**VINAYAKA MISSION'S RESEARCH FOUNDATION**

**(Deemed to be University)**

**FACULTY OF ARTS & SCIENCE**

# Curriculum and Syllabus

**for**

# B.Sc.

# CHEMISTRY (Regular)

## LOCF – 2021

**(For the Academic Year starting from 2021-2022 onwards)**

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

**FACULTY OF ARTS AND SCIENCE**
**B.Sc. CHEMISTRY – CURRICULUM & SYLLABUS- 2021**

# PROGRAMME LEARNING OUTCOMES

The Bachelor of Science with Chemistry (B.Sc. Chemistry) program enables students to accomplish, by the time of graduation:

PLO-A. Systematic and coherent understanding of the fundamental concepts in Physical chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry and all other related allied chemistry subjects..

PLO-B. Students will be able to use the evidence based comparative chemistry approach to explain the chemical synthesis and analysis.

PLO-C. The students will be able to understand the characateriziaton of materials.

PLO-D. Students will be able to understand the basic principle of equaipments, instruments used in the chemistry laboratory.

PLO-E. Students will be able to demonstrate the experimental techniques and methods of their area of specialization in Chemistry.

PLO-F. A graduate student is expected to be capable of demonstrating comprehensive knowledge and understanding of both theoretical and experimental/applied chemistry knowledge in various fields of interest like Analytical Chemistry, Physical Chemistry, Inorganic Chemistry, Organic Chemistry, Material Chemistry, etc. Further, the student will be capable of using of advanced instruments and related soft-wares for in-depth characterization of materials/chemical analysis and separation technology.

PLO-G. The course curriculum incorporates basics and advanced training in order to make a graduate student capable of expressing the subject through technical writing as well as through oral presentation.

PLO-H. The course curriculum also includes components that can be helpful to graduate students to develop critical thinking ability by way of solving problems/numerical using basic chemistry knowledge and concepts.

PLO-I. It is expected that the course curriculum will develop an inquisitive characteristics among the students through appropriate questions, planning and reporting experimental investigation.

PLO-J. The course curriculum has been designed to provide opportunity to act as team player by contributing in laboratory, field based situation and industry.

**Additional PLOs**

The Bachelor of Science in with Chemistry (B.Sc. Chemistry) program enables students to achieve following additional features besides the abovee-mentioned attributes, by the time of graduation:

PLO-K. The course curriculum has been designed in such a manner as to enabling a graduate student to become a skilled project manager by acquiring knowledge about chemistry project management, writing, planning, study of ethical standards and rules and regulations pertaining to scientific project operation.

PLO-L. The course curriculum has been so designed to impart a good working knowledge in understanding and carrying out data analysis, use of library search tools, and use of chemical simulation software and related computational work.

PLO-M. A graduate student requires to understand and develop ethical awareness/reasoning which the course curriculum adequately provide.

PLO-N. The course curriculum is designed to inculcate a habit of learning continuously through use of advanced ICT technique and other available techniques/books/journals for personal academic growth as well as for increasing employability opportunity.

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# CURRICULUM

| Semester | Language Courses (Part - I & Part - II) | Compulsory Core Courses (CC) | Discipline SpecificElective (DSE) / Interdisciplinary Courses | Ability Enhancement Compulsory Courses (AECC) | Skill Enhancement Course (SEC) | Total Credits |
|---|---|---|---|---|---|---|
| Sem I | Tamil - I/Hindi - I (3 Credits) & English - I (3 Credits) | CC - I (1 x 6 credits = 6 credits) | DSE - I (1 x 6 credits = 6 credits) | AEC - I (Environmental Science) 4 Credits | --- | 22 |
| Sem II | Tamil - II/Hindi - II (3 Credits) & English - II (3 Credits) | CC - II (1 x 6 credits = 6 credits) | DSE - II (1 x 6 credits = 6 credits) | --- | SEC - I (1 X 4 = 4 Credits) | 22 |
| Sem III | Tamil - III/Hindi - III (3 Credits) & English - III (3 Credits) | CC - III & CC - IV (2 x 6 credits = 12 credits) | DSE - III (1 x 6 credits = 6 credits) | --- | --- | 24 |
| Sem IV | Tamil - IV/Hindi - IV (3 Credits) | CC - V & CC - VI (2 x 6 credits = 12 credits) | DSE - IV (1 x 6 credits = 6 credits) | AEC - II (English for Communication ) - 4 Credits | --- | 25 |
| Sem V | --- | CC - VII, CC - VIII & CC - IX (3 x 6 credits = 18 credits) | | --- | SEC - I & SEC - III (2 X 4 = 8 Credits) | 26 |
| Sem VI | --- | CC - X, CC - XI & CC - XII (3 x 6 credits = 18 credits) | DSE - V: Project Work (1 x 6 credits = 6 credits) | --- | SEC - IV (1 X 4 = 4 Credits) | 28 |
| Total | 21 | 72 | 30 | 8 | 16 | 147 |

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**FACULTY OF ARTS AND SCIENCE**
**B.Sc. CHEMISTRY – CURRICULUM & SYLLABUS- 2021**

| Semester | Component Code | Semester wise course details | Credits | Theory / Practical | Total Credits |
|---|---|---|---|---|---|
| **First Semester** | Part – I | Tamil-I/Hindi-I | 3 | Theory | 22 |
| | Part – II | English-I | 3 | Theory | |
| | CC - I | Inorganic Chemistry-I | 4 | Theory | |
| | | Inorganic Chemistry Practical-I | 2 | Practical | |
| | DSE-I | Discipline Specific Elective Course - I | 6 | Theory (6) / Theory (4) + Practical (2) | |
| | AEC - I | Environmental Science | 4 | Theory | |
| **Second Semester** | Part – I | Tamil-II / Hindi- II | 3 | Theory | 22 |
| | Part – II | English-II | 3 | Theory | |
| | CC - II | Organic Chemistry-I | 4 | Theory | |
| | | Organic Chemistry Practical-I | 2 | Practical | |
| | DSE-II | Discipline Specific Elective Course - II | 6 | Theory (6) / Theory (4) + Practical (2) | |
| | SEC - I | Skill Enhancement Courses - I | 4 | Theory | |
| **Third Semester** | Part – I | Tamil-III / Hindi- III | 3 | Theory | 24 |
| | Part – II | English - III | 3 | Theory | |
| | CC - III | Physical Chemistry-I | 4 | Theory | |
| | | Physical Chemistry Practical-I | 2 | Practical | |
| | CC - IV | Organic Chemistry-II | 4 | Theory | |
| | | Organic Chemistry Practical - II | 2 | Practical | |
| | DSE-III | Discipline Specific Elective Course - III | 6 | Theory (6) / Theory (4) + Practical (2) | |

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**FACULTY OF ARTS AND SCIENCE**
**B.Sc. CHEMISTRY – CURRICULUM & SYLLABUS- 2021**

| Semester | Component Code | Semester wise course details | Credits | Theory / Practical | Total Credits |
|---|---|---|---|---|---|
| **Fourth Semester** | Part – I | Tamil-IV / Hindi- IV | 3 | Theory | 25 |
| | CC - V | Physical Chemistry-II | 4 | Theory | |
| | | Physical Chemistry Practical- II | 2 | Practical | |
| | CC - VI | Organic Chemistry-III | 4 | Theory | |
| | | Organic Chemistry Practical - III | 2 | Practical | |
| | DSE-IV | Discipline Specific Elective (DSE) Course - IV | 6 | Theory (6) / Theory (4) + Practical (2) | |
| | AEC - II | English for communication | 4 | Theory | |
| **Fifth Semester** | CC - VII | Molecular Spectroscopy & Photochemistry | 4 | Theory | 26 |
| | | Spectroscopy practical | 2 | Practical | |
| | CC - VIII | Physical Chemistry-III | 4 | Theory | |
| | | Physical Chemistry practical - III | 2 | Practical | |
| | CC - IX | Inorganic Chemistry-II | 4 | Theory | |
| | | Inorganic Chemistry practical - II | 2 | Practical | |
| | SEC - II | Skill Enhancement Courses - II | 4 | Theory | |
| | SEC - III | Skill Enhancement Courses - III | 4 | Theory | |
| **Sixth Semester** | CC - X | Introduction to Quantum Chemistry | 4 | Theory | 28 |
| | | Applications of Quantum Chemistry - Practical | 2 | Practical | |
| | CC - XI | Inorganic Chemistry-III | 4 | Theory | |
| | | Inorganic Chemistry practical - III | 2 | Practical | |
| | CC - XII | Analytical Chemistry | 4 | Theory | |
| | | Analytical chemistry practical | 2 | Practical | |
| | DSE - V | Project work | 6 | Project | |
| | SEC - IV | Skill Enhancement Courses - IV | 4 | Theory | |
| **TOTAL CREDITS** | | | | | **147** |

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## COURSE LEARNING OUTCOMES

The course learning outcomes are aligned with program learning outcomes but these are specific-to-specific courses offered in a program. The course level learning shall be reflected as program level learning. The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with multi-dimensional and multidisciplinary approach.

# CORE COURSES (CC)

| S. No. | Name of the course | Type of course | L | T | P | Credits |
|---|---|---|---|---|---|---|
| **CC – I** | Inorganic Chemistry-I | Core course | 3 | 1 | 0 | **4** |
| | Inorganic Chemistry Practical | Core course | 0 | 0 | 2 | **2** |
| **CC – II** | Organic Chemistry-I | Core course | 3 | 1 | 0 | **4** |
| | Organic Chemistry Practical | Core course | 0 | 0 | 2 | **2** |
| **CC - III** | Physical Chemistry-I | Core course | 3 | 1 | 0 | **4** |
| | Physical Chemistry Practical | Core course | 0 | 0 | 2 | **2** |
| **CC – IV** | Organic Chemistry-II | Core course | 3 | 1 | 0 | **4** |
| | Organic Chemistry Practical | Core course | 0 | 0 | 2 | **2** |
| **CC – V** | Physical Chemistry-II | Core course | 3 | 1 | 0 | **4** |
| | Physical Chemistry Practical | Core course | 0 | 0 | 2 | **2** |
| **CC – VI** | Organic Chemistry-III | Core course | 3 | 1 | 0 | **4** |
| | Organic Chemistry Practical | Core course | 0 | 0 | 2 | **2** |
| **CC – VII** | Molecular Spectroscopy & Photochemistry | Core course | 3 | 1 | 0 | **4** |
| | Spectroscopy practicals | Core course | 0 | 0 | 2 | **4** |
| **CC - VIII** | Physical Chemistry-III | Core course | 3 | 1 | 0 | **4** |
| | Physical Chemisry practical | Core course | 0 | 0 | 2 | **2** |
| **CC – IX** | Inorganic Chemistry-II | Core course | 3 | 1 | 0 | **4** |
| | Inorganic Chemistry practical | Core course | 0 | 0 | 2 | **2** |
| **CC - X** | Introduction to Quantum Chemistry | Core course | 3 | 1 | 0 | **4** |
| | Chemistry Practical | Core course | 0 | 0 | 2 | **2** |
| **CC - XI** | Inorganic Chemistry-III | Core course | 3 | 1 | 0 | **4** |
| | Inorganic Chemistry practical | Core course | 0 | 0 | 2 | **2** |
| **CC – XII** | Analytical Chemistry | Core course | 3 | 1 | 0 | **4** |
| | Analytical chemistry practical | Core course | 0 | 0 | 2 | **2** |

# COURSE OUTCOMES FOR CORE COURSES:

## 1. Inorganic Chemistry-I

2. Atomic theory and its evolution.
3. Learning scientific theory of atoms, concept of wave function.
4. Elements in periodic table; physical and chemical characteristics, periodicity.
5. To predict the atomic structure, chemical bonding, and molecular geometry based on accepted models.
6. To understand atomic theory of matter, composition of atom.
7. Identity of given element, relative size, charges of proton, neutron and electrons, and their assembly to form different atoms.
8. Defining isotopes, isobar and isotone.
9. Physical and chemical characteristics of elements in various groups and periods according to ionic size, charge, etc. and position in periodic table.
10. Characterize bonding between atoms, molecules, interaction and energetics (ii) hybridization and shapes of atomic, molecular orbitals, bond parameters, bond-distances and energies.
11. Valence bond theory incorporating concepts of hybridization predicting geometry of molecules and Importance of hydrogen bonding, metallic bonding.

## 2. Organic Chemistry-I

1. Basic of organic molecules, structure, bonding, reactivity and reaction mechanisms.
2. Stereochemistry of organic molecules – conformation and configuration, asymmetric molecules and nomenclature.
3. Aromatic compounds and aromaticity, mechanism of aromatic reactions.
4. Understanding hybridization and geometry of atoms, 3-D structure of organic molecules, identifying chiral centers.
5. Reactivity, stability of organic molecules, structure, stereochemistry.
6. Electrophile, nucleophiles, free radicals, electronegativity, resonance, and intermediates along the reaction pathways.
7. Mechanism of organic reactions (effect of nucleophile/leaving group, solvent), substitution vs. elimination.

## 3. Physical Chemistry-I

1. Familiarization with various states of matter.
2. Physical properties of each state of matter and laws related to describe the states.
3. Calculation of lattice parameters.
4. Electrolytes and electrolytic dissociation, salt hydrolysis and acid-base equilibria.
5. Understanding Kinetic model of gas and its properties.
6. Maxwell distribution, mean-free path, kinetic energies.
7. Behavior of real gases, its deviation from ideal behavior, equation of state, isotherm and law of corresponding states.
8. Liquid state and its physical properties related to temperature and pressure variation.
9. Properties of liquid as solvent for various household and commercial use.
10. Solids, lattice parameters – its calculation, application of symmetry, solid characteristics of simple salts.
11. Ionic equilibria – electrolyte, ionization, dissociation.
12. Salt hydrolysis (acid-base hydrolysis) and its application in chemistry.

## 4. Organic Chemistry-II

1. Familiarization about classes of organic compounds and their methods of preparation.
2. Basic uses of reaction mechanisms.
3. Name reactions, uses of various reagents and the mechanism of their action.
4. Preparation and uses of various classes of organic compounds.
5. Organometallic compounds and their uses.
6. Organic chemistry reactions and reaction mechanisms.
7. Use of reagents in various organic transformation reactions.

## 5. Physical Chemistry-II

1. Laws of thermodynamics and concepts.
2. Partial molar quantities and its attributes.
3. Dilute solution and its properties.
4. Understanding the concept of system, variables, heat, work, and laws of thermodynamics.
5. Understanding the concept of heat of reactions and use of equations in calculations of bond energy, enthalpy, etc.
6. Understanding the concept of entropy; reversible, irreversible processes. Calculation of entropy using 3nd law of thermodynamics.
7. Understanding the application of thermodynamics: Joule Thompson effects, partial molar quantities.
8. Understanding theories/thermodynamics of dilute solutions.

## 6. Organic Chemistry-III

1. Nitrogen containing functional groups and their reactions.
2. Familiarization with polynuclear hydrocarbons and their reactions.
3. Heterocyclic compounds and their reactions.
4. Alkaloids and Terpenes
5. Understanding reactions and reaction mechanism of nitrogen containing functional groups.
6. Understanding the reactions and mechanisms of diazonium compounds.
7. Understanding the structure and their mechanism of reactions of selected polynuclear hydrocarbons.
8. Understanding the structure, mechanism of reactions of selected heterocyclic compounds.
9. Classification, structure, mechanism of reactions of few selected alkaloids and terpenes.

## 7. Molecular Spectroscopy & Photochemistry

1. Understanding electromagnetic radiation with molecules and various types of spectra
2. Determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.
3. Understanding Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations
4. Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra
5. Understanding laws of photochemistry, quantum yield. Jablonski diagrams: Franck-Condon principle, Law of photochemical equivalence, quantum efficiency, low and high quantum efficiency
6. Discussion of Electronic spectra and photochemistry

## 8. Physical Chemistry-III

1. Phases, components, Gibbs phase rule, Phase diagrams and applications.
2. Chemical kinetics: type of reactions, determination of rate, theories of reaction rate, steady state approximation.
3. Catalyst – mechanism, acid base catalysis, enzyme catalysis.
4. Adsorption isotherms.
5. Understanding phases, components, Gibb's phase rule and its applications, construction of phase diagram of different systems, the application of phase diagram.
6. Understanding the basics of chemical kinetics: determination of order, molecularity, and understanding theories of reaction rates, determination of rate of opposing/parallel/chain reactions with suitable examples, application of steady state kinetics, Steady-state approximation.
7. Catalyst – mechanism of catalytic action, enzyme catalysis.
8. Langmuir, Freundlich – adsorption isotherms, significance, multilayer adsorption – theory and significance.

## 9. Inorganic Chemistry-II

1. Oxidation-Reductions and their use in metallurgy.
2. Chemistry of s and p-block elements.
3. Chemistry of noble gases.
4. Inorganic polymers and their use.
5. Understanding redox reactions in hydrometallurgy processes.
6. Structure, bonding of s and p block materials and their oxides/compounds.
7. Understanding chemistry of boron compounds and their structures.
8. Chemistry of noble gases and their compounds; application of VSEPR theory in explaining structure and bonding.
9. Understanding chemistry of inorganic polymers, their structures and uses.

## 10. Introduction to Quantum Chemistry

1. black-body radiation and distribution of energy, photo-electic effect
2. The wave function: wave function and its interpretation, conditions of normalization and Orthogonality and its significance
3. Schrodinger equation in polar coordinates, radial and angular parts of the hydrogenic orbitals, degeneracies, spherical harmonics
4. Rigid rotator model and discussion of application of Schrodinger equation
5. Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates
6. Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates

## 11. Inorganic Chemistry-III

1. Coordination compounds – its nomenclature, theories, d-orbital splitting in complexes, chelate.
2. Transition metals, its stability, color, oxidation states and complexes.
3. Lanthanides, Actinides – separation, color, spectra and magnetic behavior
4. Bioinorganic chemistry – metal ions in biological system, its toxicity; hemoglobin.
5. Understanding the nomenclature of coordination compounds/complexes, Molecular orbital theory, d-orbital splitting in tetrahedral, octahedral, square planar complexes, chelate effects.
6. Understanding the transition metals stability in reactions, origin of colour and magnetic properties.
7. Understanding the separation of Lanthanoids and Actinoids, its color, spectra and magnetic behavior.
8. Understanding the bioinorganic chemistry of metals in biological systems.
9. Hemoglobin and its importance in biological systems.

## 12. Analytical Chemistry

1. Familiarization with fundamentals of analytical chemistry.
2. Basics of spectroscopic, thermal, electrochemical techniques
3. Learning basics of separation techniques and its applications.
4. Understanding analytical tools, statistical methods applied to analytical chemistry.
5. Understanding principle of UV-Vis spectroscopy and its applications.
6. Understanding principles of thermo-gravimetric analysis and study of thermal decomposition of materials/characterization of materials.
7. Understanding basics of electro-analytical techniques and its applications.
8. Understanding principles of separation technology and its use in advanced instrumentations.

## TAMIL - I

### பாட நோக்கம் :

1.தமிழ் மரபுக்கவிதை, புதுக்கவிதை முதலானவற்றை அறிமுகப்படுத்துதல்.

2.சிறுகதை, நாவல், கட்டுரை முதலான இலக்கிய வடிவங்களைக் கற்பித்தல்.

3.இக்கால இலக்கியத்தின் மீதான ஈர்ப்பை மிகுவித்தல்.

