing MOT diagrams for these molecule.
- Molecular orbital approach / band theory to explain bonding in metals and properties of conductors, insulators and semi conductors.

1.1 Molecular Symmetry 6L

1.1.1 Introduction and Importance.
1.1.2 Symmetry elements and Symmetry operations.
1.1.3 Concept of a Point Group with illustrations using the following point groups: (i) C∞v (HCl), (ii) D∞h (H2), (iii) C2v (H2O), (iv) C3v (NH3), (v) C2h (trans-dichloroethylene), (vi) D3h (BCl3)

1.2 Molecular Orbital Theory for polyatomic species 3L

1.2.1 Simple triatomic species H3+ and H3 (correlation between bond angle and molecular orbitals)
1.2.2 Other molecules (considering only σ bonding): (i) BeH2 (ii) H2O (with reference to Walsh diagram)

1.3 Metallic Bond 3L

1.3.1 Band theory
1.3.2 Explanation of electric properties of conductors, insulators and semiconductors (n- and p- types) on the basis of Band theory.

Module II: Bonding in Coordination Compounds 12L

Learning Objectives

The module is intended to introduce

- Two theories of bonding in coordination compounds – Crystal field theory and molecular orbital theory.
- Concept of electronic states, term symbols, micro states.

Learning Outcome

A student will understand

- The nature of bond between metal and ligand.
- Thermodynamic, kinetic, spectral and stereo chemical properties of coordination compounds.
- Interpretation of different electronic states, term symbols and micro states for d1, d4, d6, d9 electronic configurations.

2.1 Crystal Field Theory (CFT) of co–ordination complexes 6L

2.1.1 Basic tenets of Crystal Field Theory (CFT) and effect of Crystal Field on central metal valence orbitals

2.1.2 Splitting of d orbitals in octahedral, tetrahedral and square planar complexes; Jahn Teller Effect

2.1.3 Crystal field splitting energy (10Dq/Δo) for octahedral complexes and factors affecting the magnitude of Δo

2.1.4 Crystal field stabilization energy (CFSE), calculation of CFSE for octahedral and tetrahedral complexes with d1 to d10 metal ion configurations, high spin and low spin complexes.

2.1.5Effect of Crystal field splitting on (i) Ionic radius (ii) Lattice energy.

2.1.6 Experimental evidence for co-valence in co-ordination compounds:

(i)ESR spectrum of [IrCl6] -2

(ii)Nephelauxetic effect.

2.1.7. Merits and Demerits of CFT .

2.2 Molecular Orbital Theory (MOT) of co –ordination complexes 3L

2.2.1 Application to octahedral complexes in case of (i)[Ti(H2O)6]+3 (ii) Fluoro complexes of Fe(II) and Fe(III) (iii) Cyano complexes of Fe(II) and Fe(III) (iv) Fluoro and amino complexes of Co(III)

2.2.2Effect of π- bonding on ligand field splitting parameter in M□Lπ and L□Mπ interactions.

2.3 Electronic states and Terms for Polyelectronic Atoms 3L

2.3.1 Introduction, electronic configuration and electronic states, Term symbols, coupling of spin momenta (MS), orbital momenta (ML) and spin orbit coupling or Russell -Saunders coupling.

2.3.2 Determination of Terms for p2 electronic configuration (as in a carbon atom).

2.3.3 Terms and micro-stats for transition metal atoms/ions.

Module III: Chemistry of Lanthanides 12L

Learning Objectives

The module is intended to introduce

- The study of f-block elements

Learning Outcome

A student will understand

- The position of f-block elements in the periodic table.
- The electronic configuration of 4f and 5f block elements and their comparison
- Chemistry of lanthanides with respect to occurrence, extraction, separation, physical & chemical properties and applications.

3.1 Introduction **3L**

3.1.1 The shapes of f-orbitals,
3.1.2 The position of f-block elements in the periodic table,
3.1.3 Electronic configuration of 4f and 5f block
3.1.4 Comparison between lanthanides and actinides.

3.2 Chemistry of lanthanides with reference to **9L**

3.2.1 (i) lanthanide contraction, (ii) oxidation states, (iii) magnetic properties, (iv) colour and spectra (f-f transition spectra) and (v) complex formation (types and stereochemistry of the complexes).
3.2.2 Occurrence, extraction and separation of lanthanides by (i) ion- exchange (ii) solvent extraction methods
3.2.3 Application of lanthanides.

Reference books:

1Chemistry Inorganic - B.R. Puri, L.R. Sharma and K.C. Kallia - Vallabh Publications (2003).
2.Selected Topics in Inorganic Chemistry - W.U. Malik, G.D. Tuli and R.D. Madan - S. Chand Publications (2006).
3Inorganic Chemistry - J.E. Huheey, Harper and Collins - NY IV edition (1993).
4.Concise Inorganic Chemistry - J.D. Lee - III edition - Von Nostrand.
5.Industrial Chemistry - B.K Sharma - Goel Publications (1983).
6.Coordination Chemistry - S.F.A. Kettle - ELBS (1973).
7.Coordination Chemistry - K. Burger - Butterworthy (1973).
8.Advanced Inorganic Chemistry - Cotton and Wilkinson - V Edition - Wiley and Sons (1988).
9.Cotton, F.A and Wilkinson, G. (1989) Inorganic Chemistry. John Wiley and Sons, NewYork
10.Madan R.D., Juli G.D. and Malik S.M., Selected Topics in Inorganic Chemistry, S.Chand& Co, New Delhi (2006)

Course Title: Inorganic Chemistry Practicals

Course Code: 20US5CHP2

Course Credit-1

Learning Objectives

The course is intended to impart

- Knowledge on the preparation of inorganic complexes.
- Knowledge on the analytical chemistry aspects of complexometric titration.
- The concept of the experiment and the different steps involved in the experiment in the real lab more accurately and precisely.

Learning Outcome

A student will

- Acquire the skills to prepare Mohr's salt, nickel and cobalt amine complexes.
- Identify the chemicals and apparatus required for the preparation of Mohr's salt, nickel and cobalt amine complexes.
- Demonstrate the basic laboratory technique of titration.
- Learn to calculate normality gm/L based on titrations.

1.Inorganic Preparation

i)Preparation of Ferric Alum and estimation of Iron by complexometry.

ii)Preparation of Chloropentaaminecobalt (III) chloride and estimation of cobalt by complexometry.

iii)Preparation of tris(ethylene diamine) nickel (II) sulphate and estimation of nickel by complexometry

2.Titrimetric Analysis

i)Estimation of Zinc complexometrically using Eriochrome Black T indicator.

ii)Estimation of Nickel complexometrically using mureoxide indicator.

iii)Estimation of Copper complexometrically using Fast sulphone Black F indicator.

Core Course II (Paper II) Semester VI

Course Title: Inorganic Chemistry
Course Code: 20US6CHIC2
Course Credit- 2 (Teaching: 30 hrs/ 36 L)

After completion of this course a student should be able to
CO1: understand the structure of solids.
CO2: Analyze and understand the electronic spectra of complexes, stability and substitution reactions in complexes.
CO3: Learn about aqueous chemistry and non-aqueous solvents.

Module IV: Solid state chemistry 12L

Learning Objective

- The module is intended to introduce very important branch of chemistry which is solid state Chemistry as most of the inorganic compounds are solids under ordinary conditions and greater part of structural inorganic chemistry is concern with structure of solids.

Learning outcome

A student will understand

- The structure of solids through learning different lattice parameters, closest packing of spheres, atomic packing factor of crystal systems, voids in crystal structure etc.

4.1 Structures of Solids 8L

4.1.1 Importance of Solid State Chemistry.
4.1.2 Crystals: size and shape of crystals, interfacial angles in crystals, Symmetry and elements of symmetry in crystals.
4.1.3 Classification of solids on the basis of bonding.
4.1.4 Explanation of terms viz. crystal lattice, lattice points, unit cells, and lattice constants.
4.1.5 Closest packing of rigid spheres (hcp, ccp), packing density in simple cubic, bcc, fcc and hcp Lattices (numerical problems expected).
4.1.6 Tetrahedral and octahedral interstitial voids in ccp lattice, tetrahedral holes, limiting radius ratios for different coordination numbers and their significance, calculation of ionic radii and limiting radius ratio for coordination number 4.
4.1.7 Structure of sodium chloride, cesium chloride and fluorite. Structure of zinc chloride and failure of radius ratio rule (directional bonding), structure of wurtzite.

4.2 Superconductivity 4L

4.2.1 Superconductivity, Meissner effect.
4.2.2 Different superconducting materials viz., conventional superconductors, organic superconductors, alkali metal fullerides (A3C60) and high temperature superconductors.
4.2.3 Applications of superconducting materials.

Module V: Coordination Chemistry 12L

Learning Objective:

The module is intended to introduce

- The study of electronic spectra of complexes.
- Stability of complexes
- Substitution reactions in complexes.

Learning Outcome:

A student will be able to

- Analyze the electronic spectra of complexes and can recognize various types of electronic transitions, geometry of complexes.
- Appreciate the complex chemistry of transition metal coordination compounds by studying kinetics, mechanisms of various reactions and stability of complexes.

5.1 Electronic Spectra of Complexes 5L

5.1.1Type of electronic transitions like intra-ligand transitions, charge transfer transitions and intra-metal transitions (d-d or ligand field transitions for transition metals)

5.1.5Rule for electronic transitions: Spin and Orbital or Laporte selection rules

5.1.3Splitting of Terms in weak crystal field, the Hole formalism

5.1.4Orgel Diagrams for D Terms i.e. d1, d4 and d6, d9 electronic configurations

5.1.5Applications of electronic spectra in brief, with special reference to (i) cis-trans isomerism in complexes and (ii) Geometry of complexes

5.2. Stability of octahedral complexes 3L

5.2.1. Thermodynamic stability and kinetic stability of complexes with examples

5.2.2. Stability constants: stepwise and overall constants and their inter relationship

5.2.3. Factors affecting thermodynamic stability

5.3 Substitution reactions in octahedral complexes 4L

5.3.1 Introduction, types of reactions in complexes

5.3.2Ligand substitution reactions: basic mechanisms

5.3.3Inert and labile complexes and electronic configurations and lability

5.3.4Acid hydrolysis, base hydrolysis and anation reactions.

Module VI: Solution Chemistry 12L

Learning Objective

This module is intended to introduce the study of

- Aqueous chemistry
- Non aqueous solvents.

Learning Outcome

A student will

- Learn various theories of acids and bases, appreciate how these theories provide a common platform to stand.
- Recognize the behaviour of cations and anions in aqueous solution, changes brought about due to their presence and importance of maintenance of pH in aqueous solution.
- Understand the importance of non-aquesous solvents and study some important and widely used non-aqueous solvents.

6.1 Concept of acids and Bases 4L

6.1.1 Arrhenus, Bronsted Lowry, Lewis concept of Acids and Bases.

6.1.2 Solvent System Concept.

6.1.3 Levelling and differentiating solvents

6.1.4 Pearson principal and HSBC Concept

6.1.5 Usanovich Concept

6.2 Acid Base Chemistry in Aqueous Medium 4L

6.2.1 Acidity of mono- and poly atomic cations.

6.2.2 Basicity of mono- and poly atomic anions (Latimer equation and predominance diagrams).

6.3 Chemistry of Non-aqueous solvents 4L

6.3.1 Classification of solvents and importance of non-aqueous solvents

6.3.2 Characteristics of study of liquid ammonia, dinitrogentetraoxide and acetic acid as non-aqueous solvents with respect to (i) acid base reactions (ii) redox reactions

Reference books:

1.Chemistry Inorganic - B.R. Puri, L.R. Sharma and K.C. Kallia - Vallabh Publications (2003).

2.Selected Topics in Inorganic Chemistry - W.U. Malik, G.D. Tuli and R.D. Madan - S. Chand Publications (2006).

3Inorganic Chemistry - J.E. Huheey, Harper and Collins - NY IV edition (1993).

4.Concise Inorganic Chemistry - J.D. Lee - III edition - Von Nostrand.

5.Industrial Chemistry - B.K Sharma - Goel Publications (1983).

6.Coordination Chemistry - S.F.A. Kettle - ELBS (1973).

7.Coordination Chemistry - K. Burger - Butterworthy (1973).

8.Advanced Inorganic Chemistry - Cotton and Wilkinson - V Edition - Wiley and Sons (1988).

9.Cotton, F.A and Wilkinson, G. (1989) Inorganic Chemistry. John Wiley and Sons, NewYork

10.Madan R.D., Juli G.D. and Malik S.M., Selected Topics in Inorganic Chemistry, S.Chand& Co, New Delhi (2006)

Course Title: Inorganic Chemistry Practicals

Course Code: 20US6CHP2

Course Credit-1

Learning Objectives

The course is intended to impart

- Knowledge on the preparation of inorganic complexes.
- Knowledge on the analytical chemistry aspects of complexometric titration.
- The concept of the experiment and the different steps involved in the experiment in the real lab more accurately and precisely.

Learning Outcome

A student will

- Acquire the skills to prepare Inorganic complexes.
- Acquire the skills to analyze commercial samples using complexometric titration.

1. Commercial Analysis:-

i) Analysis of talcum powder for its magnesium content complexometrically.

ii) Analysis of calcium tablets for its calcium content complexometrically.

iii) Analysis of Boric acid for its percentage purity.

2. Inorganic Preparations :

i) 8-hydoxyquinolinato magnesium (II).

ii) Aluminium potassium sulphate KAl(SO4)2.12H2O

iii) Bis-(acetylacetanato) copper (II).

Core Course III (Paper III) Semester V

Course Title: Organic Chemistry
Course Credit- 2 (No. of Teaching hrs.-30/ 36 L)
Course Code: 20US5CHOC3

After completion of this course a student should be able to

CO1: Name the organic compounds according to IUPAC and understand the reaction mechanism of carbonyl compounds

CO2: predict the syntheses of unknown compounds using retrosynthetic approach and recognize the configuration and predict the products of reactions of carbohydrates

CO3: to identify the elements of symmetry and study the stereochemistry of molecules with axial chirality.

Module I: Mechanism of Organic Reactions and IUPAC 12L

Learning Objectives

The module is intended to introduce

- Mechanism of reactions of carbonyl compounds and some rearrangements.
- IUPAC of some higher organic compounds

Learning Outcome

A student will be able to

- predict and account for the most commonly encountered reaction mechanisms in of carbonyl compounds.
- Name the bicyclic compounds,biphenyls,cummulenesupto 3 double bonds, heterocyclic compounds containing a maximum of two hetero atom among N, O, S.

1.1 Mechanism of Organic Reactions 9L

1.1.1 Thermodynamic and Kinetic control of organic reactions: Concept with mechanisms of the following reactions: addition of HX to butadiene; sulfonation of naphthalene. Nucleophilicity / electrophilicity Vs Basicity / acidity.

1.1.2 Mechanism of reactions of carbonyl compounds with nucleophiles.

1.1.2.1 Reaction of aldehydes and ketones with primary and secondary amines.

1.1.2.2 Acyl nucleophilic substitution (tetrahedral mechanism): Acid catalysed esterification of carboxylic acids and base promoted hydrolysis of esters.

1.1.3 Mechanism of rearrangements with examples and stereochemistry wherever applicable.

1.1.3.1 Migration to electron deficient carbon: Pinacol, Benzilic acid.

1.1.3.2 Migration to electron deficient nitrogen: Beckmann, Hofmann.

1.2 IUPAC 3L

1.2 IUPAC systematic and accepted trivial nomenclature of the following classes of com pounds, including substituted ones (up to 2 substituents/functional groups):

1.2.1 Bicyclic compounds- spiro, fused, and bridged (upto 11carbon atoms)-saturated an unsaturated compounds.

1.2.2 Biphenyls.

1.2.3 Cummulenesupto 3 double bonds, Monocyclic (5 and 6 membered) aromatic and nonaromatic heterocyclic compounds containing a maximum of two hetero atom among N, O, S.

Module II Organic Synthesis, Retrosynthesis and Carbohydrates 12L

Learning Objectives

The module is intended to introduce

- The synthesis of some important heterocycles
- The different terms and strategies involved in synthesizing organic compounds
- The structure, synthesis, reactions and stereochemistry of monosaccharides.

Learning Outcome

A student will be able to

- Understand the synthesis of N,O,S containing heterocycles.
- predict synthesis of simple organic compounds of different classes using the retrosynthetic approach
- Identify the types and stereochemical forms of carbohydrates.
- Predict the products of reactions of D-glucose and D-fructose.

2.1. Organic Synthesis 2 L

2.1.1 Introduction: Criteria for ideal organic synthesis. Yield and selectivity.

2.1.2 Synthesis of furans, pyrroles, and thiophenes by Paal-Knor synthesis.

2.2 Retrosynthetic analysis and applications 4L

2.2.1 Introduction, Different terms used – Disconnection, Synthon, Synthetic equivalence FGI, TM.

2.2.2 One group disconnection with examples.

2.2.3 Retrosynthesis and Synthesis of the following Target Molecules- i) Acetophenone ii) t-butyl alcohol iii) Crotonaldehyde iv) Cyclohexene v) Cyclohexene-3-one vi) Benzoin vii) Cyclopentylmethanal viii) Benzylbenzoate

2.3 Carbohydrates 6L

2.3.1Introduction: Classification, Sources, Reducing and non-reducing sugars DL notation.

2. 3.2 Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides and Haworth formula-Furanose and pyranose forms of pentoses and hexoses. Interconversion: open and Haworth forms of monosaccharides with 5 and 6 carbons

2.3.3 Anomers and epimers of monosaccharides. Enantiomers and diastereomers of glucose. Mutarotation (with mechanism) in D-glucose.

2.3.4 Chain lengthening and shortening reaction: Modified Kiliani-Fischer synthesis, Wohl method.

2.3.5 Reactions of D-glucose and D- fructose: (a) osazone formation (b) reduction- H2/Ni, $NaBH_4$ (c) oxidation- bromine water, HNO_3, HIO_4. (d) interconversion of D-glucose and D-fructose (e) acetylation (f) methylation [e and f with cyclic pyranose form].

Module III: Stereochemistry 12L

Learning Objectives

The module is intended to introduce

- The elements of symmetry
- Conformations and relative stabilities of cyclohexanes
- The stereochemistry of compounds having axial chirality
- The concept of topicity

Learning Outcome

A student will be able to

- recognise the elements of symmetry in organic compounds.
- Draw the conformers of cyclohexanes
- Predict the relative stabilities of different conformers and geometrical isomers of cyclohexanes
- Understand the conditions of optical activity in molecules like cummulenes, spirans and biphenyls
- Relate topicity of ligands and faces.

3. Stereochemistry 12L

3.1 Molecular chirality and element of symmetry: Mirror Plane symmetry (inversion centre), rotation-reflection (alternating) axis, Chirality of compounds without stereogenicentre: cummulenes, spirans and biphenyls.

3.2 Stability of cycloalkanes: Strains in cycloalkanes-angle, eclipsing, transannular (3 to 8 membered). Conformations of cyclohexane, mono- and di- alkyl cyclohexanes and their relative stabilities.

3.3 Stereo selectivity and Stereo specificity: Idea of enantioselectivity (ee) and diastereoselectivity (de).Topicity-enantiotopic and diastereotopic atoms, groups and faces.

Reference books:

(1)Francis A Carey, Organic Chemistry, Pearson Education, 7th Edition, Tata McGraw Hill, 2008.

(2) R.T. Morrison and R.N. Boyd, Organic Chemistry, 6th Edition, Pearson Education.2008

(3) Paula Y. Bruice, Organic Chemistry, 3rd ed., Pearson Education, 2007.

(4) S.H. Pine, Organic Chemistry, 5th Ed, McGraw Hill Kogakusha Ltd.2007

(5) Peter Sykes, A guide to mechanism in Organic Chemistry, 6th Edition, Pearson Education, New Delhi.

(6) V.K. Ahluwalia and R.K. Parashar, Organic Reaction Mechanism, 4th ed., Narosa Publications.

(7) P.S. Kalsi, Stereochemistry, conformation and mechanism, 7th ed, New Age International Ltd.,2008.