4.கவிதை, கட்டுரை, நாவல், சிறுகதை இவற்றை சுயமாக படைக்க, படைப்பாற்றலைத் தூண்டல்.

5.படிமம், குறியீடு, இறைச்சி, உவமம் பற்றி அறிய வைத்தல்.

6.பக்தி மற்றும் ஆன்மீகத்தை பற்றி இக்கால இலக்கிய வழி அறிமுகப்படுத்துதல்.

### கற்றல் பயன் :

1.தமிழ் இலக்கியத்தின் மீதான ஆர்வம் மிகும்.

2.புதிய இலக்கிய வடிவங்களை அறிவர்

3.கவிதை, சிறுகதை ஆகியவற்றை படைக்க முயல்வர்.

4.தமிழ் இலக்கியங்களின் மூலமாக படைப்பாற்றலும், பன்முகத்திறன்களும் வெளிப்படும்.

5.முக்கிய உத்திகளை அறிந்து கொள்வர்.

6.தமிழ் இலக்கிய முன்னோடிகளை அறிவர்.

### வுயுஆஜடு □ ஜஜ

### பாட நோக்கம் :

1.அண்மைக்கால இலக்கியங்களின் வழி சமூக நிலைபாட்டினை அறிதல்.
2.இக்கால இலக்கியங்களின் மூலமாக புதிய படைப்பாளியின் அனுபவ அறிவினை பெறச்செய்தல்.

3.செய்யுள், இலக்கணம் அறியச்செய்தல்

4.இலக்கிய வரலாற்றினை முழுமையாக கற்பித்தல்.
5.வாழ்வியல் பயன்பாட்டுக் கல்வியை அறியச் செய்தல்.
6.உரைநடையை பிழையில்லாமல் எழுதச்செய்தல், வடிவம் வகைகளை அறியச்செய்தல்.

**கற்றல் பயன் :**

1.இக்கால இலக்கிய மரபுகளை அறிந்துக் கொள்வதன் மூலம் தமிழ் இலக்கிய வகைமை மாற்றங்களை புரிந்துக் கொள்ளுதல்.
2.இக்கால இலக்கிய மரபுகள் குறித்த விமர்சன பார்வை பெறல்.
3.செய்யுள் இயற்றுவது எவ்வாறு என அறிந்து கொள்வர்.
4.தமிழ் இலக்கிய வரலாறு அறிவர்.
5.பயன்பாட்டு கல்வி மூலம் விண்ணப்பங்கள் எழுதவும், விமர்சனம் செய்தல் என பல திறன்களை பெறுவர்.
6.உரைநடையினை நன்கு எழுத அறிவர்.

## TAMIL – III

**பாட நோக்கம் :**

1.தமிழ் இலக்கிய வரலாற்றில் ஐம்பெரும்காப்பியங்கள், நாடகங்கள், பக்தி இலக்கியம் பெறும் இடம் குறித்து விளக்குதல்.

2.காப்பியச் சுவையும் நாடக இன்பத்தையும் பக்தி பெருக்கையும் மாணவர்கள் அறியச் செய்தல்.

3.நாடக இலக்கியம் - அக்கால, இக்கால தன்மையினை அறியச் செய்தல்.

4.காப்பியங்களின் வழி நீதியை உணரச் செய்தல், விழுமிய கோட்டுபாடுகளை அறிய வைத்தல்.

5.பல்வேறு சமயங்கள் பக்தி இலக்கியத்தை வளர செய்த பின்புலத்தை அறியச் செய்தல்.

**கற்றல் பயன் :**

1.மாணவர்கள் தமிழ் இலக்கிய வரலாற்றின் காப்பியம், நாடகம், பக்தி இலக்கியம் பக்தி இலக்கியம் பற்றி அறிதல்.

2.வாழ்வின், வழிபாட்டின் முக்கியத்துவம் உணர்ந்து கடைப்பிடிப்பர்.

3.நாடகம் மூலம் நடிப்புக்கலை பற்றி அறிந்து கொண்டு நடிக்க முயல்வர்.

4.நாடகம் இயற்றி அதில் படைப்பாற்றலை படைக்க முயல்வர்.

5.பக்கி இலக்கியங்களின் மூலம் இசையோடு பாடுவது பற்றியும், ஆழ்வார்கள், நாயன்மார்கள், சமணம், பௌத்தம் போன்ற பல்வேறு வகையான சமய அறிவினை மாணவர்கள் பெறுவார்கள்.

## TAMIL - IV

### பாட நோக்கம் :

1.பண்டைய இலக்கியத்தின் முக்கியத்துவம் உணரச் செய்தல்.
2.நாட்டார் வாழ்வியல் கூறுகளை அறியச் செய்தல்.
3.இராமலிங்க வள்ளலார், தாயுமானவர் ஆகியோர்களின் பாடல்கள் வழி உயிர்கொல்லாமை, சமரச சன்மார்க்கம், அன்பு, கருணை ஆகிய நெறிகளை அறிய வைத்தல். திருமந்திர பாடல்களையும் அறிய செய்தல்.
4.ஔவையார், காளமோகம், ஒட்டக்கூத்தர், இரட்டைப்புலவர்கள் மூலம் கவிநயப் பாடல்களை அறிய வைத்தல்.
5.நாட்டுப்புற தாலாட்டு, ஒப்பாரி, கும்மி, தெருக்கூத்து, பழந்தமிழர் உணவு, கைவினை கலைகள், விடுகதைகள், பழமொழிகள் ஆகியவற்றை அறியச் செய்தல்.
6.கட்டுரை எழுதுவது எவ்வாறு என அறிய வைத்தல்.

### கற்றல் பயன் :

1.பண்டைய இலக்கியத்தினை உணர்ந்து அதன் நெறியில் வாழ முற்படுதல்.
2.பழந்தமிழரின் மரபினை பின்பற்றி அதன் விழுமியங்களை நடைமுறைப்படுத்துதல்.
3.உயர் அறங்கள் மற்றும் வாழ்வில் கடைப்பிடிக்க வேண்டிய விதிமுறைகள் நன்மை, தீமை எவை என பாகுபாடு உணர்தல் ஆகியவற்றை மாணவர்கள் அறிந்து கொள்வார்கள்.
4.பழங்கால புலவர்களின் படைப்பாற்றல் எவ்வாறு இருந்தது என்பதையும், கவித்திறன்களையும் அறிவார்கள்.
5.நாட்டார் வழக்காற்றினை அறிந்து, அதனை ஆய்வு செய்ய முற்படுவார்கள்.
6.சுயமாக கட்டுரைகள் எழுத முற்படுவார்கள்.

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## ENGLISH - I

1. Instigate the significance of various cultures, languages and historic periods, letting the students to appreciate poetry as a literary art and its various elements of poetry, such as diction, tone, form, genre and the use of imagery in day to day life.
2. To explore the 'How' question, where writers use the resources language as a creativity to explore the entire range of human experience through dramas as a literary form.
3. Record the experience of imaginative stories learnt with advanced techno-cum aids, ie: Visual teaching and audio clips respectively.
4. A two- dice platform of teaching and learning is prevailed promoting every student a basement in grammar staging from basics to collective advertising.
5. Implementation of English would concentrate, not just on the subjective credits, but also focus on

the objective living from academic to personal endeavours on thorough teaching.

6. Students will hail to be suitable for self-skills through the vital impact of English and its pre-reading to re-learning.

**ENGLISH II**

1. To understand the nuances of Poetry, Short stories and Plays to have confidence to deal with real life situation.
2. To learn the grammar, this in turn enhances the four skills of LSRW.
3. To be instigated to have an eminent craves on the poems.
4. To Improve Communication Skills to compete with the other students to have better future.
5. To comprehend the various literary writers' style and their depiction of various things in their writing.
6. To practice various methods of second language teaching and to focus on the three components of sound, grammar, vocabulary
7. To understand the use of English language in expression.

**FACULTY OF ARTS AND SCIENCE**
**B.Sc. CHEMISTRY – CURRICULUM & SYLLABUS- 2021**

# SYLLABUS - CORE COURSES (CC)

These are 12 courses. All courses are compulsory. These courses have the following credit pattern.

For Theory papers:

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

For Practical based papers:

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

## 1. Inorganic Chemistry-I:

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

On completion of this course, the students will be able to understand:

## Learning objective:

1. Atomic theory and its evolution.
2. Learning scientific theory of atoms, concept of wave function.
3. Elements in periodic table; physical and chemical characteristics, periodicity.
4. To predict the atomic structure, chemical bonding, and molecular geometry based on accepted models.
5. To understand atomic theory of matter, composition of atom.
6. Identity of given element, relative size, charges of proton, neutron and electrons, and their assembly to form different atoms.
7. Defining isotopes, isobar and isotone.
8. Physical and chemical characteristics of elements in various groups and periods according to ionic size, charge, etc. and position in periodic table.
9. Characterize bonding between atoms, molecules, interaction and energetics (ii) hybridization and shapes of atomic, molecular orbitals, bond parameters, bond- distances and energies.
10. Valence bond theory incorporating concepts of hybridization predicting geometry of molecules. Importance of hydrogen bonding, metallic bonding.

## Self-study:

1. Electronic configuration of various elements in periodic table
2. Predicting structure of molecules
3. How hydrogen bonding, metallic bonding is important in common materials' scientific applications to material fabrication

**Atomic Structure: (10 hours)**

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de' Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of $\psi$ and $\psi 2$. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

**Periodicity of Elements: (10 hours)**

*s*, *p*, *d*, *f* block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s* and *p*-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

(b) Atomic radii (van'der Waals)

(c) Ionic and crystal radii.

(d) Covalent radii (octahedral and tetrahedral)

(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.

(f) Electron gain enthalpy, trends of electron gain enthalpy.

(g) Electro-negativity, Pauling, Mullikan, Allred Rachow scales, electro-negativity and bond order, partial charge, hybridization, group electro-negativity. Sanderson electron density ratio.

**Chemical Bonding: (14 hours)**

(i) *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals.

(ii) *Covalent bond:* Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone-and bond-pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bents rule, Resonance and resonance energy, Molecular orbital theory, Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules, MO diagrams of simple tri and tetra-atomic molecules, e.g., $N_2$, $O_2$, CO, NO, and their ions; HCl, $BeF_2$ (idea of s-p mixing and orbital interaction to be given). Covalent character in ionic compounds, polarizing power and polarizability. Fajan rules, polarization. Ionic character in covalent compounds: Bond moment and dipole moment, ionic character from dipole moment and electronegativities.

**Metallic bonding and Weak chemical forces: (6 hours)**

(iii) *Metallic Bond:* Qualitative idea of free electron model, Semiconductors, Insulators.

(iv) *Weak Chemical Forces:* van'der Waals, ion-dipole, dipole-dipole, induced dipole dipole-induced dipole interactions, Lenard-Jones 6-12 formula, hydrogen bond, effects of hydrogen bonding on melting and boiling points, solubility, dissolution.

## Recommended Books/References:

1. Lee, J. D. *Concise Inorganic Chemistry,* Wiley, 5th Edn.
2. Douglas, B.E., McDaniel, D.H., Alexander J.J., *Concepts & Models of Inorganic Chemistry, (Third Edition)* John Wiley & Sons,1999.
3. Atkins, P. W. and DePaula, J. *Physical Chemistry*, Tenth Edition, Oxford University Press, 2014.
4. Rodger, G. E. *Inorganic and Solid State Chemistry*, Cengage Learning, 2002.

## 1.1. Inorganic Chemistry Practical

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

**(A) Titrimetric Analysis**

(i) Calibration and use of apparatus.

(ii) Preparation of solutions of different Molarity/Normality of titrants.

(iii) Use of primary and secondary standard solutions.

### (B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents

### (C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

## Recommended Books/References:

1. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* Sixth Edition, Pearson, 2009.
2. Svehala G. and Sivasankar I. B, Vogel's Qualitative Inorganic Analysis, Pearson, India, 2012.

## 2. Core course: Organic Chemistry-I

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

On completion of this course, the students will be able to understand:

## Learning objectives:

1. Basic of organic molecules, structure, bonding, reactivity and reaction mechanisms.
2. Stereochemistry of organic molecules – conformation and configuration, asymmetric molecules and nomenclature.
3. Aromatic compounds and aromaticity, mechanism of aromatic reactions.
4. Understanding hybridization and geometry of atoms, 3-D structure of organic molecules, identifying chiral centers.
5. Reactivity, stability of organic molecules, structure, stereochemistry.
6. Electrophile, nucleophiles, free radicals, electronegativity, resonance, and intermediates along the reaction pathways.
7. Mechanism of organic reactions (effect of nucleophile/leaving group, solvent), substitution *vs*. elimination.

## Self-study:

1. Design and syntheses of organic molecules.
2. Structure identification through IR, NMR and Mass spectroscopic data.
3. Lab/Instrumentation techniques used for analyzing reaction mechanisms.
4. Advanced soft-wares/Models used for predicting stereochemistry/study of energy

minimization of organic molecules.

## Basics of Organic Chemistry: (10 classes of 60 minutes each)

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and relative stabilities of reaction intermediates (Carbocations, Carbanions, Free radicals and Carbenes).

Organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

## Stereochemistry: (6 classes of 60 minutes duration each)

Concept of asymmetry, Fischer Projection, Newmann and Sawhorse projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixtures, Relative and absolute configuration: D/L and R/S designations.

## Chemistry of Aliphatic Hydrocarbons: (18 classes of 60 minutes duration each)

### A. Carbon-Carbon sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz- Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and selectivity.

### B. Carbon-Carbon pi-bonds

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2- and 1, 4- addition reactions in conjugated dienes and, Diels-

Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions.

### C. Cycloalkanes and Conformational Analysis

Cycloalkanes and stability, Baeyer strain theory, Conformation analysis, Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms.

## Aromatic Hydrocarbons (6 classes of 60 minutes duration each)

Aromaticity: Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation,nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of substituent groups.

## Recommended Books/References:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, 6th Edn., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, (2007)
3. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
4. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford Universitiy Press.
5. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, Kluwer Academic Publisher, (2000).

## 2.1.Course course: Organic Chemistry Practical

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

1. Checking the calibration of the thermometer.
2. Purification of organic compounds by crystallization using the following solvents:
   a. Water b. Alcohol c. Alcohol-Water

3. Determination of the melting points of given organic compounds and unknown organic compounds (using Kjeldahl method and electrically heated melting point apparatus).

4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds.

5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)

6. Chromatography

a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography

b. Separation of a mixture of two sugars by ascending paper chromatography. Separation of a mixture of *o*-and *p*-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC).

## Recommended Books/Reference:

1.Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)

2.Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)

## 3. Core course: Physical Chemistry-I

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

On completion of this course, the students will be able to understand:

## Learning objective:

1. Familiarization with various states of matter.
2. Physical properties of each state of matter and laws related to describe the states.
3. Calculation of lattice parameters.
4. Electrolytes and electrolytic dissociation, salt hydrolysis and acid-base equilibria.
5. Understanding Kinetic model of gas and its properties.
6. Maxwell distribution, mean-free path, kinetic energies.
7. Behavior of real gases, its deviation from ideal behavior, equation of state, isotherm, and law of corresponding states.
8. Liquid state and its physical properties related to temperature and pressure variation.
9. Properties of liquid as solvent for various household and commercial use.
10. Solids, lattice parameters – its calculation, application of symmetry, solid characteristics of simple salts.
11. Ionic equilibria – electrolyte, ionization, dissociation.
12. Salt hydrolysis (acid-base hydrolysis) and its application in chemistry.

## Self-study:

1. Determination of lattice parameters of given salt.
2. Study of X-Ray diffraction pattern and finding out reference from JCPDI file.
3. Numerical related to salt hydrolysis, ionic equilibria.

## Gaseous state: (12 classes of 60 minutes duration each)

**Behavior of real gases**: Deviations from ideal gas behavior, compressibility factor, and its variation with pressure for different gases. Causes of deviation from ideal behavior. van der Waals equation of state, its derivation and application in explaining real gas behaviour; van der Waals equation expressed in virial form, Boyle temperature. Isotherms of real gases and their comparison

with van der Waals isotherms, continuity of states, critical state, critical and van der Waals constants, law of corresponding states.

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

## Liquid state: (5 classes of 60 minutes duration each)

Structure and physical properties of liquids; vapour pressure, surface tension, viscosity, and their dependence on temperature, Effect of addition of various solutes on surface tension, cleansing action of detergents. Structure of water.

## Ionic equilibria: (13 classes of 60 minutes duration each)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and tri-protic acids.

Salt hydrolysis, hydrolysis constants, degree of hydrolysis and pH for different salts. Buffer solutions; Henderson equation, buffer capacity, buffer range, buffer action, applications of buffers in analytical chemistry, Solubility and solubility product.

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.

Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolytes.

## Solid state: (10 classes of 60 minutes duration each)

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-raydiffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Various types of defects in crystals, Glasses and liquid crystals.

## Recommended Text books/references:

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press (2006).
2. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
3. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
4. Mortimer, R. G. *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP (2009).
5 G. M. Barrow, Tata McGraw Hill (Fifth Edition) (2007)

## 3.1.Physical chemistry Practical

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

**1. Surface tension measurements.**

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension of detergent solutions with concentration.

## 2. Viscosity measurements using Ostwald's viscometer.

a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.

b. Viscosity of sucrose solution with the concentration of solute.

## 3. pH metry

a. Effect on pH of addition of HCl/NaOH to solutions of acetic acid,
sodium acetate and their mixtures.

i. Preparation of buffer solutions of different pH.Sodium acetate-acetic acid

ii. Ammonium chloride-ammonium hydroxide

b. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.

c. Determination of dissociation constant of a weak acid.

## Recommended text books/references:

1.Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

2.Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed*.; McGraw-Hill: New York (2003).

3 Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

4 Athawale V. D. amd Mathur P. Experimental Physical Chemistry,, New Age Intenational (2001)

## 4. Core course: Organic Chemistry-II

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

After completion of the course, the learner shall be able to understand:

## Learning objective:

1. Familiarization about classes of organic compounds and their methods of preparation.
2. Basic uses of reaction mechanisms.
3. Name reactions, uses of various reagents and the mechanism of their action.
4. Preparation and uses of various classes of organic compounds.
5. Organometallic compounds and their uses.
6. Organic chemistry reactions and reaction mechanisms.
7. Use of reagents in various organic transformation reactions.

## Self-study:

1. Elucidating reaction mechanisms for organic reactions.
2. Organometallic compounds and their uses.
3. Use of active methylene groups in organic mechanism and preparation of new organic compounds.

## Chemistry of Halogenated Hydrocarbons: (8 classes of 60 minutes duration each)

*Alkyl halides:* Methods of preparation, nucleophilic substitution reactions – $S_N1$, $S_N2$ and $S_N^i$ mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

*Aryl halides:* Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li and their use in synthesis.

## Alcohols, Phenols, Ethers and Epoxides: (6 classes of 60 minutes duration each

*Alcohols:* preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement.

*Phenols:* Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism.

*Ethers and Epoxides:* Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

## Carbonyl Compounds: (10 classes of 60 minutes duration each)

Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PGC);

Addition reactions of unsaturated carbonyl compounds: Michael addition.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

### Carboxylic Acids and their Derivatives: (10 classes of 60 minutes duration each)

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids; Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions,

Hofmannbromamide degradation and Curtius rearrangement.

## Sulphur containing compounds: (6 classes of 60 minutes duration each)

Preparation and reactions of thiols, thioethers and sulphonic acids.

## Recommended Books/references:

1 Solomons, T.W G., Fryhle, B. Craig. *Organic Chemistry,* John Wiley & Sons, Inc (2009).

2 McMurry, J.E. *Fundamentals of Organic Chemistry*, Seventh edition Cengage Learning, 2013.

3 P Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition (1997), Orient Longman, New Delhi.

4 Morrison R. T. and Boyd R. N. Organic Chemistry, Sixth Edition Prentice Hall India, 2003.

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## 4.1. Core course: Organic Chemistry-Practical

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

(List of experiments given are suggestive. One experiment from each group to be demonstrated)

1.Identification of elements (N, S, and halogen) and Functional group tests for alcohols, phenols, carbonyl, carboxylic acid and amine group of compounds.

2. Organic preparations:

i. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method: (Using conventional method.and Using green chemistry approach)

ii. Benzolyation of one of the amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) and one of the phenols (*β*-naphthol, resorcinol, *p*-cresol) by Schotten-Baumann reaction.

iii. Oxidation of ethanol/ isopropanol (Iodoform reaction).

iv. Bromination (any one)

a. Acetanilide by conventional methods

b. Acetanilide using green approach (Bromate-bromide method)

v. Nitration: (any one)

a. Acetanilide/nitrobenzene by conventional method

b. Salicylic acid by green approach (using ceric ammonium nitrate).

vi. Selective reduction of *meta* dinitrobenzene to *m*-nitroaniline.

vii. Reduction of *p*-nitrobenzaldehyde by sodium borohydride.

viii. Hydrolysis of amides and esters.

ix. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.

x. *S*-Benzylisothiouronium salt of one each of water soluble/ insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).

xi. Aldol condensation with either conventional or green method.

xii. Benzil-Benzilic acid rearrangement.

Collected solid samples may be used for recrystallization, melting point and TLC.

## Recommended Books/References:

1 Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)

2 Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.* Pearson (2012)

3 Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000)

4 Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000).

## 5.Core course: Physical Chemistry-II

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

After completion of the course, the learner shall be able to understand:

## Learning objective:

1. Laws of thermodynamics and concepts.
2. Partial molar quantities and its attributes.
3. Dilute solution and its properties.
4. Understanding the concept of system, variables, heat, work, and laws of thermodynamics.
5. Understanding the concept of heat of reactions and use of equations in calculations of bond energy, enthalpy, etc.
6. Understanding the concept of entropy; reversible, irreversible processes. Calculation of entropy using 3nd law of thermodynamics.
7. Understanding the application of thermodynamics: Joule Thompson effects, partial molar quantities.
8. Understanding theories/thermodynamics of dilute solutions.

## Self-study:

1. Use of thermochemical equations for calculation of energy and related terms.
2. Use of thermodynamics in explaining chemical behavior of solute/solvent and reactions.
3. Study of calorimeter principle and its use.

## Introduction to thermodynamics: (6 classes of 60 minute duration each)

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. *First law:* Concept of heat, $q$, work, $w$, internal energy, $U$, and statement of first law; enthalpy, $H$, relation between heat capacities, calculations of $q$, $w$, $U$ and $H$ for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

## Thermochemistry: (6 classes of 60 minutes duration each)

Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations), pressure on enthalpy of reactions.

## Second Law: (6 classes of 60 minutes duration each)

Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

## Third law of thermodynamics: (4 classes of 60 minutes duration each)

Third Law of thermodynamics, residual entropy, calculation of absolute entropy of molecules.

## Free Energy Functions: (6 classes of 60 minutes duration each)

Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

## Partial molar quantities: (6 classes of 60 minutes duration each)

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

## Dilute solutions: (6 classes of 60 minutes duration each)

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties: [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

## Recommended Books/References

1 Atkins P. and De Paula, J. *Physical Chemistry* Tenth Ed., OUP, 2014.

2 Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa, 2004.

3 Engel, T. and Reid, P. *Physical Chemistry 3rd Ed.,* Prentice Hall, 2012.

4 McQuarrie, D. A. and Simon, J. D. *Molecular Thermodynamics* Viva Books, 2004.

5 Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 2001

*6 Commonly Asked Questions in Thermodynamics.* CRC Press, 2011.

7 Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill, 2010.

8 Metz, C.R. *2000 solved problems in chemistry,* Schaum Series, 2006.

## 5.1.Core course: Physical Chemistry-Practical

| L | T | P | Cr |
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| 0 | 0 | 2 | 2 |

(A list of suggested experiments are given. However, more experiments can be added based on facilities available in the laboratories).

1. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
2. Study the equilibrium of at least one of the following reactions by the distribution method:

(i) $I_2$ (aq) + I----□ $I_3^-$(aq)

*(ii)* $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$

3. Study the kinetics of the following reactions.

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate.

## Adsorption

Verification of Freundlich and Langmuir isotherms for adsorption of acetic acid and selected organic dye(s) on activated charcoal.

(Use of calorimeter for calculation of heat of reactions may be demonstrated)

## Recommended Books/References:

1.Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand, New Delhi, 2011.

2.Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry,* Eighth Edition, McGraw-Hill(2003).

3 Halpern, A. M. and McBane, G. C. *Experimental Physical Chemistry,* Third Edition, W, H. Freeman (2003).

## 6. Core course: Organic Chemistry-III

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

After completion of the course, the learner shall be able to understand:

## Learning objective:

1. Nitrogen containing functional groups and their reactions.
2. Familiarization with polynuclear hydrocarbons and their reactions.
3. Heterocyclic compounds and their reactions.
4. Alkaloids and Terpenes
5. Understanding reactions and reaction mechanism of nitrogen containing functional groups.
6. Understanding the reactions and mechanisms of diazonium compounds.
7. Understanding the structure and their mechanism of reactions of selected polynuclear hydrocarbons.
8. Understanding the structure, mechanism of reactions of selected heterocyclic compounds.
9. Classification, structure, mechanism of reactions of few selected alkaloids and terpenes.

## Self-study:

1. Use of benzene diazonium salt in organic synthesis.
2. Applications of heterocyclic compounds in pharmaceutics/drugs and the mechanism of actions.
3. Pharmaceutics/Biomedical applications of alkaloids and terpenes.
4. Nitrogen containing organic compounds/heterocyclic compounds in synthetic chemistry.

## Nitrogen Containing Functional Groups (8 classes of 60 minutes duration each).

Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. Diazonium salts: Preparation and synthetic applications.Polynuclear Hydrocarbons: (8 classes of 60 minutes duration each)

Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.

## Heterocyclic Compounds: (12 classes of 60 minutes duration each)

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction Derivatives of furan: Furfural and furoic acid.

## Alkaloids (6 classes of 60 minutes duration each)

Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

## Terpenes (6 classes of 60 minutes duration each)

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and α-terpineol.

## Recommended Text Books/references:

1.Morrison, R. T., Boyd, R. N., Bhatterjee, S.K., Organic Chemistry, 7th Edn., Pearson.
2 Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly & Sons (1976).
3 Solomons, T.W., Fryhle Craig, *Organic Chemistry,* John Wiley & Sons, Inc (2009).
4 McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
5 Kalsi, P. S. *Organic reacations and their mechanisms*, New Age Science (2010).
6 Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford University Press Inc., New York (2001).
7 Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan (2010).
8 Bansal R. K. *Heterocyclic Chemistry: Syntheses, Reactions and Mechanisms*, New Age, Third Edition (1999).
9.Clayden J., Greeves N., Warren S., Organic Chemistry, (2nd Ed)., (2012), Oxford University Press.

## 6.1.Core course: Organic Chemistry Practical

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

1. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols, etc.
2. Identification of functional groups of simple organic compounds by IR spectroscopy and NMR spectroscopy (IR and NMR of simple organic compounds may be done wherever facilities are available, otherwise sample spectra may be provided for simple organic compounds like Ethanol, Aniline, Phenol, acetic acid, other simple aldehydes, carboxylic acid, etc., for identification of functional groups. References from standard spectroscopy books may also be taken for such purpose for enhancing students understanding and skill).
3. Preparation of methyl orange.
4. Extraction of caffeine from tea leaves.
5. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars using simple lab procedures.

## Recommended Books/References:

1. Vogel, A.I. *Quantitative Organic Analysis,* Part 3, Pearson (2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000).
5. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000).

## 7. Core course: Molecular Spectroscopy & Photochemistry

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

### Unit-I: (15 classes of 60 minutes duration each)

Interaction of electromagnetic c; Born- Oppenheimer approximation. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

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

### Unit-II: (10 classes of 60 minutes duration each)

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

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation.

### Unit-III: (15 classes of 60 minutes duration each)

**Photophysical and photochemical processes:** laws of photochemistry, quantum yield. Jablonski diagrams: Franck-Condon principle, Law of photochemical equivalence, quantum efficiency, low and high quantum efficiency. kinetics of photochemical reactions ($H_2 + Br_2 = HBr$, $2HI = H_2 + I_2$), energy transfer in photochemical reactions (photosensitization and quenching), fluorescence,

phosphorescence, chemiluminescence, Discussion of Electronic spectra and photochemistry (Lambert-Beer law and its applications).

## Recommended books/References:

1. Laideler K. J. and Meiser J. M. *Physical Chemistry* Third Edition (International)1999
2. Levine I. N., *Physical Chemistry,* Fourth Edition), McGraw-Hill (International), 1995.
3. McQuarrie D. A. and Simon J. D. *Physical Chemistry- A Molecular Approach,* University Science Books, 1998
4. Rohatgi-Mukherjee K. K. Fundamentals of Photochemistry, New age (revised second edition).
5. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).

### 7.1. Suggested laboratory experiments:

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

(i). Determination of indicator constant - colorimetry. (instructor may vary indicators available in the lab).

(ii). Verification of Beer's Law - Determination of concentration of solution by colorimetry. (Instructor may explain the principle of using colorimeter, its handling drawing standard calibration curve, and its application in finding unknown concentration of dyes, concentration of metal solutions (*e.g.*Ni, Cu using appropriate reagent) from standard calibration curve.

## Suggested books/reference books:

1. Practicals in physical chemistry – a modern approach, P.S.Sindhu, Macmillan,
2. Experiments in Physical Chemistry, J.M.Wilson, R.J.Newcomb, A.R.Denaro, 2nd Edn., Elsevier.

## 8. Core course: Physical Chemistry-III

| L | T | P | Cr |
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| 3 | 1 | 0 | 4 |

After completion the course, the learner shall be able to understand:

## Learning objective:

1. Phases, components, Gibbs phase rule, Phase diagrams and applications.
2. Chemical kinetics: type of reactions, determination of rate, theories of reaction rate, steady state approximation.
3. Catalyst – mechanism, acid base catalysis, enzyme catalysis.
4. Adsorption isotherms.
5. Understanding phases, components, Gibb's phase rule and its applications, construction of phase diagram of different systems, the application of phase diagram.
6. Understanding the basics of chemical kinetics: determination of order, molecularity, and understanding theories of reaction rates, determination of rate of opposing/parallel/chain reactions with suitable examples, application of steady state kinetics, Steady-state approximation.
7. Catalyst – mechanism of catalytic action, enzyme catalysis.
8. Langmuir, Freundlich – adsorption isotherms, significance, multilayer adsorption – theory and significance.

## Self-study:

1. Application of phase diagram.
2. Study of reaction kinetics, Fast reactions.
3. Heterogeneous catalysis used in industry and its mechanism of action.
4. Application of adsorption isotherms in metal adsorption, significance.

## Phase Equilibria: (10 classes of 60 minutes duration each)

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems, water-chloroform-

acetic acid system, triangular plots. *Binary solutions:* Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

## Chemical Kinetics: (10 classes of 60 minutes duration each)

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated rate laws for first, second and fractional order reactions, pseudounimolecular reactions, determination of the order, kinetics of complex reactions (limited to first order): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

## Catalysis: (10 classes of 60 minute duration each)

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

## Surface chemistry: (10 classes of 60 minutes duration each)

Physical adsorption, chemisorption, adsorption isotherms (Freundlich, Temkin, Derivation of Langumuir adsorption isotherms, surface area determination), BET theory of multilayer adsorption (no derivation), Adsorption in solution.

## Recommended books/References:

1. Atkins P. W. and De Paula J., *Physical Chemistry, (*tenth edition) Oxford University Press, 2014.
2 Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa , 2004.
3 McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books, 2004.
4 Engel, T. & Reid, P. *Physical Chemistry* Third Edition*,* Prentice-Hall,2012.
5 Zundhal, S.S. *Chemistry concepts and applications* Cengage India, 2011
6 Ball, D. W. *Physical Chemistry* Cengage India, 2012.

7 Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP, 2009.
8.Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill, 2011.
9.Metz, C. R. *Physical Chemistry 2nd Ed.,* Tata McGraw-Hill, 2009.

## 8.1.Core course: Physical Chemistry Practical

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

**Conductometry**

1 Determination of cell constant

2 Equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

3.Conductometric titrations of: Strong acid Vs. strong base (ii) Weak acid vs. strong base, (iii) Mixture of strong acid and (iv)weak acid vs. strong base, Strong acid vs. weak base.

## Potentiometry

Potentiometric titrations of: (i) Strong acid vs. strong base (ii) Weak acid vs. strong base (iii) Dibasic acid vs. strong base (iv) Potassium dichromate vs. Mohr's salt.

## Recommend books/References:

1 Khosla, B. D.; Garg, V. C. and Gulati, A. *Senior Practical Physical Chemistry,* R. Chand New Delhi, 2011.

2 Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry* Eighth Edition*;* McGraw-Hill: New York, 2003.

3 Halpern, A. M. and McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York, 2003.

(List of experiments and references are suggestive. However, more experiments can be added/list of experiments can be revised as per available facilities).

## 9. Core course: Inorganic Chemistry-II

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

After completion of the course, the learner shall be able to understand:

## Learning objective:

1. Oxidation-Reductions and their use in metallurgy.
2. Chemistry of s and p-block elements.
3. Chemistry of noble gases.
4. Inorganic polymers and their use.
5. Understanding redox reactions in hydrometallurgy processes.
6. Structure, bonding of s and p block materials and their oxides/compounds.
7. Understanding chemistry of boron compounds and their structures.
8. Chemistry of noble gases and their compounds; application of VSEPR theory in explaining structure and bonding.
9. Understanding chemistry of inorganic polymers, their structures and uses.

## Self-study:

1. Extraction of metals through metallurgical operations and their uses.
2. Bonding of various s and p block elements.
3. Use of boron compounds.
4. Chemistry of inorganic polymers and their uses.

## Oxidation-Reduction and general principle of metallurgy: (8 classes of 60 minutes duration each)

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon or carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel- de Boer process and Mond's process, Zone refining.

## Chemistry of *s* and *p* Block Elements: (16 classes of 60 minutes duration each)

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behavior of first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

Structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Per-oxo acids of Sulphur inter-halogen compounds, poly-halide ions, pseudo-halogens, properties of halogens.

## Noble Gases: (8 classes of 60 minutes duration each)

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of $XeF_2$, $XeF_4$ and $XeF_6$; Bonding in noble gas compounds (Valence bond and MO treatment for $XeF_2$), Shapes of noble gas compounds (VSEPR theory).

## Inorganic Polymers: (8 classes of 60 minutes duration each)

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

## Recommended books/references:

1 Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.

2 Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.

3 Greenwood, N.N., Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.

4 Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.

5 Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.

6 Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* Fourth Ed., Pearson, 2010

7 Atkins, P. W and Shriver D. N. *Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).

## 9.1. Course course: Inorganic Chemistry-practical

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

**(A) Iodo / Iodimetric Titrations**

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).

(ii) Estimation of (i) arsenite and (ii) antimony iodimetrically

(iii) Estimation of available chlorine in bleaching powder iodometrically.

### (B) Inorganic preparations

(i) Cuprous Chloride, $Cu_2Cl_2$

(ii) Preparation of Aluminium potassium sulphate (Potash alum) or Chrome alum.

## Recommended books/references:

Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* Sixth Edition Pearson, 2009.

(The above list of experiments are suggestive. Faculty/academic bodies may incorporate revision/may incorporate text and reference books as per need).

## 10. Introduction to Quantum Chemistry:

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**Unit-I:** Introduction to black-body radiation and distribution of energy, photo-electic effect, concept of quantization, wave particle duality (de-Broglie's hypothesis), The uncertainty principle, The wave function: wave function and its interpretation, conditions of normalization and Orthogonality and its significance. Basic idea about operators, eigen function and values, Schrodinger equation and application to free-particle and particle in a box, boundary conditions, wave functions and energies, degeneracy, hydrogen atom, Schrodinger equation in polar coordinates, radial and angular parts of the hydrogenic orbitals, degeneracies, spherical harmonics, representations of hydrogenic orbitals. (**15 classes of 60 minutes durations**)

**Unit-II:** Quantitative treatment of simple harmonic osciallator model, setting up of Schodinger equation and discussion of solution of wave functions. Rigid rotator model and discussion of application of Schrodinger equation. idea about transformation to spherical polar coordinate, discussion on solution, (**15 classes of 60 minutes durations**)

**Unit-III: (10 classes of 60 minutes durations)**

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Valence bond and molecular orbital approaches, LCAO-MO treatment of $H_2$, $H_2^+$; bonding and anti-bonding orbitals, Comparison of LCAO-MO and VB treatments of $H_2$ (only wavefunctions, detailed solution not required) and their limitations.

## Recommended books/References:

1. Laideler K. J. and Meiser J. M. *Physical Chemistry* Third Edition (International)1999
2. Levine I. N., *Physical Chemistry,* Fourth Edition), McGraw-Hill (International), 1995.
3. McQuarrie D. A. and Simon J. D. *Physical Chemistry- A Molecular Approach,* University Science Books, 1998.
4. Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
5. House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).

## 10.1. Suggested laboratory experiments:

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

(i)The students may be demonstrated hyperchem lab activities – building a molecular model (leveling of atoms, editing individual atoms, changing bond order, centrering, rotation of atoms), Selection of calculation method (*e.g.*force field calculation, ab-initio set up), displaying calculated properties, (instructor may demonstrate Computer programs that calculate the energy of various conformations of molecules and predict the lowest energy, to learn how to construct or draw representations of molecules using a molecular modeling program called HyperChem (HyperCube, Inc.), to perform geometry optimizations (energy minimizations) to determine the lowest energy conformations of molecules).

(Depending upon the availability of infrastructure facilities, instructor can demonstrate the students use of hyperchem software, Gaussian software – geometry optimization). They can be allowed for academic visit to computational labs to gain knowledge and a report may be considered for viva voce/examination). Open source softwares may be used for lab demonstration and students may prepare a report along with viva-voce shall constitute practical examination. Instructor may encourage the students to gain hand-on experience in using open-source softwares (for perfoming various calculation as mentioned) in lab computers, periodic evaluation of which can also be

accepted as conducting lab practical examination. Basic idea is to encourage the students to get knowledge without keeping any rigid practical syllabus framework).

(Examples of the computational work that can be done: Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds.

(a) Perform a conformational analysis of butane. (b) Determine the enthalpy of isomerization of cis and trans 2-butene.

Visualize the electron density and electrostatic potential maps for LiH, HF, N2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules.

Software: ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similar software.

(ii). Determination of indicator constant - colorimetry.

(iii). Verification of Beer's Law - Determination of concentration of solution by colorimetry.