(8) E. L. Eliel, Stereochemistry of Carbon compounds, Tata McGrawHill, New Delhi.

(9) I.L. Finar, Organic Chemistry, 6th Edition Volume 2

(10) Stuart Warren, Designing Organic Syntheses, Wiley India Pvt. Ltd., 2009.

Course Title: Organic Chemistry Practicals

Course Code: 20US5CHP3

Course Credit-1

Learning Objectives

The course is intended to introduce

- Separation of a Binary mixture by chemical method.
- Identification of the Separated component
- Purification techniques

Learning Outcome

After completing this course, a student will be able to

- Find the chemical type of mixture in the given Binary mixture.
- Separate the components using different separating reagents.
- Purify the separated organic compound using different purification techniques

1. Binary Mixture Separation & identification (Solid + Solid)

Core Course III (Paper III) Semester VI

Course Title: Organic Chemistry

Course Credit- 2 (No. of Teaching hrs.-30/ 36 L)

Course Code: 20US6CHOC3

After completion of this course a student should be able to

CO1: Understand the chemistry of natural products and biomolecules.

CO2: Predict the products of reactions using organometallic reagents and catalysts.

CO3: Elucidate the structure of simple organic compounds using U.V, I.R and NMR spectra.

Module IV: Natural Products and Biomolecules 12L

Learning Objective

The module is intended to introduce chemistry of molecules derived from living organisms.

Learning outcome

After completing the course the student will be able to

- provide an overview of the field of natural product chemistry
- identify different types of natural products, their structure and synthesis.
- relate the use of natural products as starting materials for medicines.

4.1 Natural products 6L

4.1.1 Terpenoids. Introduction, isoprene rule, special isoprene rule, and gem dialkyl rule. Citral: Structure determination of citral, synthesis of citral from methyl heptenone

4.1.3 Alkaloids:Introduction, Hofmann's exhaustive methylation and degradation Nicotine: Structure determination of nicotine, synthesis of nicotine from nicotinic acid

4.2 Chemistry of some Important Biomolecules: 6L

4.2.1 α-Amino acids: Structure, configuration, Essential amino acids and their classification, Methods of preparations: Strecker Explanation of terms viz. crystal lattice, lattice points, unit cells, and lattice constants.

4.2.2 Polypeptides and Proteins: Polypeptides: Peptide bond. Nomenclature and representation of polypeptides. Merrifield's solid phase peptide synthesis (example of di- and tri- peptides for nomenclature and synthesis). Proteins: General idea of primary, secondary, tertiary and quaternary structures

Module V: Organometallic Chemistry and Reagents and Catalysts 12L

Learning Objective:

- This module is intended to introduce students to chemistry of organo metallic compounds and various reagents along with their uses in organic synthesis.

Learning Outcome:

After completing this course student will be able to

- Design the synthesis of simple organolithium and Gilman reagents.
- Predict its reactivity and formulate its use for synthesis of simple organic compounds
- Predict the reagent for carrying various functional group inter conversion useful in synthesis of a particular molecule.

5.1 Organometallic Chemistry 4L

5.1.1 Organolithium Compounds: Preparation using alkyl/aryl halides. Reactions with compounds containing acidic hydrogen, alkyl halides, carbonyl compounds, cyanides and CO2. Lithium dialkylcuprates: Preparation and reactions with aliphatic /aromatic/vinylic halides.

5.1.2 Organozinc compounds: Preparation of dialkyl zinc. Reaction with water, acid chlorides and alkyl halides. Reformatsky reaction (with mechanism).

5.2 Reagents and Catalysts 8L

5.2.1 Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism).

5.2.2 Catalysts: Catalysts for hydrogenation: Raney Ni, Pt and PtO2: C=C, CN, NO2, aromatic ring; Pd/C: C=C, COCl→ CHO (Rosenmund's); Lindlar catalyst: alkynes; Wilkinson's catalyst for stereo selective reduction of olefins.

5.2.3 Reagents: (1) $LiAlH_4$ and Red-Al: reduction of CO, COOR, CN, NO_2. (2) $NaBH_4$: reduction of CO (3) SeO_2: hydroxylation of allylic and benzylic positions, oxidation of CH2, alpha to CO to CO. (5) mCPBA and R-OOH/H_2O_2 for epoxidation of C=C. (6) NBS: allylic and benzylicbromination of position alpha to CO.

Module VI: Spectroscopy 12L

Learning Objective

- This module will enable the student to elucidate the structure of simple organic compounds using U.V, I.R and NMR spectra.

Learning Outcome

After completing this course student will be able to:

- identify various functional groups on the basis of the U.V and IR spectra.
- predict the electronic environment around different types hydrogen present in the organic compound based on the 1H NMR spectrum.
- predict the structure of simple organic compounds using U.V, IR and 1H NMR spectrum in synchronization and vice versa.

6. Spectroscopy 12L

6.1.1 Introduction: Electromagnetic spectrum, units of wavelength and frequency.

6.1.2 UV- Visible Spectroscopy: Basic theory, solvents, nature of UV-VIS spectrum

6.1.3 IR Spectrocopy: Basic theory, nature of IR spectrum, selection rule, fingerprint region.

6.1.4 PMR Spectroscopy: Basic theory of NMR, nature of PMR spectrum, chemical shift (∂ unit), standard for PMR, solvents used. Factors affecting chemical shift: (1) inductive effect (2) anisotropic effect (with reference to C=C, CΞC, C=O and benzene ring). Spin spin coupling and coupling constant. Proton exchange- application of deuterium exchange, Application of PMR in structure determination.

6.1.5 Spectral characteristics of following classes of organic compounds, including benzene and monosubstituted benzenes, with respect to UV-VIS, IR, PMR: (1) alkenes (2) alkenes and polyenes (3) alkynes (4) haloalkanes (5) alcohols (6) carbonyl compounds (7) ethers (8) carboxylic acids (9) esters (10)amines (11) amides (broad regions characteristic of different groups are expected).

6.1.6 Problems of structure elucidation of simple organic compounds using individual or combined uses of the above spectroscopic technique are expected. (index of hydrogen deficiency should be the first step in solving the problems).

Reference books:

(1)Francis A Carey, Organic Chemistry, Pearson Education, 7th Edition, Tata McGraw Hill, 2008.

(2)Paula Y. Bruice, Organic Chemistry, 3rd ed., Pearson Education, 2007.

(3)Peter Sykes, A guide to mechanism in Organic Chemistry, 6th Edition, Pearson Education, New Delhi.

(4)V.K. Ahluwalia and R.K. Parashar, Organic Reaction Mechanism, 4th ed., Narosa Publications.

(5)P.S. Kalsi, Spectroscopy of Organic compounds, New Age International Ltd, 1995

(6)W. Kemp, Organic Spectroscopy, 3rd Edition, Palgrave, Indian Edition, 2005.

(7)Williams and Fleming, Spectroscopic methods in Organic Chemistry, 5th Ed, McGraw Hill 1995

(8)I.L. Finar, Organic Chemistry, 6th Edition Volume 2 .

(9)Organic Chemistry by Cram and Hammond.

(10)Organic Chemistry by Graham Solomons

(11)Organic Chemistry by Clayden, Greeves, Warren and Wothers (Oxford Press)

Course Title: Organic Chemistry Practicals

Course Code: 20US6CHP3

Course Credit-1

Learning Objectives

The course is intended to introduce

- Separation of a Binary mixture by Physical method.
- Purification by distillation method.
- Preparation of different Organic Compounds

Learning Outcome

After completing this course, a student will be able to

- find the chemical type of mixture in the given Binary mixture.
- Separate the components using distillation technique
- Purify the separated organic compound using distillation.

Binary Mixture Separation:

Separation of mixture containing (VL + NVL) & (S + VL) components.

Organic Preparations:

1. Aniline/p-toluidine → N-Acetyl derivative

2. Salicylic acid/nitrobenzene/ Acetanilide → Nitro derivative

3. β-naphthol → Methyl Ether derivative (Using dimethyl sulphate)

4. Acetanilide → p-bromoacetanilide derivative

5. Aniline/ p-toluidine → Schiff base with benzaldehyde

6. Hydroquinone/beta naphthol → Acetyl derivative

Core Course IV (Paper IV) Semester V

Course Title: Analytical Chemistry
Course Credit- 2 (Teaching: 30 hrs/ 36 L)
Course Code: 20US5CHAC4

After completion of this course a student should be able to
CO1: understand the importance of statistics and its application in chemical analysis
CO2: Learn the basics of separation science and classical chromatography
CO3: Acquire knowledge and applications of different atomic and molecular spectroscopic methods.

Module I: Quality in Analytical Chemistry and Statistical treatment of Data 12L

Learning Objectives

The module is intended to introduce

- Concept of Quality in Analytical chemistry. Quality systems for chemical analysis.
- Introduction to basic statistics and use of it for establishing quality in chemical analysis.
- Use of statistics for data analysis and interpretation of results.
-

Learning Outcome

A student will understand

- The basic concept Quality, role of quality in chemical analysis. Quality control and quality assurance. Quality management systems like ISO, ICH etc.
- Use of simple statistical parameters like mean, mode, standard deviation etc. for interpretation of data.
- Implementation of statistics for rejection of results, concept of errors, types and quantitative measurement of errors.

1.1 Introduction to Quality in Analytical Chemistry 4L

1.1.1 Concept of Quality, definition and requirement

1.1.2 Quality control and quality assurance. Similarities and difference between QC and QA

1.1.3 Introduction to different quality systems: ISO, ICH guide lines and other quality systems and their use.

1.2 Statistical treatment of data 8L

1.2.1 Types of errors, determinate and indeterminate errors, minimization of errors, constant and proportionate errors.

1.2.2 Accuracy and precision, measure of dispersion and central tendency: mean, median, mode, average deviation, relative average deviation, variance, coefficient of variation. (Numerical problems expected)

1.2.3 Determinate and Indeterminate errors, constant and proportionate errors, distribution of random errors, Histogram, Frequency polygon, Gaussian curve, students t, confidence limits and confidence intervals, criteria for rejection of result 2.5 d rule,4.0 d rule, Q-test, F-test, Test of significance method of averages method of least squares. [Numerical problems expected]

Module II: Titrimetric analysis and Introduction to Chromatography 12L

Learning Objectives

The module is intended to introduce

- Two important titrimetric methods viz. Redox titrations and non aqueous titrations
- Introduction to chromatography as a major separation technique.
- Basic principles, usage and applications of planar chromatographic techniques.

Learning Outcome

A student will understand

- The basic theory of redox and non aqueous titrations. Selection of appropriate indicators and applications of both.
- Definition and use of chromatography as a separation technique. Different chromatographic techniques and their classification.
- Basic theory and use of planar chromatographic techniques like Paper chromatography, TLC and HPTLC. Their types and applications.
-

2.1 Titrimetric analysis 7L

2.1.1 Redox titrations: Introduction and basic principles

2.1.2 Titration curves for redox titration: Titration of Fe+2 v/s Ce+4, Fe+2 v/s dichromate (Cr2O72-), Fe+2 v/s MnO-4 ions.

2.1.3 Detection of end point of redox titration using indicators and potentiometrically. Some useful redox indicators.

2.1.4 Non aqueous titrations: Definition and basic principles. Different types of non aqueous solvents.

2.1.5 Requirements for non aqueous solvents. Properties of non aqueous solvents. Leveling effect.

2.1.6 End point detection in non aqueous titrations. Advantages and limitations of non aqueous titrations. Applications.

2.2 Introduction to chromatography 5L

2.2.1 Introduction to chromatographic techniques, classification of chromatographic techniques.

2.2.2 Planar Chromatography: Principle, techniques and applications of Paper chromatography Thin layer chromatography and HPTLC

Module III: Optical methods 12L

Learning Objectives

The module is intended to introduce

- Atomic spectroscopy, different atomic spectroscopic methods like flame photometry and atomic absorption spectroscopy
- Introduction to Molecular fluorescence and phosphorescence methods.
- Basic principles, usage and applications of light scattering techniques like Turbidimetry and Nephelometry

Learning Outcome

A student will understand

- The basic theory of redox and non aqueous titrations. Selection of appropriate indicators and applications of both.
- Definition and use of chromatography as a separation technique. Different chromatographic techniques and their classification.
- Basic theory and use of planar chromatographic techniques like Paper chromatography, TLC and HPTLC. Their types and applications.

3.1 Atomic Spectroscopy 6L

3.1.1 Absorption and emission spectra, energy level diagrams, process involved in atomization,

3.1.2 Flame photometry, flame atomizer, types of burners, monochromators and detectors,

3.1.3 Atomic absorption spectroscopy; flame and electro thermal atomizer, sources, instrumentation, quantitative applications of atomic absorption and flame photometry, calibration curve method and standard addition method.

3.2 Molecular Fluorescence and Phosphorescence Spectroscopy 3L

3.2.1 Basic Theory,

3.1.2 Instrumentation and applications

3.3 Turbidimetry and Nephelometry 3L

3.3.1 Scattering of light, effect of concentration, particle size and wavelength on light scattering,

3.3.2 Instrumentation and applications

Reference books:

1.D. A. Skoog, D.M.West, F.J.Holler Fundamantals of Analytical Chemistry, 8th ed. Philadelphia, Saunders college Publishing, 1996

2.D. A. Skoog, F.J.Holler, T.A.Nieman, Principles of Instrumental Analysis, 6th ed. Philadelphia, Saunders college Publishing, 1996

3.G.D.Christian, Analytical Chemistry, 6th ed. John Wiley &Sons, Singapore, 2004.

4.J.G.Dick, Analytical Chemistry, International Student's Edition, McGraw Hill, Kogakusha Limited, New Delhi, 1973.

5.R.A.Dey & D.L.Underwood, Quantitative Analysis, 6th ed. Prentice Hall Of India Pvt. Ltd. New Delhi, 1993.

6.M.Valcarcel, Principles Of Analytical Chemistry, Springer International Edition, Berlin, 2000

7.E..Prichard, & V. Barwick, Quality Assurance in Analytical Chemistry, Wiley.

8.S. M. Khopkar, Basic Concepts of Analytical Chemistry, 3rd ed,New Age International Publishers, 2008

9.S. M. Khopkar, Analytical Chemistry Problems and Solutions, New Age International Publishers, 2002

Course Title: Analytical Chemistry Practicals

Course Code: 20US5CHP4

Course Credit-1

Learning Objectives

The course is intended to introduce

- Redox titrations for estimation of real samples like Honey
- Complexo metric titrations and estimations using complexometry.
- Non aqueous titrations and Assay of pharmaceutical formulation
- Use of instrumental methods for analysis of real samples like toothpaste.

Learning Outcome

A student will understand

- The correlation between theoretical principles of different types of titration methods and estimation of commercial samples.
- Importance of non aqueous titrations and their relevance for analysis of organic weak acids and bases.

1. Estimation of $K_2S_2O_8$ in the given solution.
2. Determination of glucose in honey by Willstatter's method.
3. Determination of Aluminum by EDTA titration (Back titration). Detection of hardness of water.
4. Determination of percentage assay of Mebendazole drug tablet by non aqueous titration.
5. Detection of fluoride content in a tooth paste by colorimetry
6. Detection of Vitamin C in a tablet by pH metry

Course IV (Paper IV) Semester VI

Course Title: Analytical Chemistry
Course Credit- 2 (Teaching: 30 hrs/ 36 L)
Course Code: 20US6CHAC4

After completion of this course a student should be able to
CO1: understand importance of solvent extraction and other extraction techniques in chemistry.
CO2: Learn about chromatography as a major separation tool in Chemistry
CO3: Learn about polarography and related techniques as a analytical method for sample analysis.

Module IV: Solvent extraction and Solid phase extraction 12L

Learning Objectives

The module is intended to introduce

- Solvent extraction as a major method of separation in analytical chemistry
- basic extraction methods using different extraction mechanism and different extraction methodologies
- Solid phase extraction as a new versatile method of separation.

Learning Outcome

A student will understand

- The basic concept solvent extraction. Different extraction systems and mechanisms
- Experimental extraction techniques, role of pH and selecting appropriate method for desired separation
- Applicability of solvent extraction technique in chemistry
- Solid phase extraction as new method of separation.
-

4.1 Solvent Extraction 8L

4.1.1 Partition coefficient and distribution ratio,

4.1.2Extraction efficiency, separation factor,

4.1.3 Role of complexing agents in solvent extraction, chelation, ion pair formation, solvation,

4.1.4 Types of solvent extraction: batch, continuous. [Numerical problems expected]

4.2 Introduction to Solid phase extraction 4L

4.2.1 Limitations of solvent extraction,

4.2.2 Basic Principles, Equipments used

4.2.3 Applications of Solid phase extraction

Module V: Chromatographic methods 12L

Learning Objectives

The module is intended to introduce

- Basic principles and importance of chromatographic methods
- Gas Chromatography as major method of separation in analytical chemistry.
- Use of High Performance Liquid Chromatography as an Analysis tool for complex separations and estimations
- Ion exchange chromatography as a versatile separation method

Learning Outcome

A student will understand

- The basic principles of chromatography. Different terms and concepts related to chromatographic separations
- Gas chromatography, its instrumental and operational details and applications.
- HPLC as versatile method for separations, qualitative and quantitative analysis
- Ion exchange chromatography and its wide applications in analytical chemistry.

5.1 Gas chromatography **5L**

5.1.1 Gas liquid chromatography, basic principles, retention time, retention volume, resolution, peak width theoretical plates. HETP,

5.1.2 Instrumentation, columns, detectors, applications.

5.2 High Performance Liquid Chromatography **3L**

5.2.1 Instrumentation, types of elution, U.V. and I.R. detector and applications

5.3 Ion Exchange Chromatography **4L**

5.3.1 Types of ion exchangers,

5.3.2 Mechanism of ion exchange, selectivity coefficients and separation factors, capacity and its determination, factors affecting the separation of ions.

Module VI: Elctroanalytical methods 12L

Learning Objective:

The module is intended to introduce

- Introduction of Polarography as a major electro analytical method for analysis.
- Qualitative and Quantitative applications of classical polarography
- Use of Amperometric titration as a tool for rapid analysis.

Learning Outcome:

A student will be able to

- Solve Ilkovic equation for quantitative analysis using polarographic method
- Appreciate the importance of classical polarography with DME as a potent tool to analyze metal ions using electrolytic cells.
- Understand the use of rotating platinum electrode and measurement of current from elctrlytic cell as means of end point determination in the titration of analyte.

6.1 D.C. Polarography 9L

6.1.1 Polarizable and nonpolarizable electrodes,

6.1.2 Basic principles, residual current, diffusion current, limiting current, dropping mercury electrode, supporting electrolyte, half wave potential,

6.1.3 Derivation of the polarographic wave equation for a reversible reaction. Ilkovic equation,

6.1.4 Oxygen interference and its removal, maxima and maxima suppressors, polarographic cell,

6.1.5 Qualitative and quantitative analysis, calibration curve and standard addition method, applications. [Numerical problems expected]

6.2 Amperometric Titrations 3L

6.2.1 Basic principles, rotating platinum electrode and nature of the titration curves,

6.2.2 Applications, advantages and limitations.

Reference books:

1.D. A. Skoog, D.M.West, F.J.Holler Fundamantals of Analytical Chemistry, 8th ed. Philadelphia, Saunders college Publishing, 1996

2.D. A. Skoog, F.J.Holler, T.A.Nieman, Principles of Instrumental Analysis, 6th ed. Philadelphia, Saunders college Publishing, 1996

3.G.D.Christian, Analytical Chemistry, 6th ed. John Wiley &Sons, Singapore, 2004.

4.J.G.Dick, Analytical Chemistry, International Student's Edition, McGraw Hill, Kogakusha Limited, New Delhi, 1973.

5.R.A.Dey & D.L.Underwood, Quantitative Analysis, 6th ed. Prentice Hall Of India Pvt. Ltd. New Delhi, 1993.

6.M.Valcarcel, Principles Of Analytical Chemistry, Springer International Edition, Berlin, 2000

7.E..Prichard, & V. Barwick, Quality Assurance in Analytical Chemistry, Wiley.