## Suggested books/reference books:

1.Essentials of computational chemistry – Theories and models, C. J. Crammer, Wiley, 2nd Edn.,

2.Principle and applications of quantum chemistry, V.K.Gupta, Elsevier, 2016.

3. Practicals in physical chemistry – a modern approach, P.S.Sindhu, Macmillan,

4. Experiments in Physical Chemistry, J.M.Wilson, R.J.Newcomb, A.R.Denaro, 2nd Edn., Elsevier.

5. A.R. Leach, *Molecular Modelling Principles and Application*, Longman, 2001.

6. J.M. Haile, *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.

7. Gupta, S.P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.

## 11. Course course: Inorganic Chemistry-III

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

After completion of the course, the learner shall be able to understand:

## Learning objective:

1. Coordination compounds – its nomenclature, theories, d-orbital splitting in complexes, chelate.
2. Transition metals, its stability, color, oxidation states and complexes.
3. Lanthanides, Actinides – separation, color, spectra and magnetic behavior
4. Bioinorganic chemistry – metal ions in biological system, its toxicity; hemoglobin.
5. Understanding the nomenclature of coordination compounds/complexes, Molecular orbital theory, d-orbital splitting in tetrahedral, octahedral, square planar complexes, chelate effects.
6. Understanding the transition metals stability in reactions, origin of colour and magnetic properties.
7. Understanding the separation of Lanthanoids and Actinoids, its color, spectra and magnetic behavior.
8. Understanding the bioinorganic chemistry of metals in biological systems.
9. Hemoglobin and its importance in biological systems.

## Self-study:

1. IUPAC nomenclature of coordination compounds/complexes.
2. Prediction of structure of complexes using various theories; color and magnetic properties of different complexes.
3. Use of lanthanide/actinide compounds in industries.
4. Toxicity of various metals and mechanism of metal-biological system interactions.

## Coordination Chemistry: (10 classes of 60 minutes duration each)

Werner's theory, EAN rule, piano-stool compounds, valence bond theory (inner and outer orbital complexes), Crystal field theory, d-orbital splitting, , weak and strong fields, pairing energies, factors affecting the magnitude of (Δ). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar complexes, d orbital splitting in trigonal bipyramidal, square pyramidal and cubic ligand field environments, CFSE, Variation of lattice energies, enthalpies of hydration and crystal radii variations in halides of first and second row transition metal series, Qualitative aspect of Ligand field theory, MO diagrams of representative coronation complexes, IUPAC nomenclature of coordination compounds,

isomerism in coordination compounds. Stereochemistry of complexes with the coordination number 4 and 6, Chelate effect,

## Transition Elements: (10 classes of 60 minutes duration each)

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series. Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

## Lanthanoids and Actinides: (10 classes of 60 minutes duration each)

Electronic configuration, oxidation states, color, spectra and magnetic behavior, lanthanide contraction, separation of lanthanides (ion-exchange method only).

## Bioinorganic Chemistry: (10 classes of 60 minutes duration each)

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), toxicity, chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

## Recommended text books/References:

1. Purcell, K.F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977. Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
2. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.
3. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
4. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.

## 11.1.Core course: Inorganic Chemistry Practical

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

1.Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given on understanding of the chemistry of different reactions. Following radicals may be analyzed:

Carbonate, nitrate, nitrite, sulphide, sulphate, sulphite, acetate, fluoride, chloride, bromide, iodide, borate, oxalate, phosphate, ammonium, potassium, lead, copper, cadmium, bismuth, tin, iron, aluminum, chromium, zinc, manganese, cobalt, nickel, barium strontium, calcium, magnesium. Mixtures containing one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, $CaF_2$ or $Al_2O_3$) **or** combination of anions e.g. $CO_3^{2-}$and $SO_3^{2-}$, $NO_2^-$ and $NO_3^-$,$Cl^-$ and $Br^-$, $Cl^-$ and $I^-$, $Br^-$ and $I^-$, $NO_3^-$ and $Br^-$, $NO_3^-$ and $I^-$. Spot analysis/tests should be done whenever possible.

2. Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs thermodynamic factors.

3. Preparation of acetylacetanato complexes of $Cu^{2+}$/$Fe^{3+}$. (Also find the $\lambda_{max}$ of the prepared complex using instrument).

4. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

## Recommended text books/references:

1. Vogel's *Qualitative Inorganic Analysis,* Revised by G. Svehla. Pearson Education, 2002.
2. Marr & Rockett *Practical Inorganic Chemistry.* John Wiley & Sons 1972.

## 12. Core course: Analytical Chemistry

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

After completion of the course, the student shall be able to understand:

## Learning objective:

1. Familiarization with fundamentals of analytical chemistry.
2. Basics of spectroscopic, thermal, electrochemical techniques
3. Learning basics of separation techniques and its applications.
4. Understanding analytical tools, statistical methods applied to analytical chemistry.
5. Understanding principle of UV-Vis spectroscopy and its applications.
6. Understanding principles of thermo-gravimetric analysis and study of thermal decomposition of materials/characterization of materials.
7. Understanding basics of electro-analytical techniques and its applications.
8. Understanding principles of separation technology and its use in advanced instrumentations.

## Self-study:

1. Thermo-gravimetric Analysis of different compounds and application of mathematical models.
2. Study of different kinds of chromatograms; calculation of $R_f$,
3. Analysis of GC/HPLC data for known materials/compounds.

## Qualitative and quantitative aspects of analysis: (4 classes of 60 minutes duration each)

Tools in analytical chemistry and their applications, Sampling, evaluation of analytical data, errors, accuracy and precision, statistical test of data; F, Q and t-test, rejection of data, and confidence intervals.

## Spectroscopy: (8 classes of 60 minutes duration each)

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

**Vibration spectroscopy:** Basic principles of instrumentation, sampling techniques. Application of IR spectroscopy for characterization through interpretation of data, Effect and importance of isotope substitution. Introduction to Raman spectra

**UV-Visible Spectrometry:** Basic principles of instrumentation, principles of quantitative analysis using estimation of metal ions from aqueous solution, Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

## Thermal analysis: (6 classes of 60 minutes duration each)

Theory of thermogravimetry (TG and DTG), instrumentation, estimation of Ca and Mg from their mixture.

## Electroanalytical methods: (6 classes of 60 minutes duration each)

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. determination of pKa values.

## Separation techniques: (16 classes of 60 minutes duration each)

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.

Chromatography techniques: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis using LC, GLC, TLC and HPLC.

## Recommended Books/Reference Books:

1 Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

2 Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing California, USA, 1988.

Christian, G.D, *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.

4 Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.

*5* Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis, Saunder College Publications, (1998).*

6 Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood John Wiley 1979.

7 Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.

8 Khopkar, S. M., Basic Concepts of Analytical Chemistry, New Age (Second edition)1998

9.Skoog D.A., Holler F.J., Nieman T.A., Principles of instrumental analysis, 5th Edn., Brooks & Cole (1997).

## 12.1.Core course: Analytical Chemistry Practical

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

**(Recommended to carry out at least two experiments from each section)**
**I. Chromatography:**

(i) Paper chromatographic separation of $Fe^{3+}$, $Al^{3+}$, and $Cr^{3+}$.

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the $R_f$ values.

iii. Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their $R_f$ values.

(iv) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

## II. Solvent Extractions:

(i) To separate a mixture of $Ni^{2+}$ & $Fe^{2+}$ by complexation with DMG and extracting the $Ni^{2+}$-DMG complex in chloroform, and determine its concentration by spectrophotometry.

ii. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

iii. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.

## III. Analysis of soil:

(i) Determination of pH of soil.

(ii) Total soluble salt

(iii) Estimation of calcium, magnesium, phosphate, nitrate

## IV. Ion exchange:

(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.

(ii) Separation of metal ions from their binary mixture.

(iii) Separation of amino acids from organic acids by ion exchange chromatography.

## V. Spectrophotometry

(i). Determination of pKa values of indicator using spectrophotometry.

(ii) Structural characterization of compounds by infrared spectroscopy.

(iii) Determination of dissolved oxygen in water.

(iv) Determination of chemical oxygen demand (COD).

(v) Determination of Biological oxygen demand (BOD).

(vi) Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

## Recommended text books/references:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International

Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
7. Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.* Van Nostrand, New York, 1974.

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**FACULTY OF ARTS AND SCIENCE**
**B.Sc. CHEMISTRY – CURRICULUM & SYLLABUS- 2021**

## Tamil - I
**முதற் பருவம்**

(B.A .,BSC., BCA., Bcom Corporate Secretaryship) பயில்வோருக்குரியது.)

**Credit : 2**
**hours : 30**

TITLE : (செய்யுள், உரைநடை, இலக்கியவரலாறு, இலக்கணம், பயன்பாட்டுக்கல்வி)

SUB CODE :

SUB PATTERN : ( THEORY)

**பாட நோக்கம் :**

தமிழ் மரபுக்கவிதை, புதுக்கவிதை முதலானவற்றை அறிமுகப்படுத்துதல்.

சிறுகதை, நாவல், கட்டுரை முதலான இலக்கிய வடிவங்களைக் கற்பித்தல்.

இக்கால இலக்கியத்தின் மீதான ஈர்ப்பை மிகுவித்தல்.

**கற்றல் பயன் :**

தமிழ் இலக்கியத்தின் மீதான ஆர்வம் மிகும்.

புதிய இலக்கிய வடிவங்களை அறிவர்

கவிதை, சிறுகதை ஆகியவற்றை படைக்க முயல்வர்.

**அலகு – 1 மரபுக்கவிதைகள்** (hours : 6)

1.பாரதியார் - புதுமைப்பெண்

2.பாரதிதாசன் - வான் (இயற்கை)

3.நாமக்கல் கவிஞர் - உலகம் வாழ்க

4.கண்ணதாசன் - காலக்கணிதம்

5.கவிஞர் சுரதா - கலப்பை

6.வல்லம் வேங்கடபதி - நெருப்பிலிடு

**அலகு – 2 புதுக்கவிதைகள்** (hours : 6)

1.சிற்பி – ஒரு விதையின் கதை

2.அறிவுமதி – நட்புக்காலம்

3.தாமரை - ஒரு கதவும் கொஞ்சம் கள்ளிப்பாலும்

4.ஈரோடு தமிழன்பன் - ஹைக்கூ கவிதைகள் (10 கவிதைகள்)

5.அப்துல் ரகுமான் - ஒப்புதல் வாக்கு மூலம்

6.அபி - மாப்பிள்ளைகள்

7.குட்டி ரேவதி - குடுகுடுப்பைச் சிறுவன்

8.மாலதி மைத்ரி - அகதி

**அலகு - 3 உரைநடை** (hours : 6)

1.கவிப்பேரரசு வைரமுத்து - சிற்பியே உன்னை செதுக்குகிறேன்

**அலகு – 4 இலக்கிய வரலாறு - இலக்கணம்** (hours : 6)

1.புதுக்கவிதை, ஹைக்கூ கவிதை தோற்றமும் வளர்ச்சியும்

2.படிமம், குறியீடு பற்றிய விளக்கங்கள்

3.சிறுகதையின் தோற்றமும் வளர்ச்சியும்

4.உரைநடையின் தோற்றமும் வளர்ச்சியும்

5.இலக்கணக் குறிப்பெழுதி விளக்கம் அறிதல்

6.கலைச்சொல்லாக்கம், எழுத்துப்பிழை நீக்கம்

7.தமிழ் எண்கள்

**அலகு - 5 பயன்பாட்டுக்கல்வி - மொழிபெயர்ப்பு** (hours :6)

1.கவிதை படைத்தல்

2.வினா விடை அமைத்தல்

3.கற்பனை சந்திப்பிற்கு உரையாடல் எழுதுதல்

4.சிறுகதைகள் குறித்த விமர்சனம்

5.பொதுப்பகுதி அலுவலகப்பகுதி ஆங்கிலத்திலிருந்து தமிழில் மொழிபெயர்த்தல்

**6.தன்முனைப்பு படிப்பு - சிறுகதை**

1.ஒரு காட்டில் ஒரு மான் - அம்பை

2.சுந்தரவனம் - தேவதேவன்

3.மவராசர்கள் - விந்தன்

4.ஒரு சிறு இசை - வண்ணதாசன்

5.மாத்திரை - நீலபத்மநாபன்

**பார்வை நூல்கள்**

1.இலக்கிய வரலாறு - முனைவர் பாக்யமேரி

2.இலக்கணமும் மொழிப்பயிற்சியும் - க.கோ.வேங்கட்ராமன்

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## Tamil - II
## இரண்டாம் பருவம்

(B.A .,BSC., BCA., Bcom Corporate Secretaryship) பயில்வோருக்குரியது.)

Credit : 2

TITLE : செய்யுள், உரைநடை, இலக்கியவரலாறு, இலக்கணம், பயன்பாட்டுக்கல்வி

hours : 30

SUB PATTERN : ( THEORY)

**பாட நோக்கம் :**

தமிழ் மரபுக்கவிதை, புதுக்கவிதை முதலானவற்றை அறிமுகப்படுத்துதல்.
சிறுகதை, நாவல், கட்டுரை முதலான இலக்கிய வடிவங்களைக் கற்பித்தல்.
இக்கால இலக்கியத்தின் மீதான ஈர்ப்பை மிகுவித்தல்.

**கற்றல் பயன் :**

தமிழ் இலக்கியத்தின் மீதான ஆர்வம் மிகும்.
புதிய இலக்கிய வடிவங்களை அறிவர்
கவிதை, சிறுகதை ஆகியவற்றை படைக்க முயல்வர்.

**அலகு – 1 – சங்க இலக்கியம்** (hours : 6)

1.குறுந்தொகை

1.குறிஞ்சி - கொங்குதேர் வாழ்க்கை (2)

2.முல்லை - கார் புறந்தந்த (162)

3.மருதம் - கழனி மா அத்து (8)

4.நெய்தல் - நள்ளென்றற்றே (6)

5.பாலை - எறும்பி அளையின் (12)

2. ஐங்குறுநூறு - அன்னாய் வாழிப்பத்து (21)

3. புறநானூறு - பாடல் எண் : 91, 142,192,195,312.

**அலகு – 2 நீதி இலக்கியம்** (hours : 6)

1.திருக்குறள் - நட்பாராய்தல்

2.நாலடியார் - நட்பிற்பிழை பொறுத்தல்

3.இனியவை நாற்பது – 1,3,5,6,20

4.பழமொழி நானூறு – 5,27,46,73,114

5.மூதுரை – 1,2,5,10,16,17,18,26,30

**அலகு -3 – நாவல் (hours : 6)**

1.வேரில் பழுத்த பலா – சு.சமுத்திரம்

**அலகு - 4 - இலக்கிய வரலாறு (hours : 6)**

1.பதினெண் மேற்கணக்கு நூல்கள் அறிமுகம்

2.பதினெண் கீழ்க்கணக்கு நூல்கள் அறிமுகம்

3.நாவலின் தோற்றமும் வளர்ச்சியும்

**அலகு – 5 - இலக்கணம் - படைப்பாற்றல் (hours : 6)**

1.வல்லினம் மிகும், மிகா இடங்கள்

2.வினா, விடை வகைகள் ( அறுவகை வினா, எண்வகை விடை)

3.தொகை நிலைத்தொடர்

4.தொகா நிலைத்தொடர்

5.மரபுக்கவிதை புதுக்கவிதை படைத்தல்

6.தன்முனைப்பு படிப்பு – புதினம் - 1, புதினம் - 2

(புதினத்தேர்வு மாணவர் விருப்பத்திற்குரியது)

**பார்வை நூல்கள்**

1.இலக்கிய வரலாறு – Dr. பாக்யமேரி

2.சங்க இலக்கியம் மூலமும் உரையும் - உரையாசிரியர் Dr.வி.நாகராசன்

3.பதினெண் கீழ்க்கணக்கு நூல்கள் - உரையாசிரியர் அ.மாணிக்கனார்.

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# FACULTY OF ARTS AND SCIENCE
# B.Sc. CHEMISTRY – CURRICULUM & SYLLABUS- 2021

## Tamil - III
## மூன்றாம் பருவம்

(B.A .,BSC., BCA., Bcom Corporate Secretaryship) பயில்வோருக்குரியது.)

Credit : 2

TITLE : (காப்பியம், நாடகம், பக்தி இலக்கியம்) hours : 30

SUB PATTERN : ( THEORY)

**நோக்கம்:**

தமிழ் இலக்கிய வரலாற்றில் ஐம்பெரும்காப்பியங்கள், நாடகங்கள், பக்தி இலக்கியம் பெறும் இடம் குறித்து விளக்குதல்.

காப்பியச் சுவையும் நாடக இன்பத்தையும் பக்தி பெருக்கையும் மாணவர்கள் அறியச் செய்தல்.

**கற்றல் பயன்கள் :**

மாணவர்கள் தமிழ் இலக்கிய வரலாற்றின் காப்பியம், நாடகம், பக்தி இலக்கியம் பக்தி இலக்கியம் பற்றி அறிதல்.

வாழ்வின் வழிபாட்டின் முக்கியத்துவம் உணர்ந்து கடைப்பிடிப்பர்.

### அலகு – 1 (hours : 6)

சிலப்பதிகாரம் - (கட்டுரை காதை)

மணிமேகலை - (சிறை விடு காதை)

### அலகு – 2 (hours : 6)

அ. தேவாரம் - திருநாவுக்கரசர்

ஆ. திருவாசகம் - மாணிக்கவாசகர் (திருவெம்பாவை முதல் 10 செய்யுட்கள்)

இ. நாலாயிரத் திவ்ய பிரபந்தம் - நாச்சியார் திருமொழி 10 செய்யுட்கள்

### அலகு -3 (hours : 6)

அ. கம்ப இராமாயணம் - வாலி வதைப்படலம் (70 பாடல்கள்)

ஆ. பெரியபுராணம் - (காரைக்கால் அம்மையார் புராணம்)

**அலகு -4** (hours : 6)

உடல்மொழி : (ஆளுமை வளர்ச்சி)

அ.அடிப்படைகளைப் புரிந்து கொள்வது

ஆ.தினமும் பார்க்கும் பிரபலமான சைகைகள்

நாடகம் :

நீதி தேவன் மயக்கம் - அறிஞர் அண்ணா

**அலகு -5** (hours : 6)

1.அணிகள்

அ. உவமையணி

ஆ. எடுத்துக்காட்டு உவமையணி

இ. இரட்டுற மொழிதல் அணி

ஈ. வஞ்சப் புகழ்ச்சி அணி

2.பொதுக்கட்டுரை

அ. சுற்றுப்புறச்சுழல்

ஆ. பெண்ணியம்

இ. வேளாண்மை

ஈ. சமூகத் தலைவர்கள் குறித்த தலைப்புகளில் எழுதச் செய்தல்

3.நாடகத்தின் தோற்றமும் வளர்ச்சியும்

4. பக்தி இலக்கியங்கள்

5.இரட்டைக்காப்பியங்கள்

**பார்வை நூல்கள்**

1.உடல்மொழி - ஆலன் & பார்பராபீஸ்

2.நீதி தேவன் மயக்கம் - அறிஞர் அண்ணா

3.தமிழ் இலக்கிய வரலாறு - முனைவர் க.பாக்ய மேரி

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# FACULTY OF ARTS AND SCIENCE
# B.Sc. CHEMISTRY – CURRICULUM & SYLLABUS- 2021

## Tamil - IV
## நான்காம் பருவம்

(B.A .,BSC., BCA., Bcom Corporate Secretaryship) பயில்வோருக்குரியது.)

Credit : 2

TITLE : (பண்டைய இலக்கியம்) hours : 30

SUB PATTERN : ( THEORY)

**நோக்கம்:**

பண்டைய இலக்கியத்தின் முக்கியத்துவம் உணரச் செய்தல்.
நாட்டார் வாழ்வியல் கூறுகளை அறியச் செய்தல்.

**கற்றல் பயன் :**

பண்டைய இலக்கியத்தினை உணர்ந்து அதன் நெறியில் வாழ முற்படுதல்.
பழந்தமிழரின் மரபினை பின்பற்றி அதன் விழுமியங்களை நடைமுறைப்படுத்துதல்.

**அலகு - 1** (hours : 6)

**மெய்யியல்**

1. (இராமலிங்க வள்ளலார் பாடல்கள்)
அ. பொன்னாகி மணியாகி .....
ஆ. பொங்கு பல சமயம் .....
இ. மெய்ஞ் ஞான .....
ஈ. பேராய அம் .....

2.தாயுமானவர் பாடல்கள்
அ. காயாத மரமீது கல்லேறு .....
ஆ. எல்லாம் அறிந்தவரும் .....
இ. புகழும் கல்வியும் .....
ஈ. ஐவர் என்ற பல வேடர்

3.திருமந்திர பாடல்கள்
அ. நாலும் இரு மூன்றும் .....
ஆ. இலிங்கமுது .....
இ. தன்னையறிதல்
ஈ. இடனொறு மூங்கில் ....

**அலகு – 2** (hours : 6)

**தனிப்பாடல் திரட்டு**

அ. காளமேகம் - நீரிலுள்ள…..
ஆ. ஔவையார் - தாயோடறு சுவை …
இ. இரட்டைப்புலவர் - மாதா பிதா…
ஈ. ஓப்பிலாமணிப்புலவர் - ஆறு பெருக்காற்….
உ. ஒட்டக்கூத்தர் - கலைவாணி …

**அலகு -3 நாட்டார் வாழ்வியல்** (hours : 6)

அ. வாய்மொழி இலக்கியமும், நாட்டரிலக்கியமும்
ஆ. கைவினைக் கலைகள்
இ. மண்பாண்டக் கலைகள்
ஈ. பத்த மடைப்பாய்
உ. நாட்டார் உணவு
ஊ. நாட்டார் விளையாட்டு
எ. தெருக்கூத்து
ஏ. பாவைக்கூத்து
ஐ. விடுகதைகள்
ஒ. மரபுத் தொடர்கள்

**அலகு -4 கட்டுரைகள்** (hours : 6)

அ. சுஜாதா - மூளையின் சாப்பாடு
ஆ. அகிலன் - எழுத்தாளர் கார்க்கி (கதைகள்)
இ. சு.நரேந்திரன் - தமிழ்நாட்டு அறிவியல் அறிஞர்கள்
ஈ. இளம்பிறை மணிமாறன் - அன்பின் வண்ணம் கம்பனின் எண்ணம்

**அலகு -5 பயன்பாட்டுக் கல்வி / இலக்கணம்** (hours : 6)

அ. இதழ் உருவாக்கம் ( நாட்டுப்புறவியல்)
ஆ. மரபுத் தொடர் வழி – கதை உருவாக்கம்
இ. வட்டார வழக்குச் சொற்கள் ( உதாரணம் : உசிர் - உயிர் , சிலவு – செலவு
ஈ. அருஞ்சொற் பொருள் அறிக
இ. உரை நடை தோற்றமும் வளர்ச்சியும்

**பார்வை நூல்கள் :**

1.இராமலிங்க வள்ளலாரின் மகா தேவமாலை - இராம. இருசுப்பிள்ளை
2.தாயுமான சுவாமிகள் பாடல்கள் - வீ. சிவஞானம்
3.தனிப்பாடல் திரட்டு - கா.சு.பிள்ளை
4.திருமந்திரம் - அடியன் மணிவாசகம்
5.நாட்டார் வழக்காற்றியல் - தே.லூர்து
6.தமிழ் இலக்கிய வரலாறு - மது.ச.விமலானந்தம்

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| ளுரடிதநஉவ வுவைடந : ர்னைனை - ஐ | ீயவவநசright : வாநழசல |
|---|---|
| ழே ழக ஊசநனவைள : 2 | ழே ழக ர்ழரசள : 30 |

| | | |
|---|---|---|
| **Objective** | : | कविता के द्वारा भक्ति व प्रेम के योगदान साहित्य में सम्मलित भारत के संस्कृति के ऊपर प्रकाशन डालना |

| | | |
|---|---|---|
| **Outcome** | : | प्राचीन एवं नवीन कवियों का योगदान संचाना।<br>भक्ति काल के साहित्य को प्रमाणिकता देना |

| டு | வு | ீ | ஊ |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**UNIT – I** ` **6 Hours**

कबीरदास , सूरदास , तुलसीदास और रहिम

**UNIT – II** **6 Hours**

मैथिलि सारण गुप्तः – आर्य,
सूर्यकांत त्रिपाठी निराला - जागो फिर एक बार
महादेवी वर्मा - पंथ होने दो अपरिचित
हरिवंशराय बच्चन – अग्निपथ

**UNIT – III** **6 Hours**

सर्वेश्वर दयाल सक्सेना - पोस्टर और आदमी
आग्नेय – नाच

**6 Hours**

**UNIT – IV**

कुंवर नारायण - घर पहुंचना
लीलाधर गजुडी - जरूरत है
अरुण कमल - पुतली संसार

**UNIT – V** **6 Hours**

अशोक बाजपै - एक खिड़की
कात्यायनी –सिटकनी
ओमप्रकाश वाल्मिकी - ठाकुर का कुवा
ज्ञानेन्द्रपति - रेत के द्वीप पसर आये है

**Reference**
हिंदी कविता - राजकमल प्रशासन , नई दिल्ली

| | |
|---|---|
| ளரடிதநஉவ வுவைடந : ர்னைனை - ஐஐ | ீயவவநசெ : வாநழசல |
| மே ழக ஊசநனவைள : 2 | மே ழக ர்ழரசள : 30 |

| | | |
|---|---|---|
| **Objective** | : | • भाषा की प्रमाणिकता। छात्र एवं छात्रावों की दैनिक जीवन में भाषा की सांस्कारिक एवं वैज्ञानिक गति विधियों का अवलंबन करना<br>जीवन में भाषा की महत्व संझाना खत लिखने का महत्व को समझाना |

| | | |
|---|---|---|
| **utcome** | : | संस्कार के प्रति अवलोकन , सभ्यता की ओर दृष्टिकोण |

| டு | வு | ீ | ஊ |
|---|---|---|---|
| **3** | **0** | **0** | **3** |

**UNIT – I** **6 Hours**

**सज्ञा , सर्वनाम , क्रिया, लिंग , एक वचन , बहुवचन , नियम , करक**

**UNIT – II** **6 Hours**

पत्र लेखन , अनुवाद , अंग्रेजी हिंदी अनुवाद

**UNIT – III** **6 Hours**

सम्प्रेक्षण के अभ्यास - संकेत बिंदुओं के आधार पर कहानी लेखन

**UNIT – IV** **6 Hours**

यात्रा जिसे में भुला नहीं पाता
समय का महत्व
इंटरनेट की दुनिया
प्रदूषण की समस्या
ब्रष्टाचार : एक समस्या
साम्प्रदायिकता - एक अभिशाप

**UNIT – V** **6 Hours**

आरक्षण - कितना उचित कितना अनुचित
भारत में आतंगवाद
विद्याधि और अनुशासन
खेल और व्यायाम

**Reference**

लोकमंगल प्रकाशन , दिल्ली
सुबोध हिंदी

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| ளுரடிதநஉவ வுவைடந : ர்னைனை - ஐஐஐ | ீயவவநசெ : வுாநழசல |
|---|---|
| ழே ழக ஊசநனவைள : 2 | ழே ழக ர்ழரசள : 30 |

| | | |
|---|---|---|
| **Objective** | : | व्याकरण का महत्व संचना |

| | | |
|---|---|---|
| **Outcome** | : | दैनिक वर्तलाप में व्याकरण के महत्व को समचाना और प्रायोगिक रूप में पेश करना |

| டு | வு | ீ | ஊ |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**UNIT – I** **6 Hours**

उपन्यास - सपनों की होम डिलीवरी - ममता कालिया

**UNIT – II** **6 Hours**

पूस की रात – प्रेमचंद

बिसाती - जयशंकर प्रसाद

**UNIT – III** **6 Hours**

मक्रील – यशपाल

**UNIT – IV** **6 Hours**

सुम्मिंगपूल - असगर बजाहत

**UNIT – V** **6 Hours**

**नो बार - जयप्रकाश कर्दम**

**हरी बिंदी - मृदुला गर्ग**

**Reference**

**राजकमल प्रकाशन , दरियागंज , नई दिल्ली- 110002**

**राजपाल एंड सन्स , कश्मीरी गेट , नई दिल्ली- 110006**

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|---|---|
| ழே ழக ஊசநனவைள : 2 | ழே ழக ர்ழரசள : 30 |

| | | |
|---|---|---|
| **Objective** | : | कहानियों की आवस्यकता संचाना |

| | | |
|---|---|---|
| **Outcome** | : | कहानियों का योगदान सामूहिक रूप में समझना |

| டு | வு | ீ | ஊ |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**UNIT – I** **6 Hours**

चरवाहे - उपेन्द्रनाथ अश्क

**UNIT – II** **6 Hours**

ममता का विष - विष्णु प्रभाकर

**UNIT – III** **6 Hours**

कलिंग विजय - जगदीशचंद्र माथुर

**UNIT – IV** **6 Hours**

आषाढ़ का एक दिन - मोहन राकेश

**UNIT – V** **6 Hours**

माधवी - भीष्म साहनी

**Reference**

लोक भारती प्रकाशन , महात्मा गाँधी मार्ग , इलाहाबाद

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

**FACULTY OF ARTS AND SCIENCE**
**B.Sc. CHEMISTRY – CURRICULUM & SYLLABUS- 2021**

**Subject title: English I** **Pattern: Theory**
**No. of Credits: 2** **No. of hours: 30**

## Syllabus

**Objective:**
To understand the various literary writers and their portrayal of life and society.
To understand the use of language in expression.
To enable the students to read English and comprehend and interpret the text.

**Course Outcome:**
**After completion of the course**
The Students will be able to understand various literary writers and their portrayal of life and society.
The students will be able to understand the use of language in expression
The students will be able to read English and comprehend and interpret the text.

**UNIT I**

**Poetry** Harmony, ED. K. TRIPATHY – PUB. OUP, CHENNAI.

1. Wordsworth : Solitary Reaper
2. Robert Frost : Stopping by Woods on a Snowy Evening
3. Shakespeare : All the World is a Stage

**UNIT II**
**Short Stories**: Popular Short Stories ED. Board OF EDITORS – PUB. OUP, CHENNAI.
1. Katherine Mansfield :A cup of tea
2. R.K.Narayan :The Gateman's Gift
3. Leo Tolstoy : How Much Land Does a Man Need?

**UNIT III**
**Plays:** Tales from Shakespeare, Published by Madhuban Educational Books, UBS Publishers & Distributors, New Delhi.
1. The Merchant of Venice
2. Macbeth
3. Twelfth Night

**UNIT IV**

**Grammar:** Form And Function, By V.Sasikumar& V.S yamala, Emerald Publishers, Chennai-8.

1. Statements and Questions
2. Determiners including Articles
3. Conjunctions and other Devices

Composition: Communication Skills For Undergraduates, Dr. T.M.Farhathulah, RBA Publications, Chennai

**UNIT V**

1. Letter Writing
2. Telegrams
3. Advertisements

**Further Reading and Reference Book:**

1. Shakespeare,William *The Merchant of Venice*. Harlow,Essex,England: Longma,1994.
2. Shakespeare,William, Mowat,Barbara A. Werstine,Paul. *The Tragedy of Macbeth*. New York: Washington, Square press,2004, c1992 print.
3. Shakespeare, William, *Twelfth Night*. Boston; New York: Houghton Mifflin,1928.
4. Sokkalingam,S.R.M, *The Art of Speaking English*. Versatile Publishing House: ChennaiPlatinum digital prints.2010.
5. Word Worth,William. *The Collected poems of William Words Worth*. Words Worth Editions, 1994.

**Subject title: English II** **Pattern: Theory**
**No. of Credits: 2** **No. of hours: 30**

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**FACULTY OF ARTS AND SCIENCE**
**B.Sc. CHEMISTRY – CURRICULUM & SYLLABUS- 2021**

## Syllabus

**Objective:**
To understand the nuances of Poetry.
To learn the grammar, which in turn enhances reading of literature.
To train the students to write effectively
**Course Outcome:**
**After the completion of the course**
The Students will be able to understand the nuances of poetry
The students will be able to use basic grammatical structures in short conversations and discussions.
The students will be able to write effectively.

**Unit-I. Poetry: HarmonyEd. K.Tripathy– pub. OUP, Chennai.**

1. Milton : On His Blindness
2. Shelley : Ozymandias
3. Keats : La Belle Dame Sans Merci

**Unit-II. Short Stories : Popular Short Stories. Board of editors – pub. OUP, Chennai.**

1. Sir Arthur Conan Doyle : The Dying Detective
2. Ernest Hemingway : Old Man at the Bridge
3. Guy de Maupassant : The Necklace

**Unit–III Plays: Tales from Shakespeare, published by Madhuban educational books, UBS Publishers & Distributors, New Delhi**

1. A Midsummer Night's Dream
2. Much Ado About Nothing
3. Julius Caesar

**Unit-IV. Grammar: Form and Function, By V. Sasikumar & V. Syamala, Emerald Publishers, Chennai.**

1. The Active and Passive Voice
2. Reported Speech
3. Conditional Clauses

**Unit-V. Composition: Communication Skills for Undergraduates, Dr.T.M.Farhathulah, RBA Publications, Chennai.**

1. Notices
2. Designing a Resume
3. Writing a Report

**Further Reading &Reference Book:**

1. Doyle, Arthur Conan. The Adventure of Dying Detective. The Strand Magazine.1913.

2. Shakespeare, William. A Midsummer Night's Dream. New York: Signet Classic,1998.
3. Shakespeare, William. Much Ado About Nothing. London; New York: Penguin,2005.
4. Shakespeare, William. Julius Caesar. New York: Dover Publications, 1991.Print.
5. Sokkalingam,S.R.M, The Art of Speaking English. Versatile Publishing House: ChennaiPlatinum digital prints.2010.

## DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES

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**FACULTY OF ARTS AND SCIENCE**
**B.Sc. CHEMISTRY – CURRICULUM & SYLLABUS- 2021**

| S. No. | Name of the course | Type of course | L | T | P | Credits |
|---|---|---|---|---|---|---|
| 1 | Medicinal Chemitry | Discipline Specific Elective Course | 3 | 1 | 2 | **6** |
| 2 | Electrochemistry | Discipline Specific Elective course | 3 | 1 | 2 | **6** |
| 3 | Polymer Chemistry | Discipline Specific Elective Course | 3 | 1 | 2 | **6** |
| 4 | Environmental Chemistry | Discipline Specific Elective Course | 3 | 1 | 2 | **6** |
| 5 | Advanced Material Chemistry | Discipline Specific Elective Course | 3 | 1 | 2 | **6** |
| 6 | Advanced Analytical Chemistry | Discipline Specific Elective Course | 3 | 1 | 2 | **6** |
| 7 | Nuclear & Radiation Chemistry | Discipline Specific Elective Course | 3 | 1 | 2 | **6** |
| 8 | Organic spectroscopy | Discipline Specific Elective Course | 3 | 1 | 2 | **6** |
| 9 | Heterocyclic chemistry | Discipline Specific Elective Course | 3 | 1 | 2 | **6** |
| 10 | Biochemistry | Discipline Specific Elective Course | 3 | 1 | 2 | **6** |
| 11 | Organometallics and Bioinorganic chemistry | Discipline Specific Elective Course | 3 | 1 | 2 | **6** |
| 12 | Introduction to Nanochemistry & applications | Discipline Specific Elective Course | 3 | 1 | 2 | **6** |

# COURSE OUTCOMES FOR
# DISCIPLINE SPECIFIC ELECTIVE COURSES

## 1. Medicinal Chemistry

1. The basics of medicinal chemistry, biophysical properties
2. Biological activity parameters
3. Drug metabolism
4. Biophysical and chemical properties of enzymes, hormones, vitamins
5. Concept of rational drug design

## 2. Electrochemistry

1. Basic principle of laws of electrochemistry.
2 Understanding about chemical cells and their function
3 Understanding about electrodes, EMF measurement.
4 Understanding about potentiometric titrations and their applications.

## 3. Polymer Chemistry

1. The mechanism of polymer material formation.
2. Molecular weight and structure property relationship
3. Polymerization procedure and Zigler-Natta catalysis.
4. Characterization of polymers

## 4. Environmental Chemistry

1. Composition of atmosphere
2. Biogeochemical cycles
3. Hydrological cycle
4. Water quality parameters
5. Atmospheric chemical phenomenon and environmental pollution
6. Water pollution, parameters of water pollution, treatment of polluted water.

## 5. Advanced Materials Chemistry

1. Understanding Fundamental of lattices, unit cell, atomic coordinates, Bravais lattices,

crystal direction and planes, types

2. Synthesis of Inorganic solids; solid state, solution phase and vapor phase synthesis.
3. Crystal structure determination by X-ray diffraction, d-spacing formula, symmetrically absent reflections
4. Concept of reciprocal lattice. Electron microscopy techniques.
5. Basic principles of conducting polymers, delocalized electronic states of conjugated polymers,
6. Basic principles of conducting polymers, delocalized electronic states of conjugated polymers.

## 6. Advanced Analytical Chemistry

1. Theory of error and treatment of quantitative data, accuracy and precision, ways of expressing accuracy and precision
2. Understanding the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of two standard values
3. Comparison of mean with true values, regression analysis (least square method).
4. Current-voltage relationship, theory of polarographic waves, instrumentation, qualitative and quantitative applications
5. Solid, liquid and gaseous fuels, ultimate and proximate analysis of solid fuel, Determination of calorific value of solid, liquid and gaseous fuels.
6. Classification of drugs, Analysis of some standard drug using various chromatographic techniques.

## 7. Nuclear & Radiation Chemistry

1. Nucleus and its classification, nuclear forces, nuclear stability, binding energy, nuclear models. Radioactive decay
2. Nuclear reactions: Bethe notation, types of nuclear reactions (n, p, α, d and γ), conservation of quantities
3. Measurement of radioactivity, idea about accelerator and detectors, Van de Graaaf and linear acceletors, synchrontrons
4. Elementary ideas of radiation chemistry, radiolysis of water and aqueous solutions

5. Nuclear pollution and Radiological safety: Interaction of radiation with matter, Radiolysis of water, Radiation dosimetry
6. Isotopic dilution analysis, Neutron activation analysis, diposal of nuclear waste, nuclear disaster and its management

## 8. Organic Spectroscopy

1. Application of Woodward-Fiser rule in interpretation of Organic compounds: Application of visible, ultraviolet and infrared spectroscopy
2. Identification of Functional groups of various classes of organic compounds: Infrared radiation and types of molecular vibrations
3. Application of Chemical Shifts, Splitting of signals, Spin coupling and Over Houser effect in interpretation of NMR spectra, Isotopic exchange
4. Application of fragmentation rule in characterization of organic compounds. Problems on structure elucidation of organic compounds based on spectral data.