8. S. M. Khopkar, Basic Concepts of Analytical Chemistry, 3rd ed,New Age International Publishers, 2008

9.S. M. Khopkar, Analytical Chemistry Problems and Solutions, New Age International Publishers, 2002

Course Title: Analytical Chemistry Practicals

Course Code: 20US6CHP4

Course Credit-1

Learning Objectives

The course is intended to introduce

- Solvent extraction as a major tool of separation
- Use of ion exchange chromatography for estimation of cations.
- Introduction of GC and HPLC for real sample analysis.
- Use of instrumental methods for analysis of real samples like Vinegar

Learning Outcome

A student will understand

- Solvent extraction with different separation mechanisms for separation of desired analyte.
- Importance of ion exchange techniques as separation tool.
- Importance of GC and HPLC as a major separation and estimation techniques in Analytical Chemistry

1. Separation and estimation of Fe(III) and Mg(II) using solvent extraction .

2. Detection of Na^+ ions in a given solution by using cation ion exchanger.

3. Estimation of acetic acid in vinegar by potentiometry.

4. Detection of hardness of water.

5. Demonstration experiments (3U)

a) To study the separation of alcohols/ esters on gas chromatograph and detection of retention time

b) To study the separation of alcohol on HPLC, to calculate HETP from the chromatograph.

DSE 1- Semester V

Course Title: Drugs

Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)

Course Code: 20US5CHDRC5

After completion of this course a student should be able to

CO1: Understand the various terms and concepts used in drug chemistry

CO2: Routes of administration and metabolism of drugs.

CO3: Chemistry of various chemotherapeutic agents and pharmacodynamic agents.

Module I: Introduction to Drug 12L

Learning Objectives:

- This module intends to introduce the students to basic terminologies involved in chemistry of drugs, routes of drug administration and the metabolism of drugs

Learning Outcomes:

After completing the module the student will be able to:

- Understand the terminologies and concepts involved in drug chemistry,
- Recognize the identity, distribution, regulation of the drugs.

1. 1 General Introduction to Drug 6L

1.1.1 Definition of a drug, Requirements of an ideal drug, Classification of drugs (Based on therapeutic action)

1.1.2 Nomenclature of drugs: Generic name, Brand name, Systematic name

1.1.3 Definition of the following medicinal terms: Pharmacon, Pharmacophore, Prodrug, Halflife efficiency, LD50, ED50, Therapeutic Index.

1.1.3 Brief idea of the following terms: Receptors, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia.

1.2. Routes of Drug Administration and Dosage Forms 3L

1.2.1 Oral and Parenteral routes with advantages and disadvantages.

1.2.2 Formulations, Different dosage forms (emphasis on sustained release formulations.)

1.3 Drug Metabolism 3L

Introduction, Absorption, Distribution, Bio-transformation, Excretion Different types of chemical transformation of drugs with specific examples.

Module II: Pharmacodynamic agents 12L

Learning Objectives:

- This module intends to introduce the students to chemistry of pharmacodynamic agents used for various systemic disorders.

Learning Outcomes:

After completing the module the student will be able to:

- Classify the pharmacodynamic agents according to the chemical class and will have knowledge of therapeutic action and side effects of these.

2.Pharmacodynamic agents

- A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical structure, chemical class, therapeutic uses, and side effects.

2.1 CNS Drugs: 2L

Classification based on pharmacological actions Concept of sedation and hypnosis, anaesthesia. Phenobarbitone (Barbiturates), Phenytoin(Hydantoins), Trimethadione (Oxazolidinediones), Piracetam (Pyranones), Midazolam, Alprazolam (Benzodiazepines) Methylphenidate (Piperidines) Chlorpromazine (Phenothiazines) Fluoxetine (Phenyl propyl amines) Synthesis of Trimethadione

2.2 Analgesics and Antipyretics 1L

Morphine (Phenanthrene alkaloids), Tramadol (Cyclohexanols), Aspirin (Salicylates), Paracetamol (p-Aminophenols), Synthesis of Paracetamol.

2.3 Anti-inflammatory Drugs 2L

Mechanism of inflammation and various inflammatory conditions. Prednisolone, Betamethasone (Steroids), AceclofenacandMefenamic Acid (N-Aryl anthranilic acids). Synthesis of Aceclofenac

2.4 Antihistaminic Drugs 2L

Mechanism of histamine release & its action Diphenhydramine (ethanolamines), Cetrizene (piperazine), Chloropheniramine maleate (ethyl amines),Omeprazol, pantoprazole (Benzimidazoles) Synthesis of Cetrizine

2.5 Cardiovascular drugs 2L

Classification based on pharmacological action Enalapril (-amino acids), Isosorbide dinitrate (Nitrates), Atenoldol (Aryloxy propanol amines), Nifedipine (Pyridines), Chlorthiazide (Thiazides),Frusemide /Furosemide (Sulfamyl benzoic acid), Spironolactone (Steroidal- 17- -lactones).

2.6 Antidiabetic Agents 1L

General idea and types of diabetes; Insulin therapy Glibenclamide (sulphonyl ureas), Metformin (Biguanides)

2.7Antiparkinsonism Drugs 1L

Idea of Parkinson's disease. Procyclidine hydrochloride (Pyrrolidines), Ethopropazine hydrochloride (Phenothiazines) Laevodopa (-amino acids)

2.8 Drugs for Respiratory System 1L

General idea of Expectorants; Mucolytes; Bronchodilators Decongestants and Antitussives, Bromhexine (Phenyl methyl amines), Salbutamol, Pseudo- ephedrine (Phenyl ethyl amines) Oxymetazoline (Imidazolines) Codeine Phosphate (Opiates)

Module III: Chemotherapeutic Agents 12L

Learning Objectives:

- This module intends to introduce the students to chemistry of chemotherapeutic agents used for various infectious diseases.

Learning Outcomes:

After completing the module the student will be able to:

- Classify the chemotherapeutic agents according to the chemical class and will have knowledge of therapeutic action and side effects of these.

3.Chemotherapeutic Agents

- Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, and side effects.

3.1 Antibiotics 2L

Definition, Amoxicillin; Cloxacillin (β- lactum antibiotics) Cephalexin (Cephalosporins) Doxycycline (Tetracyclines) Gentamycin (Aminoglycosides) Ciprofloxacin (Quinolones) Synthesis of Ciprofloxacin

3.2 Antimalarials 2L

Types of malaria: Symptoms; pathological detection during window period (Life cycle of the parasites not o be discussed) Chloroquine (3-Amino quinolines) Paludrine (Biguanides) Pyrimethamine (Diamino pyrimidines) Artemether (Benzodioxepins) Following combination to be discussed (i) Sulfadosine-Pyrimethamine (ii) AtremetherLumefantrine (no structure) Synthesis of Paludrine.

3.3 Anthelmintics 2L

Drugs effective in the treatment of Nematodes and Cestodes intestations. Diethyl carbamazine (Piperazines) Mebandazole; Albendazole (Benzimidazoles) Niclosamide (Amides) Synthesis of Albendazole

3.4Antiamoebic Drugs 1L

Types of Amoebiasis Metronidazole; Diloxamide furoate (Furans) Following combination therapy to be discussed: Ciprofloxacin-Tinidazo Synthesis of Metronidazole

3.5 Antitubercular and Antileprotic Drugs 2L

Types of Tuberculosis; Symptoms and diagnosis of Tubeculosis. Types of Leprosy. General idea of Antibiotics used in their treatment. PAS (Aminosalicylates) Isoniazide (Hydrazides) Pyrazinamide (Pyrazines) (+) Ethambutol (Aliphatic diamines) Ethionamide (Thioamides) Dapsone (Sulfonamides) Clofazimine (Phenazines) Following combination therapy to be discussed: (i) Rifampin + Ethambutol + Pyrazinamide (ii) Rifampin + Isoniazide + Pyrazinamide (iii) Rifampin + Clofazimine + Ethionamide. Synthesis: (+) Ethambutol.

3.6 Anti-Neoplastic Drugs 2L

Idea of malignancy; Causes of cancer, brief idea of Immuno Stimulants, Immuno depressants. (1) Lomoustine (Nitrosoureas) (2) Fluorouracil (Pyrimidines) (3) Estrogen (Steroidal hormones) (3) Mitomycin C (Antibiotics) (5) Vincristine; vinblastine; vindesine (Vinca alkaloids-no structures)

3.7Anti HIV Drugs 1L

Idea of HIV pathogenecity, Symptoms of AIDS, AZT, Lamivudine, Stavudine (Pyrimidines), DDI (Purines)

Course Title: Drugs Practicals

Course Code: 20US5CHP5

Course Credit-1

Learning Objectives

The course is intended to introduce the learner to

- Preparation of Drugs and Drug intermediates
- Estimation of Drugs

Learning Outcome

After completing this course, a student will be able to

- Use simple reactions to synthesize drugs and drug intermediates
- Estimate the drugs quantitatively by titrimetry.

Preparation:

1) Preparation of Aspirin from Salicylic Acid

2) Preparation of p-Nitroacetanilide from Acetanilide

3) Preparation of p-Nitroaniline from p- Nitroacetanilide

Estimation:

1) Estimation of Tincture of Iodine

2) Estimation of Ibuprofen

Project

1)Representation of monogram of any one drug from syllabus by I.P. method

2)Industrial Visit (Pharmaceutical company)

Reference books:

1) Pharmacology and pharmaceutics Vol.I and II, Satoskar.

2) Textbook of organic, medicinal, and pharmaceutical chemistry, Wilson and Gisvold.

3) Textbook of medicinal chemistry, William O. Foye and David A. William.

4) Medicinal chemistry, G. R. Chatwal

DSE 2 - Semester V

Course Title: Research Methodology
Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)
Course Code: 20US5CHRMC6

After completion of this course a student should be able to
CO1: Identify the various type of research
CO2: Apply digital tools available on Google app.
CO3: Developing basic skills set required for statistical treatment of research data.
CO4: Recognize the importance of safety measures during research

MODULE I: Research Methodology: An Introduction 12L

Learning Objectives

The module is intended
• To understand research terminology
• Be aware of the ethical principles of research, ethical challenges and approval processes
• Describe quantitative, qualitative and mixed methods approaches to research

Learning Outcome

• A student will understand and identify objective and significance of research.
• A student will understand about Plagiarism and the restrictions in research,

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method Research Design
Importance of Knowing How Research is Done, Research Process, Criteria of Good Research
Ethical issues:
Plagiarism, Restriction to Plagiarism, concept of patents and trademarks

MODULE II: Data Analysis The Investigative Approach 12L

Learning Objectives

The module is intended
• To understand importance and use of statistical treatment of research data

Learning Outcomes

• Students will develop the skills of using data analysis for treatment of research data

Testing of hypothesis: Basic definition (Null hypothesis, alternate hypothesis, critical region, acceptance region, Probability of type I and Type II errors, Level of significance P value,
Type of Test: parametric, non parametric, comparison between sample mean and population mean, comparison between two sample means, Chi square test

Analysis of variance (ANOVA) for one way, Correlation and regression, Curve fitting, fitting of linear equations

MODULE III: Chemical Safety and Ethical Handling of Chemicals 12L

Learning Objectives

- Help students develop an understanding of the principles of chemical safety
- Enable students to apply these concepts when working in a laboratory.
- Encourage the scientific community to keep safety a high priority

Learning Outcome

- Recognize the Hazards
- Assess the Risks
- Minimize the Risks
- Prepare for Emergencies from Uncontrolled Hazards

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation.

Material Safety Data Sheet (MSDS), Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage.

Safe disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

Course Title: Research Methodology Practicals

Course Code: 20US5CHP6

Course Credit-1

Learning Objectives

The course is intended to introduce the learner to,

- Review research article from different sources
- Carry out research project
- To write scientific reports and
- Presentation of research outcomes by using power point presentations

Learning Outcome

After completing this course, a student will be able to

- Write scientific reports for their projects.
- Communicate their project report in power point presentations.
- To apply research method and perform short term research project

Reading of the three research articles.

Power point presentation based on any Chemistry related research article.

Write a T.Y. B.Sc. project report in a scientific method

Submit the progress report for the project.

Power point presentation of the project finding.

References

1) Thesis and assignement writing- J. Anderson, B. H. Dursten and M. Poole, Wiley Eastern 1977.

2) A Handbook of methodology of Research- P. Rajammal and P. Devadoss, R. M. M. Vidya Press1976

3) The craft of scientific writing-Michael Alley (Springer).

4) Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) Practical skills in chemistry. 2nd Ed. Prentice-Hall, Harlow.

5) Hibbert, D. B. & Gooding, J. J. (2006) Data analysis for chemistry. Oxford University Press.

6) Topping, J. (1984) Errors of observation and their treatment. Fourth Ed., Chapman Hall, London.

7) Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3-5.

8) Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis. Cambridge Univ. Press (2001) 487 pages.

9) Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.

10) OSU safety manual 1.01.

DSE 3 - Semester VI

Course Title: Dyes

Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)

Course Code: 20US6CHDYC5

After completion of this course a student should be able to

CO1: Identify the essential properties of dyes

CO2: Relate the colour with structure of dyes and recognize the toxic effects of dyes.

CO3: Describe the dyeing techniques and methodologies involved in the manufacture of dyes.

Module I: Introduction to Dyestuff 12L

Learning Objective

- The module is intended to introduce the basic aspects of dyestuff chemistry.

Learning outcome

After completing the module the student will be able to

- understand the important properties of dyes
- relate the names of dyes with its properties and application
- classify the based on their mode of application to the substrate

1.1 Introduction to Dyestuff Chemistry 6L

1.1.1 Important landmark in the history of dyes:

1.1.1.1Natural colouring matter and their limitations:e.g,; Heena, Turmeric, kesar, Chlorolphyll, Indigo, Alizarine from roots of madder plants, Logwood. Tyrian purple.

1.1.1.2Synthetic Dyes: Important milestones, i.e. Mauve, Diazotization, aniline Yellow, Congo Red, Synthesis and structure of Indigo, disperse Dye, fluorescent Brighteners, procion reactive Dyes, Remazole Dyes. (Emphasis on Name of the Scientist and dyes and the year of the discovery is required and structure is not expected)

1.1.2 Definition of dyes, Propertiesi.e. colour, chromophore and auxochrome, Solubility, Linearity, Coplanarity, fastness properties, substantivity, and Economic viability.

1.1.3 Explanation of nomenclature of commercial dyes with atleast one example. Suffixes-G, O, R, B, 6B, GK, 3GK, 6GK, L, S Explanation: naming of dyes by colour index(two examples)

1.2Classification Based on Application 6L

Definition, fastness properties & applicability on substrates examples with structures (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, Victoria Blue B (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes-Diazo components; Fast yellow G,Fast orange R. Coupling components. Naphtol AS, Naphthol ASG (e) Mordant Dyes-Erichrome Black A, Alizarin. (f) Vat Dyes- Indanthrene brown RRD, Indanthrene Red 5GK. (g) Sulphur Dyes- Sulphur Black T (no structure) (h) Disperse Dyes-Celliton Fast brown 3R, perlon fast blue FFR (i) Reactive Dyes-cibacron Brillant Red B, procion briilant Blue HB.

Module II: Properties of dye 12L

Learning Objective

- The module is intended to relate the colour property of dye with its structure

Learning outcome

After completing the module the student will be able to

- Identify the principles of color theory as it relates to structure,
- recognize the use of dyes as optical brightners and pigments
- review the toxic effects caused by dyes and dye intermediates

2. 1 Colour and chemical constitution of dyes 5L

2.1.1 Absorption of visible light, colour of wavelength absorbed, complementary colour.

2.1.2 Relation between colour and chemical constitution. (i) Witt's Chromophore theory (ii) Armstrong theory (quinonoid theory) and its limitations (iii) Valence Bond theory; Comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenze, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones. (iv) Molecular Orbital Theory.

2.2 Optical Brighteners 2L

General idea and important characteristics of optical brighteners, one example each with structure of the following classes: Stilbene, Coumarin, Heterocyclic vinylene derivatives, Diaryl pyrazolines, Naphthalimide derivatives.

2.3 Organic Pigments 2L

General idea, distinguish between dyes and pigments, important characteristics of organic pigments, Toners, Lakes, Classification of organic pigments with suitable examples, i.e. Ionic pigments-Lake of acid and basic dyes. Nonionic pigments-Azo, Indigoid, Anthraquinone, Quinacridone, Phthalocyanine (Copper phthalocyanine).

2.4 Ecology and Toxicity of Dyes 3L

With reference to the textile dyes, food colours, cosmetic dyes, benzidine, phenylene diamines.

Module III: Syntheses of dyes 12L

Learning Objective

- The module is intended to illustrate the characteristic properties and syntheses of specific non-textile dyes and explain the various dyeing techniques

Learning outcome

After completing the module the student will be able to

- list the non-textile uses of dyes
- justify characteristic properties of dyes according to their application.
- identify the various unit processes involved in organic chemistry for the synthesis of dyes having non textile applicationsunderstand the various dyeing techniques for different textiles and the forces involved in their substantivity.

3.1 Non-textile Uses of Dyes 5L

Structural features of the substrate, fastness and other property requirements and main classes of dyes used to be mentioned as applicable (One example of each Class with structure expected).

1. Leather -Bismark Brown
2. Paper- Auramine O
3. Foodstuff - Tartazine
4. Cosmetics-4'-Amino Diphenylamine-4-sulphonic acid
5. Medicinal - Crystal Violet
6. Biological Stains - Methylene Blue
7. Indicator & Analytical Reagents- Eriochrome Black T
8. Coloured Smokes & Camouflage colours-Purpurin
9. Laser Dyes –Rhodamine G

3.2 Synthesis and Uses of Specific Dyes- 3L

- Brief Idea of Unit Process, Unit Operations and Intermediates.
- Bismark Brown from Benzene via m-phenylene diamine
- Auramine O from Benzene via Aniline
- Tartazine from aniline via phenyl hydrazine-4-sulphonic acid
- Crystal Violet from Aniline.
- Methylene Blue from Aniline and 4-Amino-N,N-Dimethyl aniline
- Eriochrome Black T from Napthalene.

3.3 Types of Fibres and Classes of Dyes Applicable to them 1L

Introduction to the following types of fibres with structures and classes of dyes applicable to it. Cotton, Wool, Silk, Polyester.

3.4 Dyeing Method and Dye Fibre Forces 3L

3.4.1 (i) Direct dyeing (ii) Vat dyeing (iii) Mordant dyeing (iv) Disperse dyeing

3.4.2 Forces binding of dyes to the fibres: Ionic forces, Hydrogen bonds, Vander-Wall's forces, Covalent linkages.

Course Title: Dyes Practicals

Course Code: 20US6CHP5

Course Credit-1

Learning Objectives

The course is intended to introduce the learner to

- Preparation of Dye and Dye intermediates
- Estimation of Dyes

Learning Outcome

After completing this course, a student will be able to

- Use diazotization and coupling reaction to synthesize different azo dyes.
- Estimate the dyes quantitatively using the technique of diazotization and colorimetry.

Preparation

1. Preparation of Orange-II
2. Preparation of m-nitroaniline

Estimation

1. Estimation of Primary amino group by diazotisation
2. Estimation of Methyl Orange/ Eriochrome Black T/Eosin/Congo Red by colorimetry.

Dyeing of fabric (cotton) by Direct Dyeing or by Vat Dyeing

Reference books:

(1) Chemistry of synthetic dyes, Vol. I to VI, K. Venkataraman
(2) Chemistry of synthetic dyes and pigments, H. A. Lubs
(3) Colour Chemistry, H. Zollinger
(4) Colour Chemistry, R. L. M. Allen
(5) Unit process, Groggins
(6) Synthetic dyes, M. S. Yadav
(7) Physical Chemistry of dyeing, Thomas Vickerstaff
(8) Chemistry of dyes and principles of dyeing, V. A. Shenai
(9) Practical Organic Chemistry, A. I. Vogel

DSE 4 Semester VI

Course Title: Polymers
Course Code: 20US6CHPLC6
Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)

The course examines the use of polymers and explains how their properties are controlled by their molecular structure. Students will understand how this structure determines which polymer to use for a particular product. You will also explore different recycling technologies used and the how the use of polymerisation can be used to control the structure of polymers.

After completion of this course a student should be able to
CO1: understand polymer nomenclature classification and molecular structure.
CO2: Recognize the structure, stereochemistry and factors affecting the shape and size of polymers
CO3: Aware about environmental impact assessment, circular economy, sustainability tenets and different recycling technologies

Module I: Concepts and Methods in Polymer Science 12L

Learning Objectives

The module is intended to

- make aware of today's market place of polymers.
- understand the Polymer nomenclature and classification.
- understand polymer molecular structure and polymerizabilty of monomers.

Learning Outcome

A student will be able to

- know the history of polymers and its market value.
- classify and name different polymers based on different factors such as sources, thermal properties
- earn polymer molecular structure .

I. Concepts and Methods in Polymer Science

1.1. Development of polymer science as a discipline. Why polymers? Today's market place ofpolymers. History of polymers. Fundamental terms.
1.2. Macromolecular hypothesis. Polymer nomenclature and classification based on factors - sources, thermal properties, chain type, polymerization processes, applications, Copolymers, Blend IPN Dendrite, Ladder polymers.
1.3. Molecular structure and polymerizabilty of monomers. Monomer raw materials. Polymer molecular weight. Number-Average and weight-average molecular weight. Molecular weight distribution Polydispersity index.

Module II: Polymer Structure and Properties 12L

Learning Objectives

The module is intended to

- familiarize the structure and factors affecting the shape and size of polymers.
- understand the stereochemistry of polymers.
- understand physical and chemical methods for the determination of microstructures

Learning Outcome

A student will be able to

- Differentiate primary, secondary, tertiary and quaternary structures of polymers. .
- Learn configurations and conformations of polymers.
- Understand different methods to find out the microstructures of polymers. Familiarize the design tailored functional polymers for specificapplications.

2. Polymer Structure and Properties

2.1. Structural studies of polymers. Factors influencing the shape and size. Primary, secondary, tertiary and the quaternary structures.

2.2. Stereochemistry of polymers. Molecular interactions. Configurations and strength conformations. Stereochemistry of repeating units. Chiral centres. Tacticity. Repeat unit isomerism. Optical, geometric and substitutional isomerism.

2.3. Physical and chemical methods for the determination of microstructures. Polymer crystals

Structure-Property-Performance relations. Cross-linking. Structure-property relations in cross linked functional copolymers. Design of tailored functional polymers for specific applications.

Module III: Polymer-Plastic Industry and Sustainability 12L

Learning Objectives

The module is intended to

- familiarize the environmental impact assessment.
- understand the concept of circular economy and sustainability tenets.
- Familiarize different recycling technologies.

Learning Outcome

A student will be able to

- Understand the environmental impact assessment.
- Learncircular economy,sustainability tenets.
- Understand different methods of recycling technologies.

3. Polymer-Plastic Industry and Sustainability:

3.1. Market place of polymers and plastics; Environmental Impact Assessment; Ecological footprint.

3.2. Concept of circular economy; sustainability tenets; Life Cycle Analysis Methodology.

3.3. Recycling Technologies: Feed preparation, recycling and application. Additives, processing aids and compatibilizers. Waste segregation technology for industrial plastics.

Circular economy of plastics recycling. Enhancing properties of recycled plastics. Polymeric green materials. Self-destructing plastics and sustainable polymers.

Course Title: Polymer Practicals

Course Code: : 20US6CHP6

Course Credit-1

Learning Objectives

The course is intended to introduce

- Viscosity measurements for the molecular weight determination of polymers.
- Experiments to identify different types of polymers.
- Experiments to determine saponification value o, iodine value and acid number of resins.

Learning Outcome

A student will understand

- The relationship between concentration and coefficient of viscosity and how to determine molecular weight from viscosity measurements.
- Different types of polymers and their identification methods.
- Saponification value and its determination for polymers.
- Iodine value and its determination for resins
- Acid numberand its determination for resins.

1. Determination of molecular weight of PVA by viscosity measurement.
2. Identification of polymers
3. Determination of saponification value of Polyester
4. Determination iodine value of resin.
5. Determination Acid number of resin.

DSE 5 Semester V

Course Title: Essentials of Radiation Chemistry (OPTIONAL FOR DRUGS)
Course Code: 20US5CHERC5
Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)

The course examines the basics and applications of radiation chemistry and Students will understand how the nuclear radiations can be used for peaceful and constructive purpose.

Module I: Nuclear Energy 12L

Learning Objectives

The module is intended

- To focus on constructive and peaceful uses of nuclear radiations
- Make the students aware of energy generation using nuclear energy
- To understand the nuclear reactions.

Learning Outcome

A student will be able to

- know the fusion and fission reactions.
- classify and name different types of nuclear reactors.

I. Nuclear Energy

1.1.1 Radioactivity, Nuclear radiations and it's importance, Nuclear reactions, Nuclear fission and Nuclear fusion (4L)
1.1.2 Introduction to Nuclear Reactors (2L)
1.1.3 Energy production in nuclear reactor (3L)
1.1.4 Indian Nuclear energy program. (3L)

Module II: Radiation Chemistry 12L

Learning Objectives

The module is intended

- Make the students aware of applications of radioisotopes.
- To understand the radiation units and radiological protection.

Learning Outcome

A student will be able to

- Know the applications of radioisotopes.
- Know about the effects of radiations and methods of protection.

2.Radiation Chemistry

2.1.1 Applications of radioisotopes in healthcare an effect of radiations (2L)
2.1.2 Diagnostic applications, Radiopharmaceuticals, Therapeutic Applications (3L)
2.1.3 Radiation Units, Measurement of Exposure and dose, Biological effects of Ionizing Radiations (3L)

2.1.4 Radiological protection (2L)
2.1.5 Handling of radioisotopes (2L)

Module III: Radioactive Waste Management 12L

Learning Objectives

The module is intended

- Make the students aware of radiation protection.
- To classify the radioactive waste.

Learning Outcome

A student will be able to

- Create awareness about nuclear radiations
- Know about the types of radioactive waste and the disposal methods.

3. Radioactive Waste Management

3.1.1 Protection of Human Health, Protection of Environment, Protection of Future Generations (2L)
3.1.2 Classification of radioactive waste, Waste classification by IAEA, Exempt Waste, Short lived Waste, Low level Waste, Intermidiate level waste, High level waste, Waste Categorization in India. (2L)
3.1.3 Treatment of radioactive waste Gaseous effluents, Treatment of organic Liquid Effluent, Treatment of Wet Solids, Treatment of solid Wastes (2L)
3.1.4 Radioactive waste disposal (2L)
3.1.5 Disposal of Low and Intermediate Level Waste, Storage of High Level Waste(2L)
3.1.6 Disposal of High Level Waste, Treatment of Liquid Waste (2L)

Course Title: Essentials of Radiation Chemistry

Course Code: 20US5CHP5

Course Credit-1

Learning Objectives

The course is intended to introduce

- To Determine Plateau of GM counter.
- Experiments to determine Dead Time of GM counter
- Carry out Statistical Analysis of Radioactivity Measurements
- To Determine Range of alpha particles for the given source

Learning Outcome

A student will understand

- How to determine Plateau of GM counter.
- How to determine Dead Time of GM counter
- To Carry out Statistical Analysis of Radioactivity Measurements
- To find Range of alpha particles for the given source

Experiments

1. Determination of Plateau of GM counter
2. Determination of Dead Time of GM counter
3. Statistical Analysis of Radioactivity Measurements
4. Determination of Range of alpha particles for the given source

DSE 6- Semester V

Course Title: Environmental Chemistry
(OPTIONAL FOR RESEARCH METHODOLOGY)
Course Credit- 2 (No. of Teaching 30 hrs / 36 L)
Course Code: 20US5CHENC6

Learning Objectives:

After completion of this course the student should be able to

CO1: Understand the basic concepts of Environmental Toxicology
CO2: Recognize the different Sources and control technologies of Air and Water pollution
CO3:Learn about Soil fertility and classical and instrumental methods of Soil analysis.

Module– I: Environmental Toxicology 12L

Learning Objective:

The module is intended to introduce the types of organic and inorganic toxic substances and their effects on individuals and environment

Learning Outcome:

A student will understand the basics concepts toxicology, different types of toxicants in our daily lifeand risk analysis.

1.1 Introduction too toxic substances and toxicity: Meaning of some important terms used in toxicology, types of toxic substances common environmental toxicants, hazardous waste , Teratogenesis, mutagenesis and carcinogenesisand Neurotoxins. (3L)

1.2 Effects of Metal ion toxicity and Risk analysis (3L)

Effects of Toxic substances on Individuals: Biochemical effects, Observable physiological effects, Reversible and Irreversible effects, Effect on immune system ,

Effects after exposure: Acute, subacute and chronic toxic effects

Risk analysis : Toxicity tests, Dose response curve , Effective and Lethal dose , NOAEL and LOAEL

Mechanism of metal ion toxicity: Possible ways of generation of toxicity due to heavy metal ions, Chemical speciation, Biomethylation

1.3 Toxicity of various chemicals: (6L)

1. Heavy metals-As, Hg (case study of Minamata episode) Pb,Cd (2L)
2. Non metals – SOx, NOx, CO (2L)
3. Organic – Benzene, Formaldehyde and acetaldehyde , Phenols, Nitrosamines, Isocyanateand methyl Isocyanate (Case study of Bhopal gas tragedy), organophosphates and carbamates, Dioxins PCB,PAH (2L)

Module– II: Environmental Pollution control technologies 12L

Learning Objective:

The module is intended to introduce the different types of air and water pollution control technologies

Learning Outcome:

A student will understand the different sources of air and water pollution and different chemical technologies for their treatment.

2.1 Air Pollution Control Techniques (6L)

Contaminants and pathways into atmosphere: Carbon Monoxide; Oxides of nitrogen; Sulphur Dioxide; Volatile Organic Compounds

Instruments techniques to monitor pollution: Carbon Monoxide; Oxides of nitrogen; Sulphur Dioxide; Volatile Organic Compounds;

2.2 Major Sources of Water Pollution (2L)

Possible reasons for groundwater and subsurface water contamination,

Major sources : Coal Mine Drains, Pesticides and Fertilizers, Dying and Tanning industries

Eutrophication: Sources and effects, Biomagnification

2.3 Water Pollution Treatment (5L)

1.Introduction to Sewage treatment Plant and Effluent treatment Plant

2.Technological Approach: Chemical Degradation of wastes and Chemicals; . Coagulation and flocculation; Photocatalytic degradation of pollutants;. Supercritical water oxidation

Ref: https://nptel.ac.in/courses/104103020/33

Module– III: Soil Fertility and soil Analysis 12L

Learning Objective:

The module is intended to introduce the Plant nutrients, soil fertility parameters and soil analysis

Learning Outcome:

A student will learn the significance of the soil health, plant nutrients and different methods of soil analysis

Soil Fertility and soil Analysis

3.1 Introduction to soil profile, major soil types in India, classification of soils and their agricultural importance, problem soils, soil composition, soil fertility, Soil health and reasons for deterioration of soil health (4L)

3.2. Plant nutrients and their functions-primary, secondary and micro nutrients and their forms in soil, fate of nutrient elements in soil -Crop removal, Erosion, Leaching, Volatilization, De-nitrification and Fixation. Deficiency symptoms of nutrients in plants ,soil fertility rating, Nutrient index, Balanced fertilization, (4L)

3.3. Soil analysis:Soil sampling techniques, preparation of soil samples, Soil pH, Soil Organic carbon,Soil Organic matter, Soil Organic carbon and climate change,Extraction and analysis of available nutrients(N,P,K) and micronutrients by instrumental analysis AAS, ICP-AES etc. Interpretation of soil analysis data-soil Health card scheme of govt of India. (4L)

Semester V

Course Title: Environmental Chemistry Practical
Course Credit- 1
Course Code: 20US5CHP6

Learning objective:

The laboratory course is designed for

- Developing Skills for analytical techniques of environmental monitoring

Learning outcome :

After learning the student will be able to

- Perform the soil and water analysis
- Recommend the plants suitable for improvement of air quality Experiments

1. To determine Air Pollution Tolerance Index (APTI) for a given plant species for its use in pollution control as well as pollution indicator
2. Evaluation of low cost adsorbent from non-toxic agricultural waste and study of adsorption capacity for removal of methylene blue dye from the waste water sample for tertiary treatment processes.
3. Estimation of chloride in water sample by Mohr's method.
4. Estimation of Soil organic carbon , soil pH and Bulk density
5. Estimation of Phosphorous from a soil sample
6. Estimation of potassium from a soil sample

MOOCs -Online Courses
Ref: https://nptel.ac.in/courses/126105016/36 accessed on 18th May 2019
Ref: https://nptel.ac.in/syllabus/syllabus_pdf/104103020.pdfaccessed on 18th May 2019
Ref: https://nptel.ac.in/courses/104103020/33accessed on 18th May 2019

Books:

1. Manahan, Stanley E. 'Fundamentals of Environmental Chemistry ' Boca Raton: CRC Press LLC,2001
2. Sonja Krause, Herbert M. Clark, James P. Ferris, Robert L. 'Strong Chemistry of the Environment ', Elsevier Science & Technology Books 2002
3. Eugene R. Weiner Applications of Environmental Chemistry 2000 CRC Press, LLC
4. By Clair N. Sawyer, Perry L. McCarty, Gene Parkin 'Chemistry for environmental engineering and science' (5th edition) McGraw-Hill Professional
5. Soil testing in India

DSE 7 - Semester VI

Course Title: Pesticides Chemistry (OPTIONAL FOR DYES)
Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)
Course Code: 20US6CHPSC5

CO1: To create awareness on pesticide chemicals and their applications.
CO2: After completion of this course the student will be know the chemistry of pesticides and will be able to analyse the pesticides.

Module I: Introduction to pesticides 12L

Learning objectives:
This module is intended to introduce classification, effects and activity of pesticides.

Learning outcomes:
After completing the module the student will be able to:
1. Classify the pesticides according to their origin and the chemical classes.
2. Understand the adverse and beneficial effects of pesticides.
3. Relate activity with the structure

1. General introduction to pesticides (natural and synthetic), different types of pesticides-fungicides, insecticides, herbicides (4L)
2. Benefits and adverse effects, changing concepts of pesticides, pesticides classified as potential carcinogen by US-EPA (5L)
3. Structure activity relationship (3L)

Module II: Fungicides and insecticides 12L

Learning objectives:

- This module is intended to introduce synthesis and technical manufacture of Fungicides and insecticides

Learning outcomes:

After completing the module the student will be able to:

- Understand various aspects of synthesis and technical manufacture of Fungicides and insecticides

2.Fungicides and insecticides

2.1.1 Introduction, properties, applications, formulations of some currently used fungicides and insecticides

Module III: Herbicides and fertilizers 12L

Learning objectives:

- This module is intended to introduce synthesis and technical manufacture of Herbicides and fertilizers.

Learning outcomes:

After completing the module the student will be able to:

- Understand various aspects of synthesis and technical manufacture of Herbicides and fertilizers.

1. Introduction, properties, applications, formulations of some currently used Herbicides and fertilize

Course Title: Pesticides Practicals

Course Code: 20US6CHP5

Course Credit-1

Learning Objectives

The course is intended to introduce the learner to

- Preparation of pesticides
- Estimation of pesticides

Learning Outcome

After completing this course, a student will be able to

- Use simple reactions to synthesize simple pestides
- Estimate the acidity/ basicity of pesticides quantitatively by titrimetry.

Estimation

1. To calculate acidity in given sample of pesticide formulations as per BIS specifications.
2. To calculate alkalinity in given sample of pesticide formulations as per BIS specifications.

Preparation:

1. Preparation of simple organophosphates.
2. Preparation of simple phosphonates.
3. Preparation of simple thiophosphates.

Reference Book:

• R. Cremlyn: Pesticides, John Wiley.

DSE 8 Semester VI

Course Title: Industrial Chemistry (OPTIONAL FOR POLYMERS)
Course Code: 20US6CHINC6
Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)

This course is intended to make the students aware about general aspects of chemical industries. Chemistry plays an important role in the manufacture of large number of products. A small portion of this production is covered under industrial chemistry.

Course Objectives:

A student will be able to study

- Chemical production, quality control and process control involved in industry.
- different types of fuels.
- To train students who will be employable in the industries and who can also be self employed.
- To produce graduates who can exploit the abundant natural resources of this country for the benefit of the society.

Course Outcome:

By the end of the course, student will be able to

CO1:understand basic requirement of chemical industries, chemical production and unit process.

CO2:describe characteristics of fuel and sugar, various process involved in fuel and sugar industries.

Module I: Manufacture of Ammonia, Sulphuric acid & Nitric Acid 12L

The module is intended to

- Study Physico-Chemical principles involved in manufacture of ammonia, sulphuric acid & nitric acid make aware of today's market place of polymers.

Learning Outcome

A student will be able to

- Learn the process involved in Haber & Bosch process for the manufacture of ammonia, contact process for sulphuric acid & Ostwald's process for nitric acid.
- Study applications of ammonia, sulphuric acid and nitric acid.

1. Manufacture of Ammonia, Sulphuric acid & Nitric Acid

- Physico-Chemical principles involved in manufacture of ammonia, sulphuric acid & nitric acid. (3L)
- Manufacture of ammonia by modified Haber & Bosch process with flow-sheet. Uses of ammonia. (3L)

- Manufacture of sulphuric acid by contact process with flow sheet. Uses of Sulphuric acid. (3L)
- Manufacture of nitric acid by Ostwald's process with flow sheet. Uses of nitric acid. (3L)

Module II: Fuels 12L

Learning Objectives

The module is intended to

- make the students familiar with fuels.
- Understand importance of depletion in the abundance of natural resources of this country for the benefit of the society.

Learning Outcome

A student will be able to

- Classify fuels in to different types.
- Understand different physical and chemical properties of fuels.

2. Fuels

Introduction, definition, classification of fuels, criterion of selection of fuel. (2L)
calorific value, determination of calorific value by Bomb calorimeter and problems based on it. Other properties of fuel – ignition temperature, flash point, fire point, coke number, viscosity. (4L)
Solid fuels – coal, destructive distillation of coal, chemicals from coal. By products of coal, coking of coal, distillation of coal tar, uses of tar products. Liquid fuels – distillation of crude oil, petrol gasoline and diesel oil. Gaseous fuels – Biogas or gobar gas, LPG. (4L)
Fuel cells – methanol fuel cell, hydrogen fuel cell. (2L)

Module III: Sugar and Fermentation 12L

Learning Objectives

The module is intended to

- make the students familiar with organic industries like sugar.
- Understand importance of sugar industry and fermentation process.

Learning Outcome

A student will be able to

- Manufacturing process involved in sugar industry.
- Utilization of byproducts of sugar industry.
- Fermentation process and operations.

3.1. Sugar 6L

Importance of Sugar industry, Manufacture of raw sugar from sugar cane with flow sheet, extraction of juice, compound imbibition process, concentration by multiple compound imbibition process, concentration of multiple evaporators, crystallisation (single vacuum pan) Refining of raw sugar in brief, utilisation of byproducts of sugar industry.
Estimation of sugar by Brix hydrometer &refractomer.

3.2 Fermentation **6L**

Definition, conditions favourable for fermentation, fementation operation, requirements for fermentation processes.
Manufacture of alcohol from molasses, coffey still, proof spirit, rectified spirit, absolute alcohol. Other useful fermentation products with respect to medium organism etc., Acetic acid, vinegar, citric acid etc.

Course Title: Industrial Chemistry Practicals

Course Code: 20US6CHP6

Course Credit-1

Learning Objectives

The course is intended to introduce

- How to analyze different commercial samples
- Working of chemical industry.