## 9. Heterocyclic Chemistry

1. **Three-membered rings** with one heteroatom: Chemistry of oxiranes, aziridines and episulphides - synthetic approaches and reactivities
2. **Three-membered heterocycles** with two heteroatoms: oxaziranes, diaziridines and diazirines -synthetic approaches and reactivities.
3. oxitanes, azatidanes and thietanes - synthetic approaches and reactivities. natural products:synthesis of Peniciline and cephalosporine.
4. Furans, pyrroles and thiophenes - general synthetic approaches, properties and reactivities.
5. Triazoles and tetrazoles - synthetic approaches, properties and reactivity.
6. Benzofuran, indoles and benzothiazoles - general synthetic approaches, with greater emphasis on the chemistry of Indoles.

## 10. Biochemistry

1. Understanding Biological importance of carbohydrates, Metabolism, Cellular currency of

energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.

2. Classification, biological importance; Primary, secondary and tertiary structures of proteins: α- helix and β- pleated sheets, Denaturation of proteins.
3. Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes,Coenzymes and cofactors,
4. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications
5. Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.

## 11. Organometallic and Bioinorganic Chemistry

1. Concept of hapticity of organic ligands. Metal carbonyls
2. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition)
3. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.
4. Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds.
5. Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation).

## 12.Introduction to Nanochemistry & Applications

1. Introduction to nanoscience, nanostructure and nanotechnology (basic idea), Overview of nanostructures and nano-materials
2. Size dependent properties of nanomaterials (basic idea with few examples only): Quantum confinement, Electrical, Optical
3. Synthesis of Nanomaterials: Brief introduction about Top-down and Bottom-up approaches & self-assembly techniques of nanoparticles synthesis
4. 7Self-assembled nanostructures- controlof nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.
5. Material characterization techniques (basic idea of use of following instruments in nanomaterial characterization
6. Electron microscopic technique, diffraction technique, photoelectron spectroscopy, zeta-potential measurement; Examples of use of nanomaterials in environmental remediation and biology

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**SYLLABUS - DISCIPLINE SPECIFIC ELECTIVE COURSES**

These courses have the following credit pattern.

For Theory based courses:

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 3 |

For laboratory based courses:

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

## 1. Medicinal Chemistry

| L | T | P | Cr |
|---|---|---|---|
| **3** | **1** | **2** | **6** |

After completion of the course, the learner can be able to understand:

1. The basics of medicinal chemistry, biophysical properties
2. Biological activity parameters
3. Drug metabolism
4. Biophysical and chemical properties of enzymes, hormones, vitamins
5. Concept of rational drug design

**Bio-physicochemical properties**

Acidity/Basicity, Solubility, Ionization, Hydrophobic properties, Hydrophilic properties, Lipinski Rule, Drug-like properties, Understanding of the biological activity parameters such as $K_i$, $K_d$, $LD_{50}$, $EC_{50}$, $IC_{50}$, $CC_{50}$, ADMET properties

**Structural properties**

Isosterism, Bioisosterism, Nonclassical isosteres, Understanding of the 3D-structure along with bond length, bond angle and dihydral angle, Concept of Configuration and Conformation with examples, Concept of stereochemistry in terms of biological response with examples, Stereoselective receptors or enzymes such as muscarinic receptor, Stereochemically pure drug and recemates, Examples such as catecholamines, etc.

**Drug target understanding**

Metabolism, Drug metabolism, Anti-metabolite, Enzyme inhibitor, Agonist, Antagonist, Examples.

**Medicinal Chemistry of Therapeutic Agent**

Structure, Chemistry, Mode of action and adverse effect of the representative therapeutic agents such as Anti-infective agent, Antimalarials, Antibacterial, Antiviral, Anticancer, CNS acting drugs, Adrenergic Agents, Cholinergic Drugs, Diuretics, Cardivascular, local anesthetic agent, Analgesic Agents, Histamine and Antihistamine agents

**Steroids, Prostaglandins, Enzyme, Hormone and Vitamins**

Biophysico-chemical properties, Steroid Hormone Receptors, Chemical Contraceptive agents, COX-2 inhibitors, Prostaglandins for Ophthalmic use, pharmaceutically important enzyme products such as Pancreatin, Trypsin, Insulin. Classification of vitamins with examples.

**Concept of rational drug design**

Structure activity relationship, Drug-receptor understanding, Molecular modeling, Structure based drug design. QSAR.

**Recommended books/References**:

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical ...by Charles Owens Wilson, John H. Block, Ole Gisvold, John Marlowe Beale
2. Foye's Principles of Medicinal Chemistry by David A. Williams, Thomas L. Lemke, William O. Foye (2008), Kluwer publication.
3. Remington: The Science and Practice of Pharmacy Vol 1, Ed. 19 by Joseph Price Remington, Alfonso R. Gennaro. (1995), MACK Publishing.
4. Burgers Medicinal Chemistry by Manfred E. Wolff, Alfred Burger
5. Burgers Medicinal Chemistry and Drug Discovery by Abraham D. J., Lewis F. L., Burger A., vol.5, 6th Edn., 2003, Hoboken N.J.Wiley,
6. The Organic Chemistry of Drug Design and Drug Action by Silverman R. B., 2nd Edn., Academic Press. 2012.
7. Exploring QSAR: Fundamental and applications in Chemistry and Biology by Hansch C. and Leo, A American Chemical Society (1995)
8. Patrick, G. Medicinal Chemistry, Oxford.University Press (2000)

**Practical wok suggested:**

1.Purification Techniques of Solvents by Fractional Distillation and Vacuum Distillation

2.Thin Layer Chromatography Technique and Purification of commercially available drugs/Synthesized Compounds by Column Chromatography.

3. Preparation of Acid/Basic Salts of Drugs and Evaluation of their Physicochemical Properties.(Benzilic Acid & Sodium Benzoate)

4.Synthesis & Purification of following Compounds using:
(i)Precipitation or Recrystallization.

(ii)Synthesis of Benzimidazole.

(iii)Synthesis of Anthranilic Acid.

(iv)Synthesis of Sulphanilamide.

(v)Synthesis of benzoic acid from benzyl alcohol.

(vi)Synthesis of 1,4 – dihydropyridine.

5.Computational modeling of drug design/use of softwares may be demonstrated to students.

**Suggsted books/references:**

1. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J. D. Barnes, M. J. K Thomas, 6th Edition, Pearson's Education Ltd.
2. Advanced Practical Medicinal Chemistry, Ashutosh Kar, New Age International Ltd. (2004).
3.Vogel‟s Textbook of Practical Organic Chemistry, B. S. Furniss, A. J. Hannaford , P.W.G. Smith, A. R Tatchell, 5th edition (2008), Pearson's Education Ltd

(The list of experiments and books are purly suggestive; University/institute may incorporate further changes in number of experiments and books/refererences (updated version from time to time) based on course design and available infrastructure facilities).

## 2. Electrochemistry

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 2 | 6 |

After completion of the course, the learner can be able to understand:

1. Basic principle of laws of electrochemistry.
2. Understanding about chemical cells and their function
3. Understanding about electrodes, EMF measurement.
4. Understanding about potentiometric titrations and their applications.

**Unit-I**

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

**Unit-II**

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb2O3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

**Unit-III: Electroanalytical methods:** Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination

of equivalence points. Techniques used for the determination of pKa values.

**Unit-IV: Electrical & Magnetic Properties of Atoms and Molecules:** Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.

**Recommended books/reference books**

1.Atkins, P.W & Paula, J.D. Physical Chemistry, 10th Ed., Oxford University Press (2014).

2.Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).

3.Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).

4.Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).

5.Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).

6. Rogers, D. W. Concise Physical Chemistry Wiley (2010).

7. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005).

**List of suggested laboratory experiments**

1. Determination of pH of a given solution using glass electrode.
2. Determination of cell constant.
3. Determination of equivalent conductance, degree of dissociation, and dissociation constant of weak acid.
3. Conductometric titration : strong acid *vs*. strong base, weak acid *vs*. strong base.
4. Potentiometric titration : strong acid *vs*. strong base, weak acid *vs*. strong base, potassium dichromate vs. mohr's salt.

**Recommended books/reference books**:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

2. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press.

*3.* Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).

4. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

## 3. Polymer Chemistry

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 2 | 6 |

After completion of the course, the learner can be able to understand:

1. The mechanism of polymer material formation.
2. Molecular weight and structure property relationship
3. Polymerization procedure and Zigler-Natta catalysis.
4. Characterization of polymers

**Introduction**

Polymer, monomer, examples of polymers, biopolymers, classification, polymerization process, degree of polymerization, condensation, addition polymers, kinetics of addition polymerization process.

**Polymeric Structure and Property Relationship**

Structure of polymers - Linear, branched, cross linked, and network polymers, molecular weight (number average, weight average, viscosity average) and distribution of molecular weight, polydispersity index, crystallinity in polymer, melting temperature and glass transition temperature, Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

**Polymerization Chemistry**

Industrial methods of polymerization such as a bulk, solution, emulsion, suspension. Stereochemistry of polymers and stereo-specific polymerization, Catalysts-their utility in polymers and stereo-specific polymerizations, Catalysts their utility in polymer manufacture, Zieglar-Natta, Metallocene and others.

**Characterization of Polymers**

Molecular Weight Determination by Light Scattering, Osmometry, End-Group Analysis, Viscosity, Gel Permeation Chromatography; Application, of FTIR, UV-visible, NMR, and Mass Spectroscopy for Identification of polymers.

**Recommended books/References:**

1. D.W. Van Krevelen and P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork. 1990.
2. J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt, 1996.
3. Reaction Engineering of Step Growth Polymerization, S K Gupta and Anil Kumar, Plenum Press, 1987
4. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970).
5. W. Billmeyer, Text book of polymer science, 3rd Edn., 2007, Wiley.
6. J.R.Fried, Polymer Science and Technology, (2005), PHI publication.
7. Billmeyer Jr.; Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers, New York (1962).

**List of suggested laboratory practicals**

1.Free radical solution polymerization of any one: Styrene, methylmethacrylate, methyl acrylate, methacrylic acid (using free radical initiators). (purification of monomer should be taught)
2. Preparation of phenol-formaldehyde resins
3. Emulsion polymerization of polymethylmethacrylate.
4. Use of viscometer for molecular weight determination – (any known polymer, example: polyvinyl pyrrolidone in water/polyacrylamide in $NaNO_2$ solution) by viscometry. (students should be explained regarding principles and use of ubblohde/ostwald viscometer).
5. Estimation of amount of HCHO in a given solution by sodium bisulphite method.
6. Use of FTIR/TGA/DSC – for polymer characterization (may be demonstrated to students)
7. Determination of exchange capacity of cation exchange resins and anion exchange resins.

**Recommended Books/Reference books**

1.P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. John Wiley & Sons (2002).

2.M.P. Stevens, *Polymer Chemistry: An Introduction* 3rd ed. Oxford University Press (2005).
3. L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons (2005)

(The list of experiments and books are purly suggestive; University/institute may incorporate further changes in number of experiments and books/refererences (updated version from time to time) based on course design and available infrastructure facilities).

## 4. Environmental Chemistry

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 2 | 6 |

After completion of the course, the learner can be able to understand:

1.Compositon of atmosphere
2.Biogeochemical cycles
3.Hydrological cycle
4. Water quality parameters
5.Atomospheric chemical phenomon and environmental pollution
6. Water pollution, parameters of water pollution, treatment of polluted water.

**Environment**

Composition of atmosphere, temperature variation of earth atmospheric system (temperature vs. altitude curve), biogeochemical cycles of C, N, P, S and O system.

**Hydrosphere:** Hydrological cycle, aquatic pollution and water quality parameters – Dissolve oxygen, biochemical oxygen demand, chemical oxygen demand, Analytical methods for the determination fluoride, chromium and arsenic, residual chlorine and chlorine demand, purification and treatment of municipal water and waste water.

**Atmosphere**

Chemical composition of atmosphere – particle, ions, and radicals in their formation, chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, and O and their effect, pollution by chemicals, CFC, Green House effect, acid rain, air pollution and control.

**Aquatic chemistry**

Water and its necessities, various water quality parameters (DO, BOD, COD, conductivity, pH, alkalinity, hardness) and its determination, Industrial, municipal water treatment processes, Waste water treatment procedure (primary, secondary and tertiary), Solid waste treatment. Soil pollution and Noise pollution.

**Recommended Books/References:**

1. De.A.K.Environmental Chemistry, Wiley Eastern Ltd, 1990.
2. Miller T.G.Jr., Environmental Science, Wadsworth publishing House, Meerut Odum.E.P.1971.
3. Odum, E.P. (1971) Fundamentals of Ecology. Third Edition, W.B. Saunders Co., Philadelphia
4. S. E. Manahan, Environmental chemistry, 1993, Boca Raton, Lewis publisher
5. Environmental chemistry, Sharma and Kaur, 2016, Krishna publishers
6. Environmental Pollution, Monitoring and control, S.M. Khopker, 2007, New Age International.
7. Environmental chemistry, C. Baird, M. Cann, 5th Edn, 2012, W.H.Freeman publication.

9 G. S. Sodhi Fundamental Concepts of Environmental Chemistry (Third Edition) Narosa (2009).

10. Principles of instrumental analysis: D. A. Skoog, Fifth Edition, Sauns College Publishing (London)

11 Basic concepts of analytical chemistry: S. M. Khopkar, Wiley Eastern (1995)

**List of suggested laboratory practicals**

Determination of water quality parameters in following aspect:

1. Determination of dissolved oxygen in given water (chemical method/instrumentation method).
2. Determination of Biological Oxygen Demand (BOD5).
3. Determination of Chemical Oxygen Demand (COD).
4. Finding out percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (carbonate, bicarbonate) by titration method.
7. Estimation of SPM in air samples.

**List of Recommended books/Reference Books:**

1. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, John Wiley & Sons, Inc. Publishers, New Delhi.(2005 edition).
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. A. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: New Age Int. Publisher, New Delhi.

## 5. Advanced Materials Chemistry

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 2 | 6 |

### Crystal structure of solids

Fundamental of lattices, unit cell, atomic coordinates, Bravais lattices, crystal direction and planes, types of close packing, packing efficiency, radius ratios; few important crystal structures.

Synthesis of Inorganic solids; solid state, solution phase and vapor phase synthesis; precipitation, hydrothermal, sol-gel, surfactant based synthesis. Growth of single crystals.

Crystal structure determination by X-ray diffraction, d-spacing formula, symmetrically absent reflections, Multiplicities, Scattering of X-rays by an atom and a crystal. Single crystal and powder diffraction. Electron and neutron diffraction. Concept of reciprocal lattice. Electron microscopy techniques.

### Nanomaterial fundamentals

Synthesis: Bottom-up vs. Top-down Methods. Solution phase synthetic methods. Role of surfactant in shape and size control of nanomaterials. Synthesis of nanowires and nanotubes by CVD and MOCVD method.

Nanomaterials Characterization: XRD of nanomaterials, Electron microscopy (SEM, TEM, HRTEM and EDX) of nanomaterials, Scanning probe microscopy.

Nanomaterial properties and applications: Magnetic properties of nanoparticles; superparamagnetism, ferromagnetism in antiferromagnetic nanoparticles and single domain to multidomain transition. magnetic nanoparticles as MRI contrast agents.

### Frontier areas of polymer science and technology

Conducting polymers: basic principles of conducting polymers, delocalized electronic states of conjugated polymers, polyanilines, polyacetylenes, polythiophene, applications of conducting polymers.

Biodegradable polymers: Definition classification of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soy protein, corn, zein protein, wheat gluten protein, synthetic biodegradable polymers, polyhydroxy alkanoates, polycarpolactone, poly(vinyl alcohol), polyacetic acid, application of biodegradable and biomedical polymers, contact lens, dental polymers, artificial heart, kidney, skin, and blood cells.

Fibers: natural fibers, cotton, wool, silk, rayon, artificial fibers, polyamides, acrylic acid, PVC, PVA.

Rubber: Compounding and elastomeric properties, vulcanization, reinforcement.

**Recommended books/References:**

1. Zhen Guo and Li Tan, *Fundamentals and Applications of Nanomaterials*.2009, Artech House, London Publication.
2. Physical methods for chemistry: R. S. Drago, 1992, Saunders college publication.
3. Polymer science, V. R. Gowariker, N. V.Viswanathan, J. Sreedhar, New Age International (P) Ltd., 2015.
4. P. J. Flory, Principle of polymer chemistry, Cornell University Press.
5. Polymer Science and technology, Plastics, Rubber and composites, P. Ghosh, Tata McGraw Hill.
6. V. Gowriker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age Int.Publication, 2019.

**List of suggested Laboratory Experiment.**

(The list of experiments are suggestive. However, faculties/academic bodies may add more experiments/references or incorporate suitable revisions based on infrastructure facilities available).

1. Preparation of gold and silver nano-particles.
2. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
3. Determination of composition of dolomite (by complexometric titration).
4. Analysis of XRD pattern of few selected crystals like $NaNO_3$, $CaCl_2$, etc.; Indexing of a given powder diffraction pattern of a cubic crystalline system.
5. Interpretation of FTIR, NMR and UV-Vis data of given material.
6. Estimation of particle size from the BET, SEM techniques.

**Recommended books/Reference Book:**

1.Fahlman, B.D. *Materials Chemistry,* Springer, 2004.

## 6. Advanced Analytical Chemistry

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 2 | 6 |

**Statistical methods in chemical analysis**

Theory of error and treatment of quantitative data, accuracy and precision, ways of expressing accuracy and precision, Normal error curve and its equation. Useful statistical tests with equation, test of significance, the F-test, the students t-test, the Chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, regression analysis (least square method).

**Polarography**

Current-voltage relationship, theory of polarographic waves, instrumentation, qualitative and quantitative applications.

**Atomic spectroscopy**

Atomic absorption spectroscopy, theory and application (with some examples).

**Thermal analysis**

Theory, methodology, instruments and applications of theromogravimetric analysis (TGA/DTA), and differential scanning calorimetry (DSC).

**Chromatography**

Principles of chromatography, paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC.

**Analysis of fuel and drugs**

**Fuel analysis:** Solid, liquid and gaseous fuels, ultimate and proximate analysis of solid fuel, Determination of calorific value of solid, liquid and gaseous fuels, Flash point and fire point.

**Drug analysis:** Classification of drugs, Analysis of some standard drug using various chromatographic techniques.

**Recommended books/references:**

1 Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2 Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing California, USA, 1988.
3.Christian, G.D, *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4 Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5 Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*
6 Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood John Wiley 1979.
7 Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.
8 Khopkar, S. M., Basic Concepts of Analytical Chemistry, New Age (Second edition) 1998

**List of suggested laboratory experiments**

1. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures. Preparation of buffer solutions of different pH (i. Sodium acetate-acetic acid, ii. Ammonium chloride-ammonium hydroxide
2. Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:
   i. Ni (II) and Co (II)
   ii. Fe (III) and Al (III)
3. Chromatographic separation of the active ingredients of plants, flowers and juices by TLC.
4. IR/DSC analysis of known polymer sample (for students demonstration only)
5. Determination of flash point & fire point of given fuel sample.
6. Determination of viscosity index, cloud point, pour point of given fuel sample.
7. Determination of calorific value of given fuel sample/coal sample using bomb calorimeter.
8. Proximate analysis of given coal sample.
9. Determination of the iodine number of oil.
10. Determination of the saponification number of oil.