Learning Outcome

A student will understand

- Moisture content measurements for the fuel.
- Experiment to determine strength of given commercial sample of acid.
- Experiments to determine glucose content in the given sample

1. To determine the moisture content in the given sample of fuel.
2. To determine strength of given commercial sample of acid.
3. To determine glucose content in the given sample by Folin-Wu method.
4. Visit to industry

SEC I: SEMESTER V

COURSE TITLE: Business Skills For chemist

COURSE CODE: 20US5CHBSC7

CREDITS - 02

Preamble

Chemistry is an "enabling science" i.e. chemistry facilitates other sciences, research and manufacturing. The chemicals industry is at the heart of manufacturing. It is essential to impart knowledge and skills that are required by students to be market ready as individual businessmen or as an asset to many organizations. This course is therefore designed for chemistry undergraduates who are thinking about a commercial Chemistry-related career. The course will be taught using the specialised context of chemistry-related industries to investigate the applications of business skills and commercial awareness. This course is designed to improve their Chemistry-related business skills by **distance learning**.
Ref:http:http://www.rsc.org/learn-chemistry/resources/business-skills-for-chemists/OnlineCourse/

UNIT **Chemistry in Industry** 5 Hrs

Chemists find roles in a wide range of business environments, much wider than traditional destinations such as the heavy chemical industry, petrochemicals and pharmaceuticals. The range of sizes of business spans everything from organisations with teams of chemists to others where there might be a single qualified chemist. This topic aims to highlight the current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies.

Learning Objective

- To introduce how chemistry impacts our everyday life
- To highlight the economic position of the chemistry-using industries in India and within the global economy
- To highlight the current and future challenges which face the chemistry-using industries
- To show where chemistry research is making a difference to solve some of the global challenges which face this industry, contributing to the "green economy"

Learning Outcome

The successful learners will be able to

1. Enlist at least 10 chemistry industry careers
2. Name at least ten chemistry using industries in India and their economic position in global economy
3. Discuss major challenges faced by the chemistry using industries.
4. Demonstrate the use of chemistry in reduced carbon emissions and pollution, enhanced energy and resource efficiency

Detailed syllabus

1. Importance of chemistry in our life, introduction to global chemical economy, Current Challenges faced by the Chemistry Using Industries,
2. Drivers for innovation, introduction to the concepts of Green economy and circular economy

Intellectual property 5 Hrs

The world of chemistry and pharmacy is developing tremendously. New ideas are continuously converted into valuable inventions and improvements. Protection of intellectual property is a must in these fields. This unit aims at introducing different types of intellectual property viz. copyrights-creative works, trademarks-brands &logos, Design-Appearance, patents-technical invention, trade secrets etc.

Learning Objective

The student will be able to

- Describe different features of IPR
- Explain how to get a patent
- Describe how patent is enforced

Learning Outcome

After completion of the course the successful learners will be able to

- Differentiate between different types of IPRs
- Demonstrate the patenting procedure with few examples
- Give some ideas for commercialization of patented technology

Detailed syllabus –

1. Intellectual property issues from a business perspective, important features of IPR, Patenting an invention, how to get a patent.
2. Patenting abroad, commercializing patented technology, Enforcing patent

Unit 2 **Business Basics** 10 Hours

This topic aims to introduce some of the basic skills viz. communication, planning, productivity and creativity required to develop a business plan.

Learning Objective

The student will be able to

1.Analyse the nitty-gritties ofsome of the chemical industries

2.to explain how a business plan is prepared

3.to generate swot analysis of a business

Learning Outcome

After learning this module successful learner will be able to
1.perform detail analysis of challenges basic business ,opportunities the at least one of the chemical industries
2.prepare a business plan for one of the product /services
3. perform SWOT analysis

Detail syllabus –Sub Units

Basic rules of business
1. Components of a business plan- executive summary
2. Background
3. Key personnel
4. Operations
5. Marketing
6. Financial plan
7. Swot analysis

Unit 3 **Making money-Introduction to Financial aspects of business** 10L

It is very important for an organisation to control its costs and in order to do this it must collect and manage as much cost information as possible. Financial management systems are usually set up around cost centres. e.g. Variable cost, Fixed cost, Direct and Indirect cost

Learning Objective

The student will be able to
1. illustrate key terms and concepts of finance and cost
2. differentiate between the different types of cost
3. categorise different expenses

Learning Outcome

After the course the successful learners will be able to
1 Give different examples of cost, price and value of a given product.
2 Derive cost equations for a process and Prepare a profit and loss account
3 Comprehend the balance sheet of a company

Detailed Syllabus: Sub units

1. key terms and concepts of finance, Cost, price and value, rules for debit and credit, classification of expenses-capital expenditure, revenue expenditure ,Profit and loss account and balance sheet
2. Costing – different types of costs i.e. Variable cost, fixed cost,semivariable cost, opportunity cost, marginal cost and preparation of cost sheet

References:

1. The online course developed by University of Nottingham
http://www.rsc.org/learn-chemistry/resources/business-skills-forchemists/OnlineCourse/
2. Resource developed by University of Warwick and University of York
http://www.rsc.org/learn-chemistry/resources/business-skills-and-commercial-awareness-for-chemists/
3. Inventing the Future: An Introduction to Patents for Small and Medium-sized Enterprises. WIPO publication No. 917
4."Secrets of Intellectual Property: A Guide for Small and Medium-sized Enterprises", ITC/WIPO publication on with questions and answers on intellectual property of relevance to SME exporters.

Semester VI

Course Title: Food and Cosmetics analysis
Course Credit- 2
Course Code: 20US6CHFCA7

Learning objectives:

Food, Cosmetics and forensic analysis are three fields where analytical techniques are applied for analysis of different materials. Module I introduces in food industry and role of chemistry in food industry. Module II further discusses the regulatory guidelines required for food analysis via different analytical techniques and also importance of quality in food. Cosmetic science is the area where analytical methods have revolutionized preparation of modern cosmetics products for variety of specific applications. Common analysis of cosmetics is also dealt in detail.

Course Objective:

CO1: To understand basics of food chemistry, food processing and food preservation.
CO2: Different type's food quality standards and food laws. Quality control of food items.
CO3: Cosmetics, composition of cosmetics, different analytical techniques to analyze cosmetics.
CO4: To understand the role of analytical chemistry in forensic sciences. Poisons and their classifications.
CO5: Preservation and analysis of different biological samples and extraction techniques for extraction of samples in forensic analysis.

1.1 **Introduction to Food chemistry** 12 L

1.1.1 Food chemistry: Definition, food science, Water in food, water activity and shelf life of food. 2L

1.1.2 Physical, chemical, functional properties and nutritive value of carbohydrates, fats and lipids, amino acid and proteins. 2L

1.1.5 Study and analysis of food products: Types, composition and analysis of milk and honey. 2L

1) Analysis of milk: Determination of Lactose, Fe and Ca 3L

2) Oil sample: Saponification value 3L

2.1 Food adulteration and Food quality standard 12L

2.1.1Quality control: instrumental, chemical, microbial and water quality control of food, critical quality control in different stage of food production including raw material and processing materials. 2L

2.1.2Study and analysis of food products: Types, composition and analysis of Tea and Coffee. 4L

1) Lemon juice/lemon squash sample: Vitamin C 3L

2) Honey sample: total reducing sugars before and after inversion by Lane-Eynon/Cole Ferricynaide method. 3L

3.1 **Cosmetics analysis** 12L

3.1.1Cosmetic analysis: general analysis (Water, glycerol, alcohol and propylene glycol), Potentiometric titration, Iodo-metric titration, pH analysis, spectrophotometric analysis, IR analysis, GC analysis. 3L

3.1.2Common examples: Face powder & Talcum powder (Boric acid, Magnesium, Calcium and zinc), Hair Tonic (Salicylic acid and resorcinol), Hair Oil (Acid and iodine value) 3L

1) Face powder: Mg, Zn and Boric acid 2L

2) Lipstick: Pb content complex metrically. 2L

3) Analysis of Whitfield ointment 2L

References:

1. Curry A.S; Analytical Methods in Human Toxicology, Part II, CRC Press Ohio (1986)

2. Krishnamurthy, R., Introduction to Forensic Science in Crime Investigation, 2011, Selective & Scientific Books, New Delhi.

3.Clark, E.G.C.; Isolation and Identification of Drugs, Vol. I and Vol. II, Academic Press, (1986).

4.Sunshine I; Year book of Toxicology, CRC Press Series, USA (1989 – 93).

5.Michael J. Deverlankoetal: Hand Book of Toxicology CRC Press, USA (1995)

6.Prakash M. etal; Methods in Toxicology Anmol Publication, New Delhi (1998)

7.Parikh C.K; Text Book of Medical Jurisprudence Forensic Medicines and Toxicology. CBS Pub. New Delhi (1999)

8.Reiss C etal; Advance in Molecular Toxicology, Utrecht,Netherlands (1998)
9.11. Jorg Rombkeetal; Applied & Ecotoxicology Lewis publishers NY (1995)
10.12. Shayne C.Gadetal; Acute Toxicology Testing Academic Press California USA (1998)
11.13. Chadha PV; Hand Book of Forensic Medicine and Toxicology, Jaypee Brothers New Delhi (2004) Semester-II FS-10832
12.14. Turner Paul; Recent Advances in Pharmacology & Toxicology, Churchill Livingstone, Elenburgh (1989)
13.15. Modi, Jaisingh P; Textbook of Medical jurisprudence & Toxicology, M.M. Tripathi Pub. (2001)
14.16. Cravey R.H, Baselt, R.C; Introduction to Forensic Toxicology, Biochemical Pub. Davis C A (1981)
15.17. Working Procedure Manual - Toxicology, BPR&D Publication (2000)
16.18. Ballantyne B; General and Applied Toxicology Vol-1-3 2nd Ed., Macmillan, NY (2000)

References for Practical:

1 Experimental physical chemistry; V. D. Athawale; New age international publication
2. Advance practical chemistry; DrJagdamba Singh; A pragati edition
3. Vogel's Quantitative Inorganic Analysis .Sixth edition.
4. W. G. Palmer, Experimental Inorganic chemistry, Van Nostrand Reinhold Co.

Syllabus
T.Y.B.Sc. Chemistry (3 Units)
STRUCTURE OF SYLLABUS

Semester	College Paper Code	Name of the course	Credits for Theory/Practicals
V	20US5CH1-3U	DSC I: Physical-Inorganic Chemistry	2
	20US5CH2-3U	DSC II: Organic- Analytical Chemistry	2
	20US5CHDRC5 OR 20US5CHERC5	DSE-I: Drugs (DRC) OR Essentials of Radiation Chemistry (ERC)	2
	20US5CHRMC6 OR 20US5CHENC6	DSE-II: Research methodology in Chemistry(RMC) OR Environmental Chemistry (ENC)	2
	20US5CHP1- 3U	Physical- Analytical Chemistry Practicals	1
	20US5CHP2 -3U	Organic- Inorganic Chemistry Practicals	1
	20US5CHP5	DSE-I Practicals	1
	20US5CHP6	DSE-2 Practicals	1
	Total Credits		12

Semester	College Paper Code	Name of the course	Credits for Theory/Practicals
V	20US6CH1-3U	DSC I: Physical-Inorganic Chemistry	2
	20US6CH2-3U	DSC II: Organic-Analytical Chemistry	2
	20US6CHDRC5 OR 20US6CHERC5	DSE-I: Dyes (DYC) OR Pesticides Chemistry(PSC)	2
	20US5CHRMC6 OR 20US5CHENC6	DSE-II: Polymer (PLC) OR Industrial Chemistry (INC)	2
	20US6CHP1- 3U	Physical- Analytical Chemistry Practicals	1
	20US6CHP2 -3U	Organic- Inorganic Chemistry Practicals	1
	20US6CHP5	DSE-I Practicals	1
	20US6CHP6	DSE-2 Practicals	1
	Total Credits		12

CHEMISTRY SEM V

Course I (Paper I) (3 Units)
Course Title: Physical-Inorganic Chemistry
Course Credit- 2 (No of Lecture -30 hrs/32L)
Course Code: 20US5CH1-3U

After completion of this course a student should be able to
CO1: Recognize the different types of electrochemical cells and their applications.
CO2: understand the concept of molecular symmetry and chemical bonding.
CO3: Recognize the modern theories of bonding in coordination compound.

Module I: Electrochemical Cells and Their Applications 12L

Learning Objectives

The module is intended to introduce

- Different types of Electrochemical Concentration cells
- Applications of EMF Measurements
- Concepts of Decomposition potential and Over voltage.

Learning Outcome

A student will

- Differentiate between Chemical and concentration cells
- Classify different types of Concentration cells.
- Understand the Applications of EMF Measurements.
- Recognize the concepts of Decomposition potential and Over voltage

2. 1 Electrochemical Cells and Their Applications 12L

2.1.1 Lewis concept of activity and activity coefficient, ionic strength of a solution, Debye-Huckel limiting law (derivation not expected)

2.1.2 Classification of cells: Comparison between chemical and concentration cell 1) Concentration cells with and without transference (derivation of expression for concentration cell EMF are expected), 2) Chemical cells without transference. Origin of liquid-liquid junction potential and its elimination using a salt bridge.

2.1.3 Faradaic and Non-Faradaic processes. Batteries and Superconductors.

2.1.4 Polarization, concentration polarization and its elimination, Decomposition potential, experimental determination of decomposition potential, factors affecting decomposition potential (nature of electrolyte, nature of electrodes and temperature), overvoltage, experimental determination of overvoltage, Tafel's theory and Tafel's equation for hydrogen overvoltage, simultaneous deposition of metal. Corrosion and its prevention.

Module II: Molecular Symmetry and Chemical bonding 12L

Learning Objectives

The module is intended to introduce

- Different symmetry elements, symmetry operations, concept of point group in molecule.
- Molecular orbital theory in simple polyatomic molecules.
- Band theory of metallic bonding.

Learning Outcome

A student will understand

- The basic concept in symmetry like symmetry elements, symmetry operations and point group.
- Molecular orbital approach for bonding in simple polyatomic molecules and drawing MOT diagrams for these molecule.
- Molecular orbital approach / band theory to explain bonding in metals and properties of conductors, insulators and semi conductors.

1.1 Molecular Symmetry 6L

1.1.1 Introduction and Importance.

1.1.2 Symmetry elements and Symmetry operations.

1.1.3 Concept of a Point Group with illustrations using the following point groups:
(i) C∞v (HCl), (ii) D∞h (H2), (iii) C2v (H2O), (iv) C3v (NH3), (v) C2h (trans-dichloroethylene), (vi) D3h (BCl3)

1.2 Molecular Orbital Theory for polyatomic species 3L

1.2.1 Simple triatomic species H3+ and H3 (correlation between bond angle and molecular orbitals)

1.2.2 Other molecules (considering only σ bonding): (i) BeH2 (ii) H2O (with reference to Walsh diagram)

1.3 **Metallic Bond** 3L

1.3.1 Band theory

1.3.2 Explanation of electric properties of conductors, insulators and semiconductors (n- and p- types) on the basis of Band theory.

Module III: Bonding in Coordination Compounds 12L

Learning Objectives

The module is intended to introduce

- Two theories of bonding in coordination compounds – Crystal field theory and molecular orbital theory.
- Concept of electronic states, term symbols, micro states.

Learning Outcome

A student will understand

- The nature of bond between metal and ligand.
- Thermodynamic, kinetic, spectral and stereo chemical properties of coordination compounds.
- Inter-pretation of different electronic states, term symbols and micro states for d1, d4, d6, d9 electronic configurations.

2.1 Crystal Field Theory (CFT) of co–ordination complexes 6L

2.1.1 Basic tenets of Crystal Field Theory (CFT) and effect of Crystal Field on central metal valence orbitals

2.1.2 Splitting of d orbitals in octahedral, tetrahedral and square planar complexes; Jahn Teller Effect

2.1.3 Crystal field splitting energy (10Dq/Δo) for octahedral complexes and factors affecting the magnitude of Δo

2.1.4 Crystal field stabilization energy (CFSE), calculation of CFSE for octahedral and tetrahedral complexes with d1 to d10 metal ion configurations, high spin and low spin complexes.

2.1.5 Effect of Crystal field splitting on (i) Ionic radius (ii) Lattice energy.

2.1.6 Experimental evidence for co-valence in co-ordination compounds:

(i) ESR spectrum of [IrCl6] -2

(ii) Nephelauxetic effect.

2.1.7. Merits and Demerits of CFT .

2.2 **Molecular Orbital Theory (MOT) of co –ordination complexes** 3L

2.2.1 Application to octahedral complexes in case of (i)[Ti(H2O)6]+3 (ii) Fluoro complexes of Fe(II) and Fe(III) (iii) Cyano complexes of Fe(II) and Fe(III) (iv) Fluoro and amino complexes of Co(III)

2.2.2 Effect of π- bonding on ligand field splitting parameter in M→Lπ and L→Mπ interactions.

2.3 **Electronic states and Terms for Polyelectronic Atoms** 3L

2.3.1 Introduction, electronic configuration and electronic states, Term symbols, coupling of spin momenta (MS), orbital momenta (ML) and spin orbit coupling or Russell -Saunders coupling.

2.3.2 Determination of Terms for p2 electronic configuration (as in a carbon atom).

2.3.3Terms and micro-stats for transition metal atoms/ions.

CHEMISTRY SEM VI

Course I (Paper I)
Course Title: Physical and Inorganic Chemistry
Course Credit- 2 (No of Lecture -30 hrs/32L)
Course Code: 20US6CH1-3U

After completion of this course a student should be able to
CO1: Understand the principles of molecular spectroscopy.
CO2: Learn colligative properties of dilute solutions. Understand phase rule and its applications to one and two component systems.
CO3: Analyze and understand the electronic spectra of complexes, stability and substitution reactions in complexes.

Module IV: Molecular Spectroscopy 12L

Learning Objective

- The module is intended to introduce the principles of three key spectroscopic methods- Rotational, Infra-Red and Raman spectroscopies..

Learning outcome

A student will

- acquire basic knowledge of the interaction of radiation with matter and will be able to use the quantum mechanics principles to understand molecular spectra. The student will recognize the relationship between molecular spectra and molecular properties.

4.1 Dipole moment: Dipole moment, polarization of a bond, bond moment, dipole moment andmolecular structure.
4.2 Rotational Spectrum: Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of inter nuclear distance and isotopic shift
4.3 Vibrational (IR) spectrum: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum
4.4 Vibration-Rotation spectrum of diatomic molecules, vibrating rotor, energy levels, selection rule,nature of spectrum, R and P branches, anharmonic oscillator: energy levels, selection rule, fundamental band, overtones. Introduction to infrared spectra of simple molecules like H2O and CO2.
4.5 Raman Spectroscopy: scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum, Stoke's lines, anti-Stoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion (example of CO_2 molecule).

Module V: Colligative Properties of Dilute Solutions and phase Rule 12L

Learning Objective:

The module is intended to introduce

- The concepts of colligative properties lowering of vapour pressure, elevation of boiling point, depression in freezing point and osmotic pressure.
- Relation between the colligative property and calculations of different parameters
- Phase rule and it's applications to one and two component systems

Learning Outcome:

A student will be able to

- Understand the relation between colligative property and molar mass of the non volatile solute.
- Solve numerical problems on determination of molar mass of the non volatile solutes.
- Apply phase rule to understand behavior of one and two component systems.

5.1 Colligative Properties of Dilute Solutions 7L

5.1.1 Dilute solutions, colligative properties, Raoult's law, relative lowering of vapour pressure.

5.1.2 Elevation in boiling point of a solution, thermodynamic derivation relating elevation in boiling point of a solution and the molar mass of a non-volatile solute.

5.1.3 Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and the molar mass of a non-volatile solute.

5.1.4 Osmotic pressure, van't Hoff's equation for osmotic pressure (derivation is expected) and determination of molar mass of the solute. Abnormal molar masses of solutes and van't Hoff factor (calculation of Degree of Association and Degree of Dissociation.)

5.2 Phase Rule 5 L

5.2.1 Gibb's phase rule and terms involved in the equation.

5.2.2 Application of phase rule to ONE component systems: Water system

5.2.3 Application of phase rule to TWO component systems, condensed systems, condensed phase rule, eutectic systems (Lead – Silver system), desilverisation of lead.

5.2.4 Introduction to THREE component systems , triangular plots.

Module VI: Coordination Chemistry 12L

Learning Objective:

The module is intended to introduce

- The study of electronic spectra of complexes.
- Stability of complexes
- Substitution reactions in complexes.

Learning Outcome:

A student will be able to

- Analyze the electronic spectra of complexes and can recognize various types of electronic transitions, geometry of complexes.
- Appreciate the complex chemistry of transition metal coordination compounds by studying kinetics, mechanisms of various reactions and stability of complexes.

Co-ordination Chemistry 12L

5.1 Electronic Spectra of Complexes 5L

5.1.1 Type of electronic transitions like intra-ligand transitions, charge transfer transitions and intra-metal transitions (d-d or ligand field transitions for transition metals)

5.1.5 Rule for electronic transitions: Spin and Orbital or Laporte selection rules

5.1.3 Splitting of Terms in weak crystal field, the Hole formalism

5.1.4 Orgel Diagrams for D Terms i.e. d1, d4 and d6, d9 electronic configurations

5.1.5 Applications of electronic spectra in brief, with special reference to (i) cis-trans isomerism in complexes and (ii) Geometry of complexes

5.2. **Stability of octahedral complexes** 3L

5.2.1. Thermodynamic stability and kinetic stability of complexes with examples

5.2.2. Stability constants: stepwise and overall constants and their inter relationship

5.2.3. Factors affecting thermodynamic stability

5.3 **Substitution reactions in octahedral complexes** 4L

5.3.1 Introduction, types of reactions in complexes

5.3.2Ligand substitution reactions: basic mechanisms

5.3.3Inert and labile complexes and electronic configurations and lability

5.3.4Acid hydrolysis, base hydrolysis and anation reactions.

Reference Books:

Physical

1. Puri B.R., Sharma L.R., Pathania, M.S., Principles of Physical Chemistry, 23rd edition) New Delhi, Shoban Lal, Nagin Chand & Co., (1993)
2. Negi A. S and Anand S.C., A Text Book of Physical Chemistry ,Eastern Wiley Pvt.Ltd., 2nd edition (1986).
3. Kapoor K.L., A Text Book of Physical Chemistry , Macmillan Publishers India Limited, (2006)- 4 volumes
4. Glasstone S., Text book of Physical Chemistry,D. Van Nostrand company, inc; 2nd edition (1946)
5. Castellan G.W., Physical Chemistry, 3rdEdn., NarosaPublishing House, (2004).
6. Moore W.J.,Physical Chemistry,Longman Publishing Group; 5th edition (1998)
7. Maron S. H. and PruttonC.F., Principles of Physical Chemistry, London Collier-Macmillan, 4th edition(1969)
8. Atkin's Physical Chemistry, Atkins P.W., PaulaJ. D., KeelerJ., Oxofrd University Press,11th edition (2017)
9. PrasadR.K., Quantum Chemistry, PrasadR.K., New Age International Publishers, 4th edition (2010)
10. Introductory Quantum Chemistry, A.K. Chandra, Tata Mc Graw Hill, 4th edition (1994).

Inorganic

1 Chemistry Inorganic - B.R. Puri, L.R. Sharma and K.C. Kallia - Vallabh Publications (2003).
2. Selected Topics in Inorganic Chemistry - W.U. Malik, G.D. Tuli and R.D. Madan - S. Chand Publications (2006).
3 Inorganic Chemistry - J.E. Huheey, Harper and Collins - NY IV edition (1993).
4. Concise Inorganic Chemistry - J.D. Lee - III edition - Von Nostrand.
5. Industrial Chemistry - B.K Sharma - Goel Publications (1983).
6. Coordination Chemistry - S.F.A. Kettle - ELBS (1973).
7. Coordination Chemistry - K. Burger - Butterworthy (1973).
8. Advanced Inorganic Chemistry - Cotton and Wilkinson - V Edition - Wiley and Sons (1988).
9. Cotton, F.A and Wilkinson, G. (1989) Inorganic Chemistry. John Wiley and Sons, NewYork
10. Madan R.D., Juli G.D. and Malik S.M., Selected Topics in Inorganic Chemistry, S.Chand& Co, New Delhi (2006)

Core Course II (Paper II) (3 units) Semester V

Course Title: Organic and Analytical Chemistry
Course Credit- 2 (Teaching.-30 hrs/ 36 L)
Course Code: 20US5CH2-3U

After completion of this course a student should be able to
CO1: Mechanism of reactions of carbonyl compounds and some rearrangements. IUPAC of some higher organic compounds
CO2: Understand the importance of statistics and its application in chemical analysis
CO3: Learn the basics of separation science and classical chromatography

Module I: Mechanism of Organic Reactions and IUPAC 12L

Learning Objectives

The module is intended to introduce

- Mechanism of reactions of carbonyl compounds and some rearrangements.
- IUPAC of some higher organic compounds

Learning Outcome

A student will be able to

- Predict and account for the most commonly encountered reaction mechanisms in of carbonyl compounds.
- Name the bicyclic compounds,biphenyls,cummulenesupto 3 double bonds, heterocyclic compounds containing a maximum of two hetero atom among N, O, S.

1.1 **Mechanism of Organic Reactions**

1.1.1 Thermodynamic and Kinetic control of organic reactions: Concept with mechanisms of the following reactions: addition of HX to butadiene; sulfonation of naphthalene. Nucleophilicity / electrophilicity Vs Basicity / acidity.

1.2.2 Mechanism of reactions of carbonyl compounds with nucleophiles.

1.2.2.1 Reaction of aldehydes and ketones with primary and secondary amines.

1.2.2.2 Acyl nucleophilic substitution (tetrahedral mechanism): Acid catalysed esterification of carboxylic acids and base promoted hydrolysis of esters.

1.1.3 Mechanism of rearrangements with examples and stereochemistry wherever applicable.

1.1.3.1 Migration to electron deficient carbon: Pinacol, Benzilic acid.

1.1.3.2 Migration to electron deficient nitrogen: Beckmann, Hofmann.

1.2 IUPAC

1.3 IUPAC systematic and accepted trivial nomenclature of the following classes of compounds, including substituted ones (up to 2 substituents/functional groups):

1.2.4 Bicyclic compounds- spiro, fused, and bridged (upto 11carbon atoms)-saturated an unsaturated compounds.

1.2.5 Biphenyls.

1.2.6 Cummulenesupto 3 double bonds, Monocyclic (5 and 6 membered) aromatic and nonaromatic heterocyclic compounds containing a maximum of two hetero atom among N, O, S.

Module II: Quality in Analytical Chemistry and Statistical treatment of data 12L

Learning Objectives

The module is intended to introduce

- Concept of Quality in Analytical chemistry. Quality systems for chemical analysis.
- Introduction to basic statistics and use of it for establishing quality in chemical analysis.
- Use of statistics for data analysis and interpretation of results.

Learning Outcome

A student will understand

• The basic concept Quality, role of quality in chemical analysis. Quality control and quality assurance. Quality management systems like ISO, ICH etc.

• Use of simple statistical parameters like mean, mode, standard deviation etc. for interpretation of data.

• Implementation of statistics for rejection of results, concept of errors, types and quantitative measurement of errors.

2.1 Introduction to Quality in Analytical Chemistry 4L

1.1.1 Concept of Quality, definition and requirement

1.1.2 Quality control and quality assurance. Similarities and difference between QC and QA

1.1.3 Introduction to different quality systems: ISO, ICH guide lines and other quality systems and their use.

2.2 Statistical treatment of data 8L

1.2.1 Types of errors, determinate and indeterminate errors, minimization of errors, constant and proportionate errors.

1.2.2 Accuracy and precision, measure of dispersion and central tendency: mean, median, mode, average deviation, relative average deviation, variance, coefficient of variation. (Numerical problems expected)

1.2.3 Determinate and Indeterminate errors, constant and proportionate errors, distribution of random errors, Histogram, Frequency polygon, Gaussian curve, students t, confidence limits and confidence intervals, criteria for rejection of result 2.5 d rule,4.0 d rule, Q-test, F-test, Test of significance method of averages method of least squares. [Numerical problems expected]

Module III: Titrimetric analysis and Introduction to Chromatography 12L

Learning Objectives

The module is intended to introduce

- Two important titrimetric methods viz.Redox titrations and non aqueous titrations
- Introduction to chromatography as a major separation technique.
- Basic principles, usage and applications of planar chromatographic techniques.

Learning Outcome

A student will understand

•The basic theory of redox and non aqueous titrations. Selection of appropriate indicators and applications of both.

•Definition and use of chromatography as a separation technique. Different chromatographic techniques and their classification.

•Basic theory and use of planar chromatographic techniques like Paper chromatography, TLC and HPTLC. Their types and applications.

3.1 Titrimetric analysis 7L

3.1.1 Redox titrations: Introduction and basic principles

3.1.2 Titration curves for redox titration: Titration of Fe+2 v/s Ce+4, Fe+2 v/s dichromate (Cr2O72-), Fe+2 v/s MnO-4 ions.

3.1.3 Detection of end point of redox titration using indicators and potentiometrically. Some useful redox indicators.

3.1.4 Non aqueous titrations: Definition and basic principles. Different types of non aqueous solvents.

3.1.5 Requirements for non aqueous solvents. Properties of non aqueous solvents. Leveling effect.

3.1.6 End point detection in non aqueous titrations. Advantages and limitations of non aqueous titrations. Applications.

3.2 Introduction to chromatography 5L

3.2.1 Introduction to chromatographic techniques, classification of chromatographic techniques.

3.2.2 Planar Chromatography: Principle, techniques and applications of Paper chromatography Thin layer chromatography and HPTLC

Reference books:

Organic

1. Francis A Carey, Organic Chemistry, Pearson Education, 7th Edition, Tata McGraw Hill, 2008.
2. R.T. Morrison and R.N. Boyd, Organic Chemistry, 6th Edition, Pearson Education.2008
3. Paula Y. Bruice, Organic Chemistry, 3rd ed., Pearson Education, 2007.
4. S.H. Pine, Organic Chemistry, 5th Ed, McGraw Hill Kogakusha Ltd.2007
5. Peter Sykes, A guide to mechanism in Organic Chemistry, 6th Edition, Pearson Education, New Delhi.
6. V.K. Ahluwalia and R.K. Parashar, Organic Reaction Mechanism, 4th ed., Narosa Publications.

Analytical

10. D. A. Skoog, D.M.West, F.J.Holler Fundamantals of Analytical Chemistry, 8th ed. Philadelphia, Saunders college Publishing, 1996
11. D. A. Skoog, F.J.Holler, T.A.Nieman, Principles of Instrumental Analysis, 6th ed. Philadelphia, Saunders college Publishing, 1996
12. G.D.Christian, Analytical Chemistry, 6th ed. John Wiley &Sons, Singapore, 2004.
13. J.G.Dick, Analytical Chemistry, International Student's Edition, McGraw Hill, Kogakusha Limited, New Delhi, 1973.
14. R.A.Dey & D.L.Underwood, Quantitative Analysis, 6th ed. Prentice Hall Of India Pvt. Ltd. New Delhi, 1993.
15. M.Valcarcel, Principles Of Analytical Chemistry, Springer International Edition, Berlin, 2000
16. E..Prichard, & V. Barwick, Quality Assurance in Analytical Chemistry, Wiley.
17. S. M. Khopkar, Basic Concepts of Analytical Chemistry, 3rd ed,New Age International Publishers, 2008
18. S. M. Khopkar, Analytical Chemistry Problems and Solutions, New Age International Publishers, 2002

CHEMISTRY SEM VI

Course II (Paper II) (3 Units)
Course Title: Organic and Analytical Chemistry
Course Credit- 2
Course Code: 20US6CH2-3U

After completion of this course a student should be able to
CO1: Elucidate the structure of simple organic compounds using U.V, I.R and NMR spectra.
CO2: Understand importance of solvent extraction and other extraction techniques in chemistry.
CO3: Learn about chromatography as a major separation tool in Chemistry.

Module V: Organometallic Chemistry and Reagents and Catalysts 12L

Learning Objective:

• This module is intended to introduce students to chemistry of organo metallic compounds and various reagents along with their uses in organic synthesis.

Learning Outcome:

After completing this course student will be able to

- Design the synthesis of simple organolithium and Gilman reagents.
- Predict its reactivity and formulate its use for synthesis of simple organic compounds
- Predict the reagent for carrying various functional group inter conversion useful in synthesis of a particular molecule.

5.1 Organometallic Chemistry 4L

5.1.3 Organolithium Compounds: Preparation using alkyl/aryl halides. Reactions with compounds containing acidic hydrogen, alkyl halides, carbonyl compounds, cyanides and CO2. Lithium dialkylcuprates: Preparation and reactions with aliphatic /aromatic/vinylic halides.
5.1.4 Organozinc compounds: Preparation of dialkyl zinc. Reaction with water, acid chlorides and alkyl halides. Reformatsky reaction (with mechanism).

5.2 Reagents and Catalysts 8L

5.2.1 Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism).
5.2.2 Catalysts: Catalysts for hydrogenation: Raney Ni, Pt and PtO2: C=C, CN, NO2, aromatic ring; Pd/C: C=C, COCl→ CHO (Rosenmund's); Lindlar catalyst: alkynes; Wilkinson's catalyst for stereo selective reduction of olefins.
5.2.3 Reagents: (1) LiAlH4 and Red-Al: reduction of CO, COOR, CN, NO2. (2) NaBH4: reduction of CO (3) SeO2: hydroxylation of allylic and benzylic positions, oxidation of CH2, alpha to CO to CO. (5) mCPBA and R-OOH/H2O2 for epoxidation of C=C. (6) NBS: allylic and benzylicbromination of position alpha to CO.

Module VI: Spectroscopy 12L

Learning Objective

- This module will enable the student to elucidate the structure of simple organic compounds using U.V, I.R and NMR spectra.

Learning Outcome

After completing this course student will be able to:

- Identify various functional groups on the basis of the U.V and IR spectra.
- Predict the electronic environment around different types hydrogen present in the organic compound based on the 1H NMR spectrum.
- Predict the structure of simple organic compounds using U.V, IR and 1H NMR spectrum in synchronization and vice versa.

6. Spectroscopy 12L

6.1.1 Introduction: Electromagnetic spectrum, units of wavelength and frequency.
6.1.2 UV- Visible Spectroscopy: Basic theory, solvents, nature of UV-VIS spectrum
6.1.3 IR Spectrocopy: Basic theory, nature of IR spectrum, selection rule, fingerprint region.
6.1.4 PMR Spectroscopy: Basic theory of NMR, nature of PMR spectrum, chemical shift (∂ unit), standard for PMR, solvents used. Factors affecting chemical shift: (1) inductive effect (2) anisotropic effect (with reference to C=C, CΞC, C=O and benzene ring). Spin spin coupling and coupling constant. Proton exchange- application of deuterium exchange, Application of PMR in structure determination.
6.1.5 Spectral characteristics of following classes of organic compounds, including benzene and monosubstituted benzenes, with respect to UV-VIS, IR, PMR: (1) alkenes (2) alkenes and polyenes (3) alkynes (4) haloalkanes (5) alcohols (6) carbonyl compounds (7) ethers (8) carboxylic acids (9) esters (10)amines (11) amides (broad regions characteristic of different groups are expected).
6.1.6 Problems of structure elucidation of simple organic compounds using individual or combined uses of the above spectroscopic technique are expected. (index of hydrogen deficiency should be the first step in solving the problems).

Module VII: Solvent extraction and Solid phase extraction 12L

Learning Objectives

The module is intended to introduce

- Basic principles and importance of chromatographic methods
- Gas Chromatography as major method of separation in analytical chemistry.
- Use of High Performance Liquid Chromatography as an Analysis tool for complex separations and estimations
- Ion exchange chromatography as a versatile separation method

Learning Outcome

A student will understand

- The basic principles of chromatography. Different terms and concepts related to chromatographic separations
- Gas chromatography, its instrumental and operational details and applications.
- HPLC as versatile method for separations, qualitative and quantitative analysis
- Ion exchange chromatography and its wide applications in analytical chemistry.

6.1**Gas chromatography** 5L

6.1.1 Gas liquid chromatography, basic principles, retention time, retention volume, resolution, peak width theoretical plates. HETP,

6.1.2 Instrumentation, columns, detectors, applications.

6.2HighPerformanceLiquid Chromatography 3L

6.2.1 Instrumentation, types of elution, U.V. and I.R. detector and applications

6.3IonExchange Chromatography 4L

6.3.1 Types of ion exchangers,

6.3.2 Mechanism of ion exchange, selectivity coefficients and separation factors, capacity and its determination, factors affecting the separation of ions,

Reference books:

10.D. A. Skoog, D.M.West, F.J.Holler Fundamantals of Analytical Chemistry, 8th ed. Philadelphia, Saunders college Publishing, 1996

11.D. A. Skoog, F.J.Holler, T.A.Nieman, Principles of Instrumental Analysis, 6th ed. Philadelphia, Saunders college Publishing, 1996

12. G.D.Christian, Analytical Chemistry, 6th ed. John Wiley &Sons, Singapore, 2004.

13. J.G.Dick, Analytical Chemistry, International Student's Edition, McGraw Hill, Kogakusha Limited, New Delhi, 1973.

14.R.A.Dey & D.L.Underwood, Quantitative Analysis, 6th ed. Prentice Hall Of India Pvt. Ltd. New Delhi, 1993.

15. M.Valcarcel, Principles Of Analytical Chemistry, Springer International Edition, Berlin, 2000

16. E..Prichard, & V. Barwick, Quality Assurance in Analytical Chemistry, Wiley.

17. S. M. Khopkar, Basic Concepts of Analytical Chemistry, 3rd ed,New Age International Publishers, 2008

18.S. M. Khopkar, Analytical Chemistry Problems and Solutions, New Age International Publishers, 2002.

Course Title: Physical- Analytical Chemistry Practicals

Course Code: 20US5CHP1- 3U

Course Credit-1

Learning Objectives

The course is intended to introduce

- Rate constants, effect of temperature on rate constants, energy of activation for the acid catalysed reactions like hydrolysis of methyl acetate
- Determination of acidic and basic dissociation constants of amino acid and to calculate isoelectric point.
- Colorimetric determination of fluoride content in tooth paste.

Learning Outcome

A student will understand

- The effect of temperature on rate constants and determination of energy of activation.
- The concept of isoelctric point, acidic and basic dissociation constants through pH-metric determination.
- Colorimetric determination of fluoride content.

Experiments:

1. **Chemical Kinetics**

To determine the energy of activation for the acid catalysed hydrolysis of methyl acetate.

2. **pH –Metry**

To determine acidic and basic dissociation constants of amino acid and to calculate isoelectric point.

3. **Colorimetry**

Detection of fluoride content in a tooth paste

4. Estimation of $K_2S_2O_8$ in the given solution.

Course Title: Organic- Inorganic Chemistry Practicals

Course Code: 20US5CHP2-3U

Course Credit-1

Learning Objectives

The course is intended to impart

- Separation of binary mixture of compounds by physical separation
- Knowledge on the preparation of inorganic complexes.
- Knowledge on the analytical chemistry aspects of complexometric titration.
- The concept of the experiment and the different steps involved in the experiment in the real lab more accurately and precisely.

Learning Outcome

A student will acquire the skills of

•Separating mixtures containing various organic compounds based on their physical properties.

•Acquire the skills to prepare nickel and cobalt amine complexes.

•Demonstrate the basic laboratory technique of titration.

Experiments:

1.Separation of binary mixture of compounds by chemical separation

2. **Inorganic Preparation**:-

iv)Preparation of Chloropentaaminecobalt (III) chloride and estimation of cobalt by complexometry.

v)Preparation of tris(ethylene diamine) nickel (II)sulphate and estimation of nickel by complexometry

3. **Titrimetric Analysis:-**

i) Estimation of Nickel complexometrically using mureoxideindicator.

ii) Estimation of Copper complexometrically using Fast sulphone Black Findicator.

Course Title: Physical- Analytical Chemistry Practicals

Course Code: 20US6CHP1- 3U

Course Credit-1

Learning Objectives

The course is intended to introduce

- Partition coefficient method to determine equilibrium constant of a reaction .
- Conductometric titration method of mixture of acids and salt to determine the percentage composition.
- Complexometric titration.
- Use of instrumental methods for analysis for commercial analysis.

Learning Outcome

A student will understand

•Partition coefficient method to determine equilibrium constant of a reaction.