**Recommended books/Reference books:**

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009. Jain, P.C. & Jain, M. *Engineering Chemistry* Dhanpat Rai & Sons, Delhi.
2. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009
3. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.

## 7. Nuclear & Radiation Chemistry

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 2 | 6 |

Nucleus and its classification, nuclear forces, nuclear stability, binding energy, nuclear models. Radioactive decay (Radioactive elements, general characteristics of radioactive decay, decay kinetics - decay constant, half life, mean life period), units of radioactivity, Transient and secular equilibria, Carbon dating and its usefulness.

Nuclear reactions: Bethe notation, types of nuclear reactions (n, p, α, d and γ), conservation of quantities (mass-energy and linear momentum) in nuclear reactions, reaction cross-section, compound nucleus theory and nuclear reactions. Nuclear fission: the process, fragments, mass distribution, and fission energy.

Measurement of radioactivity, idea about accelerator and detectors, Van de Graaaf and linear acceletors, synchrontrons, Geiger-Muller detector, Scintillaton detectors, Type of nuclear reactions, Nuclear fission, Nuclear fusion, Nuclear reactor: classification of reactors, the natural uranium reactor, breeder reactor. Nuclear fusion and stellar energy.

Radiation chemistry: Elementary ideas of radiation chemistry, radiolysis of water and aqueous solutions, unit of radiation chemical yield (G-value), radiation dosimetry (Fricke's dosimeter), units of radiation energy (Rad, Gray, Rontgen, RBE, Rcm, Sievert)

Nuclear pollution and Radiological safety: Interaction of radiation with matter, Radiolysis of water, Radiation dosimetry. Radioactive isotopes and their applications, Isotopic dilution analysis, Neutron activation analysis, diposal of nuclear waste, nuclear disaster and its management (nuclear accidents and holocaust – discussion about case studies).

**Recommended Books/references:**

1. Friendlander G, Kennedy G and Miller J. M. Nuclear and Radiochemistry, Wiley Interscience
2. Harvey, B. G. Introduction to Nuclear Physics & Chemistry, Prentice – Hall,
3. Overman R. T, Basic concept of Nuclear Chemistry, Chapman & Hall.
4. A. N. Nesmeyanov, Radiochemistry, MIR Publication, Moscow.
5. Spinks J. W. T. and Woods R. J. An Introduction to Radiation Chemistry, Wiley
6. Arnikar H. J., Essentials of Nuclear Chemistry, Wiley Eastern, Second Edition.

**Suggested laboratory practicals:**

1. The safe laboratory use of radionuclide and radioisotopes
2. Demonstration of activity on Geiger-Muller and scintillation based counter.
3. Liquid scintillation counting, alpha spectrometry, gamma spectrometry – to identify and quantify radioisotopes
4. Occurrence of radon daughter particles in environmental samples.
5. Liquid-liquid separation/extraction of radio nuclide from environmental samples/water samples.
6. Isotopic application in removal process adsorption / ion exchange.

(The above list is just suggestive. More experiments can be added/incorporated based on facility/expertise available. Since above experiments require certified labs which may not be available at all places, therefore, it is advised that institute/university/teacher may arrange/allow academic visit of students to nuclear chemistry labs in the country following proper procedure and to prepare comprehensive report of the visit/viva voce of students which can also form a lab course until available facilities are available).

## 8. Organic Spectroscopy

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 2 | 6 |

**Basic Principles of UV Spectroscopy:**

Application of Woodward-Fiser rule in interpretation of Organic compounds: Application of visible, ultraviolet and infrared spectroscopy in organic molecules. Electromagnetic radiation, electronic transitions, $\lambda$max & $\varepsilon$max, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating $\lambda$max of conjugated dienes and $\alpha,\beta$ – unsaturated compounds.

**Basic principles of IR Spectroscopy**:

Identification of Functional groups of various classes of organic compounds: Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

**NMR ($^{1}$H and $^{13}$C NMR):**

Application of Chemical Shifts, Splitting of signals, Spin coupling and Over Houser effect in interpretation of NMR spectra, Isotopic exchange

**Basic principles Mass Spectrometry:**

Application of fragmentation rule in characterization of organic compounds. Problems on structure elucidation of organic compounds based on spectral data.

**Recommended Books/References:**

1. R.M. Silverstein, G.C. Bassler & T.C. Morrill*: Spectroscopic Identification of Organic Compounds*, John Wiley & Sons.

2.John R. Dyer, Applications of absorption spectroscopy of organic compounds, Prentice Hall India (2012).

**Suggested laboratory experiments**

1. Purification method for liquid, solid organic substance (distillation, recrystallization, chromatorgrapy)
2. Analysis of spectra of UV-Vis, FTIR, NMR and Mass of simple organic compounds. (students may encourage to prepare simple organic compounds following given protocol (azodyes, acetanilides, benzoic acid, etc.) (or may use commercially available organic componds) and can be trained to identify/analyze important peaks/functionality, determine mass of the molecules (mass-spectra). They can submit a report regarding their analysis to course teacher.

## 9. Heterocyclic Chemistry

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 2 | 6 |

**Heterocyclic Chemistry**

**Three-membered rings** with one heteroatom: Chemistry of oxiranes, aziridines and episulphides - synthetic approaches and reactivities.

**Three-membered heterocycles** with two heteroatoms: oxaziranes, diaziridines and diazirines - synthetic approaches and reactivities.

**Four-membered heterocycles**: oxitanes, azatidanes and thietanes - synthetic approaches and reactivities. natural products:synthesis of Peniciline and cephalosporine.

**Five-membered aromatic heterocycles**:

1. With one heteroatom: furans, pyrroles and thiophenes - general synthetic approaches, properties and reactivities.
2. With two heteroatoms: oxazoles, isoxazoles, imidazoles, thiazoles, pyrazoles and isothiazoles - general synthetic approaches and reactivities.
3. With three and four heteroatoms: triazoles and tetrazoles - synthetic approaches, properties and reactivity.

**Condensed five-membered Heterocycles**:

Benzofuran, indoles and benzothiazoles - general synthetic approaches, with greater emphasis on the chemistry of Indoles.

**Recommended Books/references:**

1. Heterocyclic Chemistry, J.A. Joule, K. Mills, Wiley, 2010.
2. The Essence of heterocyclic Chemistry, A. R. Parikh, H. Parikh, R. Khunt, New Age Int. Publication,
3. Principles of Modern Heterocyclic Chemistry, L. A. Paquette, W. A. Benjamin, New York, 1968.
4. Heterocyclic Chemistry, J.A. Joule and G. F. Smith, van Nostrand, London, 1978.
5. Comprehensive Heterocyclic Chemistry. The structure, reactions, synthesis and use of Heterocyclic compounds, (Ed. A.R. Katritzky and C. W. Rees),. Vol 1-8, Pergamon Press, 1984.
6. Handbook of Heterocyclic Chemistry, A. R. Katritzky, Pergamon Press, 1985.
7. Van der plas, H. C. Ring transformations of Heterocycles, Vols 1 and 2, Academic Press, 1974.

**List of suggested laboratory experiments**

1. Identification of hetero atoms (S, N, X) in given organic compounds in lab.
2. Identification/separation of simple organic compounds containing hetero atoms using column chromatorgapy/TLC) in lab.
3. Spectroscopic identification of simple organic compounds (spectra may be provided to the students and teachers may help the students to identify the compounds using spectra). Melting point/boiling point of the compounds may be checked for its purity.
4. Teacher may guide the students for preparation of : Indigo (using aldol condensation reaction of 2-nitrobenzaldehyde with acetone in basic condition);

(Depending upon laboratory facilities, more preparation of heterocyclic group of compounds may be incorporated by teacher).

## 10. Biochemistry

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 2 | 6 |

**Carbohydrates: (8 classes of 60 minutes duration each)**

Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.

**Proteins: (8 classes of 60 minutes duration each)**

Classification, biological importance; Primary, secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Denaturation of proteins.

**Enzymes: (8 classes of 60 minutes duration each)**

Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes,Coenzymes and cofactors, Enzyme inhibitors, Biocatalysis in Green Chemistry" and Chemical Industry

**Lipids: (8 classes of 60 minutes duration each)**

Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.

**Structure of DNA/RNA: (8 classes of 60 minutes duration each)**

Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.

**Recommended Books/References:**

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VI the Edition. W.H. Freeman and Co.

2. Nelson, D. L., Cox, M. M. and Lehninger, A. L. (2009) principles of Biochemistry.IV Edition. W.H. Freeman and Co.

3. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange medical Books/ McGraw-Hill

**Suggested Practical in Biochemistry**

1. Quantitative estimation of protein using Lowry's method. Determine the concentration of the unknown sample.
2. Action of salivary amylase at optimum conditions
3. Effect of pH on the action of salivary amylase
4. Effect of temperature on salivary amylase
5. Effect of inhibitor on salivary amylase
6. Study of the activity of Trypsin using fresh tissue extracts.
7. Effect of temperature, organic solvents, on semi-permeable membrane.
8. Isolation of Genomic DNA from E Coli

(The above course structure/number of classes are suggestive. Faculty/academic bodies may incorporate revision/may incorporate text and reference books as per need).

## 11. Organometallic and Bioinorganic Chemistry

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 2 | 6 |

**Chemistry of 3d metals:** Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties); Peroxo compounds ofCr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

**Organometallic Compounds**

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. pi-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies). Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

**Bioinorganic chemistry**

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to $Na^+$, $K^+$ and $Mg^{2+}$ ions: Na/K pump; Role of $Mg^{2+}$ ions in energy production and chlorophyll. Role of $Ca^{2+}$ in blood clotting, stabilization of protein structures and structural role (bones).

**Recommended books/reference books**

1. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.
2. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
3. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
4. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997

**List of Laboratory experiments**

(necessary infrastructure may be developed and adequate precaution should be maintained to conduct such experiments; instructor may demonstrate the experiment to students)

1. Rection of metal with halide – preparation of Grignard reagent. (only demonstration purpose)
2. Grignard preparation of dye (malachite green (using methylbenoate)/crystal violet (using diethylcarbonate) (starting material as p-bromo N, N-dimethyl aniline) (only demonstration purpose)
3. Preparation of various Schiff base-metal complexes and their identification using spectroscopy.
4. Preparation of any two of the following complexes and measurement of their conductivity measurement:
    a. tetraamminecarbonatocobalt (III) nitrate
    b. tetraamminecopper (II) sulphate
    c. potassium trioxalatoferrate (III) trihydrate

**Recommended books/reference books**

1. Synthesis of organometallic compounds: A practical guide, S. Komiya, Wiley.
2. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall,

## 12. Introduction to Nanochemistry & Applications

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 2 | 6 |

**Unit-I:** Introduction to nanoscience, nanostructure and nanotechnology (basic idea), Overview of nanostructures and nano-materials, classification, (cluster, colloid, nanoparticles, and nanostructures -Spheroid, Wire, Rod, Tube, and Quantum Dot); Calculation of percentage of surface atom and surface to volume ratio of spherical, wire, rod, and disc shapes nanoparticles.

**Unit-II:** Size dependent properties of nanomaterials (basic idea with few examples only): Quantum confinement, Electrical, Optical (Surface Plasmon resonance), variation in colors (Blue shift & Red shift), Magnetic, thermal and catalytic properties.

**Unit-III:** Synthesis of Nanomaterials: Brief introduction about Top-down and Bottom-up approaches & self-assembly techniques of nanoparticles synthesis, Solvothermal process, Examples of preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-controlof nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.

**Unit-IV:** Material characterization techniques (basic idea of use of following instruments in nanomaterial characterization need to be emphasized): Electron microscopic technique, diffraction technique, photoelectron spectroscopy, zeta-potential measurement; Examples of use of nanomaterials in environmental remediation and biology (few practical examples of use of materials can be discussed).

**Recommended Books/References books:**

1.C. N. R. Rao, A. Muller, A. K. Cheetam, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Willey-VCH Verlag, Germany, 2005.
2.G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Appications, Imperial College Press, London, 2004
3.R. W. Kelsall, I. W. Hameley, M. Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, England, 2005
4.Charles P. Poole and Frank J Owens, *Introduction to nano technology*, Wiley Interscience, 2003.

5. Pradeep, T., A text of book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.

**List of Laboratory Experiments suggested:**

1. Synthesis of ZnO nanoparticles.
2. Preparation of Silver nanoparticles.

(diverse nanoparticles can be prepared by various routes)

3. verfification of Beer-Lambert law using nano-particles (above prepared nano-particles may be used for the study).

(Depending upon the availability of infrastructure facilities, instructor may encourage the students to prepare bimetallic nano-particles, etc. and characterized them, study their various properties like magnetism, adsorption, etc.)

**Recommended/Ref. Books:**

1. Pradeep T., A text book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012 edition.

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

**FACULTY OF ARTS AND SCIENCE**
**B.Sc. CHEMISTRY – CURRICULUM & SYLLABUS- 2021**

# ABILITY ENHANCEMENT COURSES

| Sr. No. | Name of the course | Type of course | L | T/ P | P | Credits |
|---|---|---|---|---|---|---|
| 1 | English for communication | Ability Enhancement Courses | 3 | 1 | 0 | 4 |
| 2 | Environmental Science | Ability Enhancement Courses | 3 | 1 | 0 | 4 |

## COURSE OUTCOMES FOR ABILITY ENHANCEMENT COURSES

### 1. English for communication

1. To introduce the nuances of language and its purpose in practical and academic life.
2. To help bridge the mobility of English language through advanced teaching aids and creative ideologies.
3. Emancipate the correct usage of communication at zones of competence and developed personality globally.
4. To inculcate the active role play of effective skills verbally and efficient skills non-verbally in discourse.
5. To contextualize new vocabulary, use of reviewing, skimming, scanning and enhance the credibility of reading and writing consciousness in students.
6. Cross- build learning styles as soft skills, classmate collaborations, group assignments, individual persona levels to utmost productivity in business sectors of work.
7. Up skill the gut-power of students on scaled platforms through comprehensive moves and casting roles in testing of the four vital communication skills held concurrently at ease.

# SYLLABUS - ABILITY ENHANCEMENT COURSES

These courses have the following credit pattern. For theory papers:

| L | T/P | Cr |
|---|---|---|
| 3 | 1 | 4 |

## 1. English for communication

| L | T | P | Cr |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

Communication: Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing.

Writing Skills; Selection of topic, thesis statement, developing the thesis; introductory, developmental, transitional and concluding paragraphs, linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

Technical Writing: Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes; common errors to be avoided.

(The above course is suggestive. However, the course teacher/academic bodies may incorporate changes as per the need with incorporation of appropriate text books, reference materials).

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# SKILL ENHANCEMENT COURSES

| Sr. No. | Name of the course | Type of course | L/ P | T | P | Credits |
|---|---|---|---|---|---|---|
| 1 | Personality Development | Skill Enhancement Courses | 2 | 0 | 0 | **2** |
| 2 | Computer Applications in Chemistry | Skill Enhancement Courses | 2 | 0 | 0 | **2** |
| 3 | Science Communication and Popularization | Skill Enhancement Courses | 2 | 0 | 0 | **2** |
| 4 | Biofertilizer | Skill Enhancement Courses | 2 | 0 | 0 | **2** |
| 5 | Herbal Science & Technology | Skill Enhancement Courses | 2 | 0 | 0 | **2** |
| 6 | Fermentation Science & Technology | Skill Enhancement Courses | 2 | 0 | 0 | **2** |
| 7 | Environment Impact Analysis | Skill Enhancement Courses | 2 | 0 | 0 | **2** |
| 8 | IT Skill for Chemist | Skill Enhancement Courses | 2 | 0 | 0 | **2** |
| 9 | IPR and business skill for chemist | Skill Enhancement Courses | 2 | 0 | 0 | **2** |
| 10 | Analytical Clinical Biochemistry | Skill Enhancement Courses | 2 | 0 | 0 | **2** |
| 11 | Mushroom Culture Technology | Skill Enhancement Courses | 2 | 0 | 0 | **2** |

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# COURSE OUTCOMES FOR SKILL ENHANCEMENT COURSES

## 1. Personality Development

After the completion of this course, the learner will be able to:

1. Develop understanding of the concepts and principles of basic psychological skills
2. Apply techniques and methods to enhance productivity and time management
3. Develop critical thinking skills
4. Organize human resources with improved leadership qualities

## 2. Computer Applications in Chemistry

After the completion of this course the learner will be able to:

1. Apply the basic operations of spreadsheet applications
2. Recognize advanced resources for accessing scholarly literature from internet
3. Utilize bibliography management software while typing and downloading citations
4. Operate various software resources with advanced functions and its open office

## 3. Science Communication and Popularization

After the completion of this course, the learner will be able to:

1. Identify the need and role of science communication in human development
2. utilize visual media science communication for creating scripts and documentaries
3. Contribute in science popularization through internet communication and public sensitization

## 4. Biofertilizers (Practical based course)

On the completion of this course, the students will be able to;

1. Develop their understanding on the concept of bio-fertilizer
2. Identify the different forms of biofertilizers and their uses
3. Compose the Green manuring and organic fertilizers
4. Develop the integrated management for better crop production by using both Nitrogenous and phosphate bio fertilizers.

**5. Herbal Technology (Practical based)**

On completion of this course the students will be able to;

1. Develop their understanding on Herbal Technology
2. Define and describe the principle of cultivation of herbal products.
3. List the major herbs, their botanical name and chemical constituents.
4. Evaluate the drug adulteration through the biological testing
5. Formulate the value added processing / storage / quality control for the better use of herbal medicine
6. Develop the skills for cultivation of plants and their value added processing / storage / quality control

**6. Fermentation Science and Technology**

After completing this course the learner will be able to;

1. Employ the process for maintenance and preservation of microorganisms
2. Analyze the various aspects of the fermentation technology and apply for Fermentative production
3. Demonstrate proficiency in the experimental techniques for microbial production of enzymes: amylase and protease, bio product recover

**7. Environmental impact analysis (Practical based)**

After completing this course the learner will be able to;

1. Have critical understanding of environmental impact
2. Learn important steps of EIA process
3. Interpret the environmental appraisal and procedures in India.

## 8. IT skills for chemists

On completion of this course the students will be able to;

1. Understand Fundamentals, mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, inter-conversion of units, constants and variables, equation of a straight line, plotting graphs
2. Get knowledge on Uncertainty in experimental techniques: Displaying uncertainties, measurements in chemistry, decimal places, significant figures, combining quantities. Uncertainty in measurement.
3. Numerical methods of finding roots (Newton-Raphson, binary –bisection, e.g. pH of a weak acid not ignoring the ionization of water
4. Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and command.

## 9. Intellectual property right (IPR) and business skills for chemists

After completing this course the learner will be able to;

1. Familiar with Introduction to Intellectual Property: Historical Perspective, Different Types of IP, Importance of protecting IP.
2. Understanding Copyrights:- Introduction, How to obtain, Differences from Patents. Trade Marks - Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.
3. Get knowledge on Patents Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

## 10. Analytical Clinical Biochemistry

On completion of this course the students will be able to;

1. Understand Structure, properties and functions of carbohydrates, lipids and proteins
2. Get knowledge in Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Structure of DNA.
3. A diagnostic approach to biochemistry: Blood: Composition and functions of blood, blood coagulation. Urine: Collection and preservation of samples. Formation of urine. Composition and estimation of constituents of normal and pathological urine

## 11. Mushroom Culture Technology

SOn completion of this course, the students will be able to:

1. Recall various types and categories of mushrooms.
2. Demonstrate various types of mushroom cultivating technologies.
3. Examine various types of food technologies associated with mushroom industry.
4. Value the economic factors associated with mushroom cultivation
5. Device new methods and strategies to contribute to mushroom production.