•Conductometric titration method.

•Application of complexometric titration for commercial analysis.

•Instrumental methods of analysis of commercial samples like vinegar.

Experiments:

1.Partition coefficient –To determine the equilibrium constant for the reaction KI + I2 KI3 by partition coefficient method.

2. Conductometry – To estimate the concentration of sulphuric acid, acetic acid and copper sulphate in the given solution by conductometric titration method.

3. Potentiometry-Estimation of acetic acid .

4. Detection of hardness of water.

Course Title: Organic- Inorganic Chemistry Practicals

Course Code: 20US6CHP2 -3U

Course Credit-1

Learning Objectives

The course is intended to introduce

•Separation of binary mixture of compounds by physical separation

•Knowledge on the preparation of inorganic complexes.

•Knowledge on the analytical chemistry aspects of complexometric titration.

•The concept of the experiment and the different steps involved in the experiment in the real lab more accurately and precisely.

Learning Outcome

A student will understand

•The technique of separation of mixtures containing various organic compounds based on their physical properties.

•Acquire the skills to prepare Inorganic complexes.

Experiments:

1.Binary Mixture Separation & Identification

(Volatile liquid + Nonvolatile liquid) (Solid + Volatile liquid)

2. **CommercialAnalysis:-**

iv)Analysis of calcium tablets for its calcium contentcomplexometrically.

v)Analysis of Boric acid for its percentagepurity.

3. **Inorganic Preparations**

i) 8-hydoxyquinolinato magnesium(II).

ii) Bis-(acetylacetanato) copper(II).

DSE 1- Semester V

Course Title: Drugs

Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)

Course Code: 20US5CHDRC5

After completion of this course a student should be able to

CO1: Understand the various terms and concepts used in drug chemistry

CO2: Routes of administration and metabolism of drugs.

CO3: Chemistry of various chemotherapeutic agents and pharmacodynamic agents.

Module I: Introduction to Drug 12L

Learning Objectives:

- This module intends to introduce the students to basic terminologies involved in chemistry of drugs, routes of drug administration and the metabolism of drugs

Learning Outcomes:

After completing the module the student will be able to:

•Understand the terminologies and concepts involved in drug chemistry,

•Recognize the identity, distribution, regulation of the drugs.

1. 1 General Introduction to Drug 6L

1.1.1 Definition of a drug, Requirements of an ideal drug, Classification of drugs (Based on therapeutic action)

1.1.2 Nomenclature of drugs: Generic name, Brand name, Systematic name

1.1.3 Definition of the following medicinal terms: Pharmacon, Pharmacophore, Prodrug, Halflife efficiency, LD50, ED50, Therapeutic Index.

1.1.3 Brief idea of the following terms: Receptors, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia.

1.2. Routes of Drug Administration and Dosage Forms 3L

1.2.1 Oral and Parenteral routes with advantages and disadvantages.

1.2.2 Formulations, Different dosage forms (emphasis on sustained release formulations.)

1.3 Drug Metabolism 3L

Introduction, Absorption, Distribution, Bio-transformation, Excretion Different types of chemical transformation of drugs with specific examples.

Module II: Pharmacodynamic agents 12L

Learning Objectives:

- This module intends to introduce the students to chemistry of pharmacodynamic agents used for various systemic disorders.

Learning Outcomes:

After completing the module the student will be able to:

- Classify the pharmacodynamic agents according to the chemical class and will have knowledge of therapeutic action and side effects of these.

Pharmacodynamic agents

A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical structure, chemical class, therapeutic uses, and side effects.

2.1 CNS Drugs: 2L

Classification based on pharmacological actions Concept of sedation and hypnosis, anaesthesia. Phenobarbitone (Barbiturates), Phenytoin(Hydantoins), Trimethadione (Oxazolidinediones), Piracetam (Pyranones), Midazolam, Alprazolam (Benzodiazepines) Methylphenidate (Piperidines) Chlorpromazine (Phenothiazines) Fluoxetine (Phenyl propyl amines) Synthesis of Trimethadione

2.2 **Analgesics and Antipyretics** 1L

Morphine (Phenanthrene alkaloids), Tramadol (Cyclohexanols), Aspirin (Salicylates), Paracetamol (p-Aminophenols), Synthesis of Paracetamol.

2.3 **Anti-inflammatory Drugs** 2L

Mechanism of inflammation and various inflammatory conditions. Prednisolone, Betamethasone (Steroids), AceclofenacandMefenamic Acid (N-Aryl anthranilic acids). Synthesis of Aceclofenac

2.4 **Antihistaminic Drugs** 2L

Mechanism of histamine release & its action Diphenhydramine (ethanolamines), Cetrizene (piperazine), Chloropheniramine maleate (ethyl amines),Omeprazol, pantoprazole (Benzimidazoles) Synthesis of Cetrizine

2.5 **Cardiovascular drugs** 2L

Classification based on pharmacological action Enalapril (-amino acids), Isosorbide dinitrate (Nitrates), Atenoldol (Aryloxy propanol amines), Nifedipine (Pyridines), Chlorthiazide (Thiazides),Frusemide /Furosemide (Sulfamyl benzoic acid), Spironolactone (Steroidal- 17- -lactones).

2.6 **Antidiabetic Agents** 1L

General idea and types of diabetes; Insulin therapy Glibenclamide (sulphonyl ureas), Metformin (Biguanides)

2.7**Antiparkinsonism Drugs** 1L

Idea of Parkinson's disease. Procyclidine hydrochloride (Pyrrolidines), Ethopropazine hydrochloride (Phenothiazines) Laevodopa (-amino acids)

2.8 **Drugs for Respiratory System** 1L

General idea of Expectorants; Mucolytes; Bronchodilators Decongestants and Antitussives, Bromhexine (Phenyl methyl amines), Salbutamol, Pseudo- ephedrine (Phenyl ethyl amines) Oxymetazoline (Imidazolines) Codeine Phosphate (Opiates)

Module III: Chemotherapeutic Agents 12L

Learning Objectives:

- This module intends to introduce the students to chemistry of chemotherapeutic agents used for various infectious diseases.

Learning Outcomes:

After completing the module the student will be able to:

- Classify the chemotherapeutic agents according to the chemical class and will have knowledge of therapeutic action and side effects of these.

Chemotherapeutic Agents

Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, and side effects.

3.1 **Antibiotics** 2L

Definition, Amoxicillin; Cloxacillin (β- lactum antibiotics) Cephalexin (Cephalosporins) Doxycycline (Tetracyclines) Gentamycin (Aminoglycosides) Ciprofloxacin (Quinolones) Synthesis of Ciprofloxacin

3.2 **Antimalarials** 2L

Types of malaria: Symptoms; pathological detection during window period (Life cycle of the parasites not o be discussed) Chloroquine (3-Amino quinolines) Paludrine (Biguanides) Pyrimethamine (Diamino pyrimidines) Artemether (Benzodioxepins) Following combination to be discussed (i) Sulfadosine-Pyrimethamine (ii) AtremetherLumefantrine (no structure) Synthesis of Paludrine.

3.3 **Anthelmintics** 2L

Drugs effective in the treatment of Nematodes and Cestodes intestations. Diethyl carbamazine (Piperazines) Mebandazole; Albendazole (Benzimidazoles) Niclosamide (Amides) Synthesis of Albendazole

3.4 **Antiamoebic Drugs** 1L

Types of Amoebiasis Metronidazole; Diloxamide furoate (Furans) Following combination therapy to be discussed: Ciprofloxacin-Tinidazo Synthesis of Metronidazole

3.5 **Antitubercular and Antileprotic Drugs** 2L

Types of Tuberculosis; Symptoms and diagnosis of Tubeculosis. Types of Leprosy. General idea of Antibiotics used in their treatment. PAS (Aminosalicylates) Isoniazide (Hydrazides) Pyrazinamide (Pyrazines) (+) Ethambutol (Aliphatic diamines) Ethionamide (Thioamides) Dapsone (Sulfonamides) Clofazimine (Phenazines) Following combination therapy to be discussed: (i) Rifampin + Ethambutol + Pyrazinamide (ii) Rifampin + Isoniazide + Pyrazinamide (iii) Rifampin + Clofazimine + Ethionamide. Synthesis: (+) Ethambutol.

3.6 **Anti-Neoplastic Drugs** 2L

Idea of malignancy; Causes of cancer, brief idea of Immuno Stimulants, Immuno depressants. (1) Lomoustine (Nitrosoureas) (2) Fluorouracil (Pyrimidines) (3) Estrogen (Steroidal hormones) (3) Mitomycin C (Antibiotics) (5) Vincristine; vinblastine; vindesine (Vinca alkaloids-no structures)

3.**7Anti HIV Drugs** 1L

Idea of HIV pathogenecity, Symptoms of AIDS, AZT, Lamivudine, Stavudine (Pyrimidines), DDI (Purines)

Course Title: Drugs Practicals

Course Code: 20US5CHP5

Course Credit-1

Learning Objectives

The course is intended to introduce the learner to

- Preparation of Drugs and Drug intermediates
- Estimation of Drugs

Learning Outcome

After completing this course, a student will be able to

- Use simple reactions to synthesize drugs and drug intermediates
- Estimate the drugs quantitatively by titrimetry.

Preparation:

1) Preparation of Aspirin from Salicylic Acid
2) Preparation of p-Nitroacetanilide from Acetanilide
3) Preparation of p-Nitroaniline from p- Nitroacetanilide

Estimation:

1) Estimation of Tincture of Iodine
2) Estimation of Ibuprofen

Project

1) Representation of monogram of any one drug from syllabus by I.P. method

42 Industrial Visit (Pharmaceutical company)

Reference books:

1) Pharmacology and pharmaceutics Vol.I and II, Satoskar.
2) Textbook of organic, medicinal, and pharmaceutical chemistry, Wilson and Gisvold.
3) Textbook of medicinal chemistry, William O. Foye and David A. William.
4) Medicinal chemistry, G. R . Chatwa.l

DSE 2 - Semester V

Course Title: Research Methodology
Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)
Course Code: 20US5CHRMC6

After completion of this course a student should be able to
CO1: Identify the various type of research
CO2: Apply digital tools available on Google app.
CO3: Developing basic skills set required for statistical treatment of research data.
CO4: Recognize the importance of safety measures during research

MODULE I: Research Methodology: An Introduction 12L

Learning Objectives

The module is intended

- To understand research terminology
- Be aware of the ethical principles of research, ethical challenges and approval processes
- Describe quantitative, qualitative and mixed methods approaches to research

Learning Outcome

- A student will understand and identify objective and significance of research.
- A student will understand about Plagiarism and the restrictions in research,

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method Research Design
Importance of Knowing How Research is Done, Research Process, Criteria of Good Research
Ethical issues:
Plagiarism, Restriction to Plagiarism, concept of patents and trademarks

MODULE II: Data Analysis The Investigative Approach 12L

Learning Objectives

The module is intended

- To understand importance and use of statistical treatment of research data

Learning Outcomes

- Students will develop the skills of using data analysis for treatment of research data

Testing of hypothesis: Basic definition (Null hypothesis, alternate hypothesis, critical region, acceptance region, Probability of type I and Type II errors, Level of significance P value,

Type of Test: parametric, non parametric, comparison between sample mean and population mean, comparison between two sample means, Chi square test
Analysis of variance (ANOVA) for one way, Correlation and regression, Curve fitting, fitting of linear equations

MODULE III: Chemical Safety and Ethical Handling of Chemicals 12L

Learning Objectives

- Help students develop an understanding of the principles of chemical safety
- Enable students to apply these concepts when working in a laboratory.
- Encourage the scientific community to keep safety a high priority

Learning Outcome

- Recognize the Hazards
- Assess the Risks
- Minimize the Risks
- Prepare for Emergencies from Uncontrolled Hazards

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation.
Material Safety Data Sheet (MSDS), Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage.
Safe disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

Course Title: Research Methodology Practicals

Course Code: 20US5CHP6

Course Credit-1

Learning Objectives

The course is intended to introduce the learner to,

- Review research article from different sources
- Carry out research project
- To write scientific reports and
- Presentation of research outcomes by using power point presentations

Learning Outcome

After completing this course, a student will be able to

- Write scientific reports for their projects.
- Communicate their project report in power point presentations.

- To apply research method and perform short term research project

Reading of the three research articles.
Power point presentation based on any Chemistry related research article.
Write a T.Y. B.Sc. project report in a scientific method
Submit the progress report for the project.
Power point presentation of the project finding.

References

1) Thesis and assignement writing- J. Anderson, B. H. Dursten and M. Poole, Wiley Eastern 1977.
2) A Handbook of methodology of Research- P. Rajammal and P. Devadoss, R. M. M. Vidya Press1976
3) The craft of scientific writing-Michael Alley (Springer).
4) Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) Practical skills in chemistry. 2nd Ed. Prentice-Hall, Harlow.
5) Hibbert, D. B. & Gooding, J. J. (2006) Data analysis for chemistry. Oxford University Press.
6) Topping, J. (1984) Errors of observation and their treatment. Fourth Ed., Chapman Hall, London.
7) Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3-5.
8) Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis. Cambridge Univ. Press (2001) 487 pages.
9) Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
10) OSU safety manual 1.01.

DSE 3 - Semester VI

Course Title: Dyes

Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)

Course Code: 20US6CHDYC5

After completion of this course a student should be able to

CO1: Identify the essential properties of dyes

CO2: Relate the colour with structure of dyes and recognize the toxic effects of dyes.

CO3: Describe the dyeing techniques and methodologies involved in the manufacture of dyes.

Module I: Introduction to Dyestuff 12L

Learning Objective

- The module is intended to introduce the basic aspects of dyestuff chemistry.

Learning outcome

After completing the module the student will be able to

•understand the important properties of dyes

•relate the names of dyes with its properties and application

•classify the based on their mode of application to the substrate

1.1Introduction to Dyestuff Chemistry 6L

1.1.1 Important landmark in the history of dyes:

1.1.1.1Natural colouring matter and their limitations:e.g,; Heena, Turmeric, kesar, Chlorolphyll, Indigo, Alizarine from roots of madder plants, Logwood. Tyrian purple.

1.1.1.2Synthetic Dyes: Important milestones, i.e. Mauve, Diazotization, aniline Yellow, Congo Red, Synthesis and structure of Indigo, disperse Dye, fluorescent Brighteners, procion reactive Dyes, Remazole Dyes. (Emphasis on Name of the Scientist and dyes and the year of the discovery is required and structure is not expected)

1.1.2 Definition of dyes, Propertiesi.e. colour, chromophore and auxochrome, Solubility, Linearity, Coplanarity, fastness properties, substantivity, and Economic viability.

1.1.3 Explanation of nomenclature of commercial dyes with atleast one example. Suffixes-G, O, R, B, 6B, GK, 3GK, 6GK, L, S Explanation: naming of dyes by colour index(two examples)

1.2Classification Based on Application 6L

Definition, fastness properties & applicability on substrates examples with structures (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, Victoria Blue B (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes-Diazo components; Fast yellow G,Fast orange R. Coupling components. Naphtol AS, Naphthol ASG (e) Mordant Dyes-Erichrome Black A, Alizarin. (f) Vat Dyes- Indanthrene brown RRD, Indanthrene Red 5GK. (g) Sulphur Dyes- Sulphur Black T (no structure) (h) Disperse Dyes-Celliton Fast brown 3R, perlon fast blue FFR (i) Reactive Dyes-cibacron Brillant Red B, procion briilant Blue HB.

Module II: Properties of dye 12L

Learning Objective

- The module is intended to relate the colour property of dye with its structure

Learning outcome

After completing the module the student will be able to

- Identify the principles of color theory as it relates to structure,
- recognize the use of dyes as optical brightners and pigments
- review the toxic effects caused by dyes and dye intermediates

2. 1 Colour and chemical constitution of dyes 5L

2.1.1 Absorption of visible light, colour of wavelength absorbed, complementary colour.

2.1.2 Relation between colour and chemical constitution. (i) Witt's Chromophore theory (ii) Armstrong theory (quinonoid theory) and its limitations (iii) Valence Bond theory; Comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenze, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones. (iv) Molecular Orbital Theory.

2.2 Optical Brighteners 2L

General idea and important characteristics of optical brighteners, one example each with structure of the following classes: Stilbene, Coumarin, Heterocyclic vinylene derivatives, Diaryl pyrazolines, Naphthalimide derivatives.

2.3 Organic Pigments 2L

General idea, distinguish between dyes and pigments, important characteristics of organic pigments, Toners, Lakes, Classification of organic pigments with suitable examples, i.e. Ionic pigments-Lake of acid and basic dyes. Nonionic pigments-Azo, Indigoid, Anthraquinone, Quinacridone, Phthalocyanine (Copper phthalocyanine).

2.4 Ecology and Toxicity of Dyes 3L

With reference to the textile dyes, food colours, cosmetic dyes, benzidine, phenylene diamines.

Module III: Syntheses of dyes 12L

Learning Objective

- The module is intended to illustrate the characteristic properties and syntheses of specific non-textile dyes and explain the various dyeing techniques

Learning outcome

After completing the module the student will be able to

- list the non-textile uses of dyes
- justify characteristic properties of dyes according to their application.
- identify the various unit processes involved in organic chemistry for the synthesis of dyes having non textile applications

- understand the various dyeing techniques for different textiles and the forces involved in their substantivity.

3.1 Non-textile Uses of Dyes 5L

Structural features of the substrate, fastness and other property requirements and main classes of dyes used to be mentioned as applicable (One example of each Class with structure expected).

1. Leather -Bismark Brown
2. Paper- Auramine O
3. Foodstuff - Tartazine
4. Cosmetics-4'-Amino Diphenylamine-4-sulphonic acid
5. Medicinal - Crystal Violet
6. Biological Stains - Methylene Blue
7. Indicator & Analytical Reagents- Eriochrome Black T
8. Coloured Smokes & Camouflage colours-Purpurin
9. Laser Dyes –Rhodamine G

3.2 Synthesis and Uses of Specific Dyes- 3L

Brief Idea of Unit Process, Unit Operations and Intermediates.

- Bismark Brown from Benzene via m-phenylene diamine
- Auramine O from Benzene via Aniline
- Tartazine from aniline via phenyl hydrazine-4-sulphonic acid
- Crystal Violet from Aniline.
- Methylene Blue from Aniline and 4-Amino-N,N-Dimethyl aniline
- Eriochrome Black T from Napthalene.

3.3 Types of Fibres and Classes of Dyes Applicable to them 1L

Introduction to the following types of fibres with structures and classes of dyes applicable to it. Cotton, Wool, Silk, Polyester.

3.4 Dyeing Method and Dye Fibre Forces 3L

3.4.1 (i) Direct dyeing (ii) Vat dyeing (iii) Mordant dyeing (iv) Disperse dyeing

3.4.2 Forces binding of dyes to the fibres: Ionic forces, Hydrogen bonds, Vander-Wall's forces, Covalent linkages.

Course Title: Dyes Practicals

Course Code: 20US6CHP5

Course Credit-1

Learning Objectives

The course is intended to introduce the learner to

- Preparation of Dye and Dye intermediates
- Estimation of Dyes

Learning Outcome

After completing this course, a student will be able to

- Use diazotization and coupling reaction to synthesize different azo dyes
- Estimate the dyes quantitatively using the technique of diazotization and colorimetry.

Preparation

I) Preparation of Orange-II

II) Preparation of m-nitroaniline

Estimation

I) Estimation of Primary amino group by diazotisation

II) Estimation of Methyl Orange/ Eriochrome Black T/Eosin/Congo Red by colorimetry.

Dyeing of fabric (cotton) by Direct Dyeing or by Vat Dyeing

Reference books:

(1) Chemistry of synthetic dyes, Vol. I to VI, K. Venkataraman
(2) Chemistry of synthetic dyes and pigments, H. A. Lubs
(3) Colour Chemistry, H. Zollinger
(4) Colour Chemistry, R. L. M. Allen
(5) Unit process, Groggins
(6) Synthetic dyes, M. S. Yadav
(7) Physical Chemistry of dyeing, Thomas Vickerstaff
(8) Chemistry of dyes and principles of dyeing, V. A. Shenai
(9) Practical Organic Chemistry, A. I. Vogel

DSE 4 Semester VI

Course Title: Polymers
Course Code: 20US6CHPLC6
Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)

The course examines the use of polymers and explains how their properties are controlled by their molecular structure. Students will understand how this structure determines which polymer to use for a particular product. You will also explore different recycling technologies used and the how the use of polymerisation can be used to control the structure of polymers.

After completion of this course a student should be able to
CO1: understand polymer nomenclature classification and molecular structure.
CO2: Recognize the structure, stereochemistry and factors affecting the shape and size of polymers
CO3: Aware about environmental impact assessment, circular economy, sustainability tenets and different recycling technologies

Module I: Concepts and Methods in Polymer Science 12L

Learning Objectives

The module is intended to

- make aware of today's market place of polymers.
- understand the Polymer nomenclature and classification.
- understand polymer molecular structure and polymerizabilty of monomers.

Learning Outcome

A student will be able to

- know the history of polymers and its market value.
- classify and name different polymers based on different factors such as sources, thermal properties
- learn polymer molecular structure .

1.1. Development of polymer science as a discipline. Why polymers? Today's market place ofpolymers. History of polymers. Fundamental terms.
1.2. Macromolecular hypothesis. Polymer nomenclature and classification based on factors - sources, thermal properties, chain type, polymerization processes, applications, Copolymers, Blend IPN Dendrite, Ladder polymers.
1.3. Molecular structure and polymerizabilty of monomers. Monomer raw materials. Polymer molecular weight. Number-Average and weight-average molecular weight. Molecular weight distribution Polydispersity index.

Module II: Polymer Structure and Properties 12L

Learning Objectives

The module is intended to

•familiarize the structure and factors affecting the shape and size of polymers.

•understand the stereochemistry of polymers.

• understand physical and chemical methods for the determination of microstructures

Learning Outcome

A student will be able to

•Differentiate primary, secondary, tertiary and quaternary structures of polymers. .

•Learn configurations and conformations of polymers.

•Understand different methods to find out the microstructures of polymers. Familiarize the design tailored functional polymers for specificapplications.

2. Polymer Structure and Properties

2.1. Structural studies of polymers. Factors influencing the shape and size. Primary, secondary, tertiary and the quaternary structures.

2.2. Stereochemistry of polymers. Molecular interactions. Configurations and strength conformations. Stereochemistry of repeating units. Chiral centres. Tacticity. Repeat unit isomerism. Optical, geometric and substitutional isomerism.

2.3. Physical and chemical methods for the determination of microstructures. Polymer crystals Structure-Property-Performance relations. Cross-linking. Structure-property relations in cross linked functional copolymers. Design of tailored functional polymers for specific applications.

Module III: Polymer-Plastic Industry and Sustainability 12L

Learning Objectives

The module is intended to

•familiarize the environmental impact assessment.

•understand the concept of circular economy and sustainability tenets.

•Familiarize different recycling technologies.

Learning Outcome

A student will be able to

•Understand the environmental impact assessment.

•Learncircular economy,sustainability tenets.

•Understand different methods of recycling technologies.

3. Polymer-Plastic Industry and Sustainability:

3.1. Market place of polymers and plastics; Environmental Impact Assessment; Ecological footprint.

3.2. Concept of circular economy; sustainability tenets; Life Cycle Analysis Methodology.

3.3. Recycling Technologies: Feed preparation, recycling and application. Additives, processing aids and compatibilizers. Waste segregation technology for industrial plastics. Circular economy of plastics recycling. Enhancing properties of recycled plastics. Polymeric green materials. Self-destructing plastics and sustainable polymers.

Course Title: Polymer Practicals

Course Code: : 20US6CHP6

Course Credit-1

Learning Objectives

The course is intended to introduce

•Viscosity measurements for the molecular weight determination of polymers.

•Experiments to identify different types of polymers.

•Experiments to determine saponification value o, iodine value and acid number of resins.

Learning Outcome

A student will understand

•The relationship between concentration and coefficient of viscosity and how to determine molecular weight from viscosity measurements.

•Different types of polymers and their identification methods.

•Saponification value and its determination for polymers.

•Iodine value and its determination for resins

•Acid numberand its determination for resins.

1. Determination of molecular weight of PVA by viscosity measurement.
2. Identification of polymers
3. Determination of saponification value of Polyester
4. Determination iodine value of resin.
5. Determination Acid number of resin.

DSE 5 Semester V

Course Title: Essentials of Radiation Chemistry (OPTIONAL FOR DRUGS)
Course Code: 20US5CHERC5
Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)

The course examines the basics and applications of radiation chemistry and Students will understand how the nuclear radiations can be used for peaceful and constructive purpose.

Module I: Nuclear Energy 12L

Learning Objectives

The module is intended
•To focus on constructive and peaceful uses of nuclear radiations
•Make the students aware of energy generation using nuclear energy
•To understand the nuclear reactions.

Learning Outcome

A student will be able to
•know the fusion and fission reactions.
•classify and name different types of nuclear reactors.
•Radioactivity, Nuclear radiations and it's importance, Nuclear reactions, Nuclear fission and Nuclear fusion (4L)
•Introduction to Nuclear Reactors (2L)
•Energy production in nuclear reactor (3L)
•Indian Nuclear energy program. (3L)

Module II: Radiation Chemistry 12L

Learning Objectives

The module is intended
•Make the students aware of applications of radioisotopes.
•To understand the radiation units and radiological protection.

Learning Outcome

A student will be able to
•Know the applications of radioisotopes.
•Know about the effects of radiations and methods of protection.

- Applications of radioisotopes in healthcare an effect of radiations (2L)
- Diagnostic applications, Radiopharmaceuticals, Therapeutic Applications (3L)
- Radiation Units, Measurement of Exposure and dose, Biological effects of Ionizing Radiations (3L)
- Radiological protection (2L)
- Handling of radioisotopes (2L)

Module III: Radioactive Waste Management 12L

Learning Objectives

The module is intended

•Make the students aware of radiation protection.

•To classify the radioactive waste.

Learning Outcome

A student will be able to

•Create awareness about nuclear radiations

•Know about the types of radioactive waste and the disposal methods.

Radioactive Waste Management

•Protection of Human Health, Protection of Environment, Protection of Future Generations (2L)

•Classification of radioactive waste, Waste classification by IAEA, Exempt Waste, Short lived Waste, Low level Waste, Intermidiate level waste, High level waste, Waste Categorization in India. (2L)

•Treatment of radioactive waste Gaseous effluents, Treatment of organic Liquid Effluent, Treatment of Wet Solids, Treatment of solid Wastes (2L)

•Radioactive waste disposal (2L)

•Disposal of Low and Intermediate Level Waste, Storage of High Level Waste (2L)

•Disposal of High Level Waste, Treatment of Liquid Waste (2L)

Course Title: Essentials of Radiation Chemistry Practicals

Course Code: 20US5CHP5

Course Credit-1

Learning Objectives

The course is intended to introduce

•To Determine Plateau of GM counter.

•Experiments to determine Dead Time of GM counter

•Carry out Statistical Analysis of Radioactivity Measurements

•To Determine Range of alpha particles for the given source

•Learning Outcome

A student will understand

•How to determine Plateau of GM counter.

•How to determine Dead Time of GM counter

•To Carry out Statistical Analysis of Radioactivity Measurements

•To find Range of alpha particles for the given source

Experiments

1. Determination of Plateau of GM counter
2. Determination of Dead Time of GM counter
3. Statistical Analysis of Radioactivity Measurements
4. Determination of Range of alpha particles for the given source

DSE 6- Semester V

Course Title: Environmental Chemistry
(OPTIONAL FOR RESEARCH METHODOLOGY)
Course Credit- 2 (No. of Teaching 30 hrs / 36 L)
Course Code: 20US5CHENC6

Learning Objectives:

After completion of this course the student should be able to

CO1: Understand the basic concepts of Environmental Toxicology
CO2: Recognize the different Sources and control technologies of Air and Water pollution
CO3:Learn about Soil fertility and classical and instrumental methods of Soil analysis.

Module– I: Environmental Toxicology 12L

Learning Objective:

- The module is intended to introduce the types of organic and inorganic toxic substances and their effects on individuals and environment

Learning Outcome:

- A student will understand the basics concepts toxicology, different types of toxicants in our daily lifeand risk analysis.

1.1 Introduction too toxic substances and toxicity: Meaning of some important terms used in toxicology, types of toxic substances common environmental toxicants, hazardous waste , Teratogenesis, mutagenesis and carcinogenesisand Neurotoxins. (3L)
1.2 Effects of Metal ion toxicity and Risk analysis (3L)
Effects of Toxic substances on Individuals: Biochemical effects, Observable physiological effects, Reversible and Irreversible effects, Effect on immune system ,
Effects after exposure: Acute, subacute and chronic toxic effects
Risk analysis : Toxicity tests, Dose response curve , Effective and Lethal dose , NOAEL and LOAEL
Mechanism of metal ion toxicity: Possible ways of generation of toxicity due to heavy metal ions, Chemical speciation, Biomethylation
1.3 Toxicity of various chemicals: (6L)
i) Heavy metals-As, Hg (case study of Minamata episode) Pb,Cd (2 L)
ii) Non metals – SOx, NOx, CO (2L)

iii) Organic – Benzene, Formaldehyde and acetaldehyde , Phenols, Nitrosamines, Isocyanateand methyl Isocyanate (Case study of Bhopal gas tragedy), organophosphates and carbamates, Dioxins PCB,PAH (2L)

Module– II: Environmental Pollution control technologies 12L

Learning Objective:

- The module is intended to introduce the different types of air and water pollution control technologies

Learning Outcome:

- A student will understand the different sources of air and water pollution and different chemical technologies for their treatment.

2.1 Air Pollution Control Techniques (6 L)
Contaminants and pathways into atmosphere: Carbon Monoxide; Oxides of nitrogen; Sulphur Dioxide; Volatile Organic Compounds Instruments techniques to monitor pollution: Carbon Monoxide; Oxides of nitrogen; Sulphur Dioxide; Volatile Organic Compounds;
2.2 Major Sources of Water Pollution (2 L)
Possible reasons for groundwater and subsurface water contamination,
Major sources : Coal Mine Drains, Pesticides and Fertilizers, Dying and Tanning industries
Eutrophication: Sources and effects, Biomagnification
2.3 Water Pollution Treatment (5L)
3.Introduction to Sewage treatment Plant and Effluent treatment Plant
4.Technological Approach: Chemical Degradation of wastes and Chemicals; . Coagulation and flocculation; Photocatalytic degradation of pollutants;. Supercritical water oxidation
Ref: https://nptel.ac.in/courses/104103020/33

Module– III: Soil Fertility and soil Analysis 12L

Learning Objective:

- The module is intended to introduce the Plant nutrients, soil fertility parameters and soil analysis

Learning Outcome:

- A student will learn the significance of the soil health, plant nutrients and different methods of soil analysis

Soil Fertility and soil Analysis
3.1 Introduction to soil profile, major soil types in India, classification of soils and their agricultural importance, problem soils, soil composition, soil fertility, Soil health and reasons for deterioration of soil health (4L)
3.2. Plant nutrients and their functions-primary, secondary and micro nutrients and their forms in soil, fate of nutrient elements in soil -Crop removal, Erosion, Leaching, Volatilization,

De-nitrification and Fixation. Deficiency symptoms of nutrients in plants ,soil fertility rating, Nutrient index, Balanced fertilization, (4L)

3.3. Soil analysis:Soil sampling techniques, preparation of soil samples, Soil pH, Soil Organic carbon,Soil Organic matter, Soil Organic carbon and climate change,Extraction and analysis of available nutrients(N,P,K) and micronutrients by instrumental analysis AAS, ICP-AES etc. Interpretation of soil analysis data-soil Health card scheme of govt of India. (4L)

Semester V

Course Title: Environmental Chemistry Practical
Course Credit- 1
Course Code: 20US5CHP6

Learning objective:

The laboratory course is designed for
1. Developing Skills for analytical techniques of environmental monitoring

Learning outcome :

After learning the student will be able to
3.Perform the soil and water analysis
4.Recommend the plants suitable for improvement of air quality

Experiments

7.To determine Air Pollution Tolerance Index (APTI) for a given plant species for its use in pollution control as well as pollution indicator
8.Evaluation of low cost adsorbent from non-toxic agricultural waste and study of adsorption capacity for removal of methylene blue dye from the waste water sample for tertiary treatment processes.
9.Estimation of chloride in water sample by Mohr's method.
10.Estimation of Soil organic carbon , soil pH and Bulk density
11.Estimation of Phosphorous from a soil sample
12.Estimation of potassium from a soil sample

MOOCs -Online Courses

Ref: https://nptel.ac.in/courses/126105016/36 accessed on 18th May 2019
Ref: https://nptel.ac.in/syllabus/syllabus_pdf/104103020.pdfaccessed on 18th May 2019
Ref: https://nptel.ac.in/courses/104103020/33accessed on 18th May 2019

Books:

1. Manahan, Stanley E. 'Fundamentals of Environmental Chemistry ' Boca Raton: CRC Press LLC,2001
2. Sonja Krause, Herbert M. Clark, James P. Ferris, Robert L. 'Strong Chemistry of the Environment ', Elsevier Science & Technology Books 2002
3. Eugene R. Weiner Applications of Environmental Chemistry 2000 CRC Press, LLC
4. By Clair N. Sawyer, Perry L. McCarty, Gene Parkin 'Chemistry for environmental engineering and science' (5th edition) McGraw-Hill Professional
5. Soil testing in India

DSE 7 - Semester VI

Course Title: Pesticides Chemistry (OPTIONAL FOR DYES)
Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)
Course Code: 20US6CHPSC5

CO1: To create awareness on pesticide chemicals and their applications.
CO2: After completion of this course the student will be know the chemistry of pesticides and will be able to analyse the pesticides.

Module I: Introduction to pesticides 12L

Learning objectives:

- This module is intended to introduce classification, effects and activity of pesticides.

Learning outcomes:

After completing the module the student will be able to:
1. Classify the pesticides according to their origin and the chemical classes.
2. Understand the adverse and beneficial effects of pesticides.
3. Relate activity with the structure

1. General introduction to pesticides (natural and synthetic), different types of pesticides-fungicides,insecticides,,herbicides (4L)
2. Benefits and adverse effects, changing concepts of pesticides, pesticides classified as potentialcarcinogen by US-EPA (5L)
3. Structure activity relationship (3L)

Module II: Fungicides and insecticides 12L

Learning objectives:

- This module is intended to introduce synthesis and technical manufacture of Fungicides and insecticides

Learning outcomes:

After completing the module the student will be able to:

- Understand various aspects of synthesis and technical manufacture of Fungicides and insecticides

1. Introduction, properties, applications, formulations of some currently used fungicides and insecticides

Module III: Herbicides and fertilizers 12L

Learning objectives:

- This module is intended to introduce synthesis and technical manufacture of Herbicides and fertilizers.

Learning outcomes:

After completing the module the student will be able to:

- Understand various aspects of synthesis and technical manufacture of Herbicides and fertilizers.

1. Introduction, properties, applications, formulations of some currently used Herbicides and fertilize

Course Title: Pesticides Practicals

Course Code: 20US6CHP5

Course Credit-1

Learning Objectives

The course is intended to introduce the learner to

•Preparation of pesticides

•Estimation of pesticides

Learning Outcome

After completing this course, a student will be able to

• Use simple reactions to synthesize simple pestides

• Estimate the acidity/ basicity of pesticides quantitatively by titrimetry.

Estimation

1. To calculate acidity in given sample of pesticide formulations as per BIS specifications.
2. To calculate alkalinity in given sample of pesticide formulations as per BIS specifications.

Preparation:
1. Preparation of simple organophosphates.
2. Preparation of simple phosphonates.
3. Preparation of simple thiophosphates.

Reference Book:

• R. Cremlyn: Pesticides, John Wiley.

DSE 8 Semester VI

Course Title: Industrial Chemistry (OPTIONAL FOR POLYMERS)
Course Code: 20US6CHINC6
Course Credit- 2 (No. of Teaching.-30 hrs / 36 L)

This course is intended to make the students aware about general aspects of chemical industries. Chemistry plays an important role in the manufacture of large number of products. A small portion of this production is covered under industrial chemistry.

Course Objectives:

A student will be able to study
•Chemical production, quality control and process control involved in industry.
•different types of fuels.
•To train students who will be employable in the industries and who can also be self employed.
•To produce graduates who can exploit the abundant natural resources of this country for the benefit of the society.

Course Outcome:

By the end of the course, student will be able to
CO1: understand basic requirement of chemical industries, chemical production and unit process.
CO2: describe characteristics of fuel and sugar, various process involved in fuel and sugar industries.

Module I: Manufacture of Ammonia, Sulphuric acid & Nitric Acid 12L

The module is intended to
•Study Physico-Chemical principles involved in manufacture of ammonia, sulphuric acid & nitric acid make aware of today's market place of polymers.

Learning Outcome

A student will be able to

•Learn the process involved in Haber & Bosch process for the manufacture of ammonia, contact process for sulphuric acid & Ostwald's process for nitric acid.

•Study applications of ammonia, sulphuric acid and nitric acid.

1. Manufacture of Ammonia, Sulphuric acid & Nitric Acid

Physico-Chemical principles involved in manufacture of ammonia, sulphuric acid & nitric acid. (3L)

Manufacture of ammonia by modified Haber & Bosch process with flow-sheet. Uses of ammonia. (3L)

Manufacture of sulphuric acid by contact process with flow sheet. Uses of Sulphuric acid.(3L)

Manufacture of nitric acid by Ostwald's process with flow sheet. Uses of nitric acid. (3L)

Module II: Fuels 12L

Learning Objectives

The module is intended to

•make the students familiar with fuels.

•Understand importance of depletion in the abundance of natural resources of this country for the benefit of the society.

Learning Outcome

A student will be able to

•Classify fuels in to different types.

•Understand different physical and chemical properties of fuels.

2. Fuels

Introduction, definition, classification of fuels, criterion of selection of fuel. (2L)

calorific value, determination of calorific value by Bomb calorimeter and problems based on it. Other properties of fuel – ignition temperature, flash point, fire point, coke number, viscosity. (4L)

Solid fuels – coal, destructive distillation of coal, chemicals from coal. By products of coal, coking of coal, distillation of coal tar, uses of tar products. Liquid fuels – distillation of crude oil, petrol gasoline and diesel oil. Gaseous fuels – Biogas or gobar gas, LPG. (4L)

Fuel cells – methanol fuel cell, hydrogen fuel cell. (2L)

Module III: Sugar and Fermentation 12L

Learning Objectives

The module is intended to

•make the students familiar with organic industries like sugar.

•Understand importance of sugar industry and fermentation process.

Learning Outcome

A student will be able to
•Manufacturing process involved in sugar industry.
•Utilization of byproducts of sugar industry.
•Fermentation process and operations.

3.1. Sugar **6L**

Importance of Sugar industry, Manufacture of raw sugar from sugar cane with flow sheet, extraction of juice, compound imbibition process, concentration by multiple compound imbibition process, concentration of multiple evaporators, crystallisation (single vacuum pan)
Refining of raw sugar in brief, utilisation of byproducts of sugar industry.
Estimation of sugar by Brix hydrometer &refractomer.

3.2 Fermentation **6L**

Definition, conditions favourable for fermentation, fementation operation, requirements for fermentation processes.
Manufacture of alcohol from molasses, coffey still, proof spirit, rectified spirit, absolute alcohol.
Other useful fermentation products with respect to medium organism etc., Acetic acid, vinegar, citric acid etc.

Course Title: Industrial Chemistry Practicals

Course Code: 20US6CHP6

Course Credit-1

Learning Objectives

The course is intended to introduce
•How to analyze different commercial samples
•Working of chemical industry.

Learning Outcome

A student will understand
•Moisture content measurements for the fuel.
•Experiment to determine strength of given commercial sample of acid.
•Experiments to determine glucose content in the given sample

1. To determine the moisture content in the given sample of fuel.
2. To determine strength of given commercial sample of acid.
3. To determine glucose content in the given sample by Folin-Wu method.
4. Visit to industry.