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

**FACULTY OF ARTS AND SCIENCE**
**B.Sc. CHEMISTRY – CURRICULUM & SYLLABUS- 2021**

# SYLLABUS - SKILL ENHANCEMENT COURSES

A number of courses has been enlisted. These courses have the following credit pattern. For theory based papers:

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

For practical based papers:

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

## 1.Personality Development

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

## Learning outcomes:

After the completion of this course, the learner will be able to:

- Develop understanding of the concepts and principles of basic psychological skills
- Apply techniques and methods to enhance productivity and time management
- Develop critical thinking skills
- Organize human resources with improved leadership qualities

## Keywords:

Mental heuristics, Mental priming, Checklists, Stress management, Cognitive biases, Leadership qualities

### Unit I: Basic Psychology Skills 8 lectures

Mental Heuristics and Priming, Cialdini's six psychological principles, Charisma and charisma enhancements, facing interviews

### Unit II: Productivity and Time Management 7 lectures

Eisenhower Matrix, Pomodoro Technique, Dealing with Procrastination, Journaling methods, Checklists, to-do lists and scheduling the events

**Unit III: Dealing Negativity** **7 lectures** Work-life balance, stress management, coping with failures and depression

**Unit IV: Critical Thinking and Human resources** **8 lectures**

Logical fallacies, Cognitive biases, Mental Models, Critical Thinking. Evaluation and improvement; Leadership qualities.

## Suggested Readings

1. Bast, F. (2016). Crux of time management for students. Available at: https://www.ias.ac.in/article/fulltext/reso/021/01/0071-0088
2. Cialdini, R.B. (2001). Influence: The Psychology of Persuasion, Revised Edition. Harper Collius.
3. Green, C.J. (2015). Leadership and soft skills for students: Empowered to succeed in High School, College and beyond. Dog Ear Publishing.
4. Velayudhan, A. and Amudhadevi, N. V. (2012). Personality Development for College Students. LAP Lambert Academic Publishing.

## 2. Computer Applications in Chemistry

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

### Learning outcomes:

After the completion of this course the learner will be able to:

1.Apply the basic operations of spreadsheet applications
2.Recognize advanced resources for accessing scholarly literature from internet
3.Utilize bibliography management software while typing and downloading citations
4.Operate various software resources with advanced functions and its open office substitutes

### Keywords:

Spreadsheet, Google search, Subscription, Bibliography, MS office, Image processing

### Unit I: Spreadsheet Applications 8 lectures

Introduction of spreadsheet (MS Excel), application, formulas and functions, performing basic statistics using spreadsheet applications, creating basic graphs using spreadsheet applications, logical (Boolean) operators.

### Unit II: Internet Resources 7 lectures

Advanced Google search operators and Boolean functions, Introduction to Google Scholar and accessing scholarly literature from Internet, Fake News and spotting the fake news, multimedia resources and podcasts, RSS/XML Feeds and feed subscription using a feed reader.

### Unit III: Bibliography management 8 lectures

Introducing a bibliography management software (for e.g. Endnote), Styles and Templates, Changing the bibliography style as per journal format, Citing while typing in the office application, downloading citations from Google Scholar.

### Unit IV: Other software resources 7 lectures

Introduction to advanced functions of MS Word and its Open Office substitutes including tracking changes, inserting page numbers and automatic table of contents, Google Docs and Forms, MS Power point, Microphotography and scale calibration with ImageJ, digital image processing (Paint.net or GIMP).

### Suggested Readings

1. User manual and online user manual of respective soft wares for the most updated content
2. Published books are not recommended as versions keep on updating very frequently; therefore, it is not easy to follow.

## 3. Science Communication and Popularization

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

## Learning outcomes:

After the completion of this course, the learner will be able to:

- Identify the need and role of science communication in human development
- utilize visual media science communication for creating scripts and documentaries
- Contribute in science popularization through internet communication and public sensitization

## Keywords:

Print science, Visual media, Internet communication, Blogs, Outreach talks, Public sensitization

## Unit I: Print Science Communication 9 lectures

Need for Science Journalism: Science has potential for breaking news, impact on Human life, impact on technology. Role of science and technology in human development. Framing policies at national and international levels. Writing and communicating popular articles effectively, case studies of celebrated works of science communicators including Cosmos by Carl Sagan, works of Bill Bryson, Richard Dawkins, Richard Feynman, Isaac Asimov, Carl Zimmer and Matt Riddley, importance for communication through regional languages.

## Unit II: Visual Media Science Communication 7 lectures

Science outreach through visual media: Creating science documentaries, creating the outline and expanding, scripts, citing authentic sources, case study: Famous documentaries of Carl Sagan, David Attenborough and Prof. Yashpal

## Unit III: Internet Science Communication 7 lectures

Science outreach through internet: Social media, Websites, Blogs, Youtube, Podcast etc.

## Unit IV: Science Outreach Talks and Public Sensitization 7 lectures

Tactics for providing a charismatic and effective public talk, use of metaphors, speaking in context, Science outreach for biodiversity conservation sensitization of public

## Suggested Readings

1. Selected works of Carl Sagan, works of Bill Bryson, Richard Dawkins, Richard Feynman, Isaac Asimov, Carl Zimmer and Matt Riddley.
2. Gigante, E. Marie (2018). Introducing Science Through Images: Cases of Visual Popularization (Studies in Rhetoric/Communication), University of South Carolina Press.

## 4. Biofertilizers (Practical based course)

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

### Learning outcomes:

On the completion of this course, the students will be able to;

- Develop their understanding on the concept of bio-fertilizer
- Identify the different forms of biofertilizers and their uses
- Compose the Green manuring and organic fertilizers
- Develop the integrated management for better crop production by using both nitrogenous and phosphate bio fertilizers

### Keywords:

Useful microbes, Cyanobacteria, Mycorrhiza, Organic farming, Recycling, Vermicompost

### Unit I 9 lectures

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

### Unit II 7 lectures

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

### Unit III 7 lectures

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

### Unit IV 7 lectures

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

## Suggested Readings

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

## 5. Herbal Technology (Practical based)

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

## Learning outcomes:

On completion of this course the students will be able to;

- Develop their understanding on Herbal Technology
- Define and describe the principle of cultivation of herbal products.
- List the major herbs, their botanical name and chemical constituents.
- Evaluate the drug adulteration through the biological testing
- Formulate the value added processing / storage / quality control for the better use of herbal medicine
- Develop the skills for cultivation of plants and their value added processing / storage / quality control

## Keywords:

Herbal medicines, Plant products, Biopesticides, Pharmacognosy, Adulteration, Secondary metabolites

### Unit I — 7 lectures

Herbal Technology: Definition and scope; Herbal medicines: history and scope; Traditional systems of medicine, and overview of AYUSH (Traditional Indian Systems of Medicine); Cultivation - harvesting - processing - storage of herbs and herbal products.

### Unit II — 7 lectures

Value added plant products: Herbs and herbal products recognized in India; Major herbs used as herbal medicines, nutraceuticals, cosmeticals and biopesticides, their Botanical names, plant parts used, major chemical constituents.

### Unit III — 8 lectures

Pharmacognosy - Systematic position, botany of the plant part used and active principles of the following herbs: Tulsi, Ginger, Curcuma, Fenugreek, Indian Gooseberry, *Catharanthus roseus*,

*Withania somnifera*, *Centella asiatica, Achyranthes aspera,* Kalmegh, Giloe (Tinospora), Saravar. Herbal foods, future of pharmacognosy.

## Unit IV

**8 lectures**

Analytical pharmacognosy: Morphological and microscopic examination of herbs, Evaluation of drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds). Plant gene banks, Cultivation of Plants and their value added processing / storage / quality control for use in herbal formulations, Introductory knowledge of Tissue culture and Micro propagation. of some medicinal plants (*Withania somnifera*, neem and tulsi),

## Suggested Readings

1. Agarwal, P., Shashi, Alok., Fatima, A. and Verma, A. (2013). Current scenario of Herbal Technology worldwide: An overview. *Int J Pharm Sci Res*; 4(11): 4105-17.
2. Arber, Agnes. (1999). Herbal Plants and Drugs. Mangal Deep Publications, Jaipur.
3. Varzakas, T., Zakynthinos, G, and Francis Verpoort, F. (2016). Plant Food Residues as a Source of Nutraceuticals and Functional Foods. Foods 5 : 88.
4. Aburjai, T. and Natsheh, F.M. (2003). Plants Used in Cosmetics. Phytotherapy Research 17 :987-1000.
5. Patri, F. and Silano, V. (2002). Plants in cosmetics: Plants and plant preparations used as ingredients for cosmetic products - Volume 1. ISBN 978-92-871-8474-0, pp 218.
6. AYUSH (www.indianmedicine.nic.in). *About the systems—An overview of Ayurveda*, *Yoga and Naturopathy*, *Unani*, *Siddha and Homeopathy.* New Delhi: Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government of India.
7. Evans, W.C. (2009): Trease and Evans PHARMACOGNOSY. 16th Edition, SAUNDERS / Elsevier.
8. Sivarajan, V.V. and India, B. (1994). Ayurvedic Drugs and Their Plant Sources.. *Oxford & IBH Publishing Company*, 1994 - Herbs - 570 pages.
9. Miller, L. and Miller, B. (2017). Ayurveda & Aromatherapy: The Earth Essential Guide to Ancient Wisdom and Modern Healing. *Motilal Banarsidass*,; *Fourth edition* .
10. Kokate, C.K. (2003). Practical Pharmacognosy. Vallabh Prakashan, Pune.

## 6.Fermentation Science and Technology

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

## Learning outcomes:

After completing this course the learner will be able to;

1. Employ the process for maintenance and preservation of microorganisms
2. Analyze the various aspects of the fermentation technology and apply for Fermentative production
3. Demonstrate proficiency in the experimental techniques for microbial production of enzymes: amylase and protease, bio product recover

## Keywords:

Microbial culture, Fermentation, Metabolites, Fermented products, Enzyme production, Bioproduct recovery

## Unit I — 8 lectures

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

## Unit II — 8 lectures

Maintenance and preservation of microorganisms, Metabolic regulations and overproduction of metabolites. Kinetics of microbial growth and product formation.

## Unit III — 8 lectures

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

## Unit IV — 6 lectures

Microbial production of enzymes: Amylase and Protease. Bioproduct recovery.

## Suggested readings

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

## 7. Environmental impact analysis (Practical based)

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

### Learning outcomes:

After completing this course the learner will be able to;

1. Have critical understanding of environmental impact
2. Learn important steps of EIA process
3. Interpret the environmental appraisal and procedures in India.

### Keywords:

Environmental management, Environmental impact assessment, Project proponent, Consultant, Environmental audit, Risk assessment, Legislation

### Unit I: Origin and Development 8 lectures

Purpose and aim, core values and principles, History of EIA development, Environmental Management Plan, Environmental Impact Statement, Scope of EIA in Project planning and Implementation.

### Unit II: EIA Process 8 lectures

Components of EIA, EIA Methodology- Screening, Scoping, Baseline data, Impact Identification, Prediction, Evaluation and Mitigation, Appendices and Forms of Application, Techniques of Assessment-Cost-benefit Analysis, Matrices, Checklist, Overlays, Impact on Environmental component: air, noise, water, land, biological, social and environmental factors. EIA Document.

### Unit III: Main participants in EIA Process 7 lectures

Role of Project proponent, environmental consultant, PCBs, PCCs, public and IAA. Public participation.

### Unit IV: Environmental Appraisal and Procedures in India and EIA

**7 lectures**

Methodology, indicators and mitigation, Environmental Audit of different environmental

resources, Risk Analysis, Strategic environmental assessment, ecological impact assessment: legislation.

## Practical

1. Prepare a Matrix of every environmental existing resource of your college or your hostel/mohalla or any defined area and evaluate each component using established methods and make audit analysis
2. Prepare a case report of Environmental impact of any area under development

## Suggested readings:

1. Kulkarni V and Ramachandra TV, (2006). Environmental Management, Capital Pub. Co. New Delhi.
2. Petts, J. (2005) Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell Publishers, UK.
3. Glasson, J. Therivel, R. and Chadwick, (2006) A. Introduction to Environmental Impact Assessment. Routledge, London..
4. Canter, W. L. (1995) Environmental Impact Assessment, McGraw-Hill Science/ Engineering/ Math, New York;
5. Morris, P. and Therivel, R. (1995) Methods of Environmental Impact Assessment, UCL Press, London;
6. Petts, J. (1999) (ed) Handbook of Environmental Impact Assessment, volume 1 and 2, Blackwell Science, Oxford;
7. Therivel, R. and Partidario, M. R. (1996) (eds) The Practice of Strategic Environmental Assessment, Earthscan, London;
8. Vanclay, F. and Bronstein, D. A. (1995) (eds) Environmental and Social Impact Assessment, Wiley & Sons, Chichester

## 8. IT skills for chemists

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

### IT Skills for Chemists

Fundamentals, mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, inter-conversion of units, constants and variables, equation of a straight line, plotting graphs.

Uncertainty in experimental techniques: Displaying uncertainties, measurements in chemistry, decimal places, significant figures, combining quantities. Uncertainty in measurement: types of uncertainties, combining uncertainties. Statistical treatment. Mean, standard deviation, relative error. Data reduction and the propagation of errors. Graphical and numerical data reduction. Numerical curve fitting: the method of least squares (regression). Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation in different forms).Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid). Numerical methods of finding roots (Newton-Raphson, binary –bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions).

Differential calculus: The tangent line and the derivative of a function, numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations). Numerical integration (Trapezoidal and Simpson's rule, e.g. entropy/enthalpy change from heat capacity data).

### Computer programming:

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

BASIC/FORTRAN programs for curve fitting, numerical differentiation and integration

(Trapezoidal rule, Simpson's rule), finding roots (quadratic formula, iterative, Newton-Raphson method).

## Recommended books/References:

1. McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).
2. Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005).
3. Steiner, E. The Chemical Maths Book Oxford University Press (1996).
4. Yates, P. Chemical calculations. 2nd Ed. CRC Press (2007).
5. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
6. Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001) 487 pages.
7. Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co. (1985).
8. Venit, S.M. Programming in BASIC: Problem solving with structure and style. Jaico Publishing House: Delhi (1996).

## 9. Intellectual property right (IPR) and business skills for chemists

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

### Introduction to Intellectual Property:

Historical Perspective, Different Types of IP, Importance of protecting IP.

### Copyrights

Introduction, How to obtain, Differences from Patents.

### Trade Marks

Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

**Patents** Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

### Geographical Indications

Definition, rules for registration, prevention of illegal exploitation, importance to India.

### Industrial Designs

Definition, How to obtain, features, International design registration.

### Layout design of integrated circuits

Circuit Boards, Integrated Chips, Importance for electronic industry.

### Trade Secrets

Introduction, Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

### Different International agreements

**(a) Word Trade Organization (WTO):**

(i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade related Services (GATS) (iii) Madrid Protocol (iv) Berne Convention (v) Budapest Treaty

**(b) Paris Convention**

**WIPO** and **TRIPS, IPR** and Plant Breeders Rights, IPR and Biodiversity

**IP Infringement issue and enforcement** – Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their

valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

## Business Basics

Key business concepts: Business plans, market need, project management and routes to market.

## Chemistry in Industry

Current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies.

## Financial aspects

Financial aspects of business with case studies.

## Recommended Books/References:

1. Acharya, N.K. Textbook on intellectual property rights, Asia Law House (2001).
2. Guru, M. & Rao, M.B. Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
3. Ganguli, P. Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
4. Miller, A.R. & Davis, M.H. Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
5. Watal, J. Intellectual property rights in the WTO and developing countries, Oxford University Press, New Delhi.

## 10. Analytical Clinical Biochemistry

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

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

*Carbohydrates:* Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysachharides.

*Proteins:* Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.

*Enzymes:* Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

*Lipids:* Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. Lipoproteins: Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones.

*Structure of DNA* (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy. *Enzymes*: Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.

A diagnostic approach to biochemistry:

*Blood:* Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

*Urine:* Collection and preservation of samples. 6. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

## Recommended books/references:

1. Cooper, T.G. *Tool of Biochemistry*. Wiley-Blackwell (1977).
2. Wilson, K. & Walker, J. *Practical Biochemistry.* Cambridge University Press (2009).
3. Varley, H., Gowenlock, A.H & Bell, M.: *Practical Clinical Biochemistry,* Heinemann, London (1980).
4. Devlin, T.M., *Textbook of Biochemistry with Clinical Correlations*, John Wiley & Sons, 2010.
5. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
6. Talwar, G.P. & Srivastava, M. *Textbook of Biochemistry and Human Biology*, 3rd Ed. PHI Learning.
7. Nelson, D.L. & Cox, M.M. *Lehninger Principles of Biochemistry*, W.H. Freeman, 2013.
8. O. Mikes, R.A. Chalmers: *Laboratory Handbook of Chromatographic Methods*, D. Van Nostrand & Co., 1961.

## Analytical Clinical Biochemistry Practical

Identification and estimation of the following:
1. Carbohydrates – qualitative and quantitative.
2. Lipids – qualitative.
5. Determination of cholesterol using Liebermann- Burchard reaction.
6. Proteins – qualitative.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids.

(visit to clinical laboratory/medical centre(s) )

## Recommended Books/References:

1. Cooper, T.G. *Tool of Biochemistry*. Wiley-Blackwell (1977).
2. Wilson, K. & Walker, J. *Practical Biochemistry.* Cambridge University Press (2009).
3. Varley, H., Gowenlock, A.H & Bell, M.: *Practical Clinical Biochemistry,* Heinemann, London (1980).
4. Devlin, T.M., *Textbook of Biochemistry with Clinical Correlations*, John Wiley & Sons, 2010.
5. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
6. Talwar, G.P. & Srivastava, M. *Textbook of Biochemistry and Human Biology*, 3rd Ed. PHI Learning.
7. Nelson, D.L. & Cox, M.M. *Lehninger Principles of Biochemistry*, W.H. Freeman, 2013.
8. O. Mikes, R.A. Chalmers: *Laboratory Handbook of Chromatographic Methods*, D. Van Nostrand & Co., 1961.

## 11. Mushroom Culture Technology

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

### Learning outcomes:

On completion of this course, the students will be able to:

- Recall various types and categories of mushrooms.
- Demonstrate various types of mushroom cultivating technologies.
- Examine various types of food technologies associated with mushroom industry.
- Value the economic factors associated with mushroom cultivation
- Device new methods and strategies to contribute to mushroom production.

### Keywords:

Edible mushrooms, Poisonous mushrooms, Cutivation technology, Mushroom bed, Mushroom unit, Storage and Nutrition

### Unit I 7 lectures

Introduction, History. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*.

### Unit II 9 lectures

Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparations of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation- Low cost technology, Composting technology in mushroom production.

### Unit III 7 lectures

Storage and nutrition: Short-term storage (Refrigeration – up to 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

**Unit IV** **7 lectures**

Food Preparation: Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

## Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj and Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.