Syllabus for B. Sc. III (Chemistry)
Implemented from June 2020.

1. TITLE : B.Sc. Chemistry
2. YEAR OF IMPLEMENTATION : 2020-2021
3. DURATION : One year
4. PATTERN : Semester
5. MEDIUM OF INSTRUCTION : English
6. STRUCTURE OF COURSE :

1] FIFTH SEMESTER — (NO. OF PAPERS - 4)

Paper IX: Physical Chemistry (BCT 501) – 40 Marks
Paper X: Inorganic Chemistry (BCT 502) – 40 Marks
Paper XI: Organic Chemistry (BCT 503) – 40 Marks
Paper XII: Analytical Chemistry (BCT 504) Elective Paper– 40 Marks
Paper XII: Analytical Chemistry (BCT 505) Elective Paper – 40 Marks
Paper XII: Analytical Chemistry (BCT 506) Elective Paper – 40 Marks

Internal examination (ISE-I, ISE-II) will be conducted for 10 marks for each paper.
Paper SECC : Paper - I (SECCCT 507) – 20 Marks
Practical- V : (BCP 508) Section I Physical Chemistry, Section - II Inorganic Chemistry, Project
Practical- VI : (BCP 509) Section - I Organic Chemistry, Section II Analytical Chemistry, project Practical exam is Semester wise and is of 100 Marks
SECC Practical (SECCCP 510) - 30 Marks

2] SIXTH SEMESTER ——— (NO. OF PAPERS 4)

Paper XIII : Physical Chemistry (BCT 601) – 40 Marks
Paper XIV : Inorganic Chemistry (BCT 602) – 40 Marks
Paper XV : Organic Chemistry (BCT 603) – 40 Marks
Paper XVI : Industrial Chemistry (BCT 604) Elective Paper –40 Marks
Paper XVI : Industrial Chemistry (BCT 605) Elective Paper–40 Marks
Paper XVI : Industrial Chemistry (BCT 606) Elective Paper –40 Marks

Internal semester examination (ISE - I, ISE - II) will be conducted for 10 marks for each paper.
SECC Paper II: SECCCT 607– 20 Marks
Practical VII: Practical I (BCP 608), Section I Physical Chemistry, Section II Inorganic Chemistry, Project
Practical VIII: (BCP 609) Section I Organic Chemistry, Section II Analytical Chemistry, Project

OR

Internship/Industrial training
Practical examination is semester wise and is of 100 Marks.
Practical SECCCP 610 - 30 Marks

Structure and Titles of Papers of B.Sc. III Semester V

Paper IX: Physical Chemistry (BCT 501)

40 Marks

Subject	Unit No.	Title	Periods	Credits
Physical Chemistry	I	Elementary Quantum Mechanics	08	2
	II	Spectroscopy	08	
	III	Photochemistry	08	
	IV	Surface Chemistry	05	
	V	Electromotive Force	08	
	VI	Polymer Chemistry	08	
Grand total			45	

Paper X: Inorganic Chemistry (BCT 502)

40 Marks

Subject	Unit No.	Title	Periods	Credits
Inorganic Chemistry	I	Metal ligand bonding in transition metal complexes.	10	2
	II	Metal semiconductors and superconductors.	10	
	III	Organometallic compounds	09	
	IV	Catalysis	10	
	V	Inter halogen compounds.	06	
Grand total			45	

Paper XI: Organic Chemistry (BCT 503)

40 Marks

Subject	Unit No.	Title	Periods	Credits
Organic Chemistry	I	Introduction to Spectroscopy	03	2
	II	UV Spectroscopy	08	
	III	IR Spectroscopy	09	
	IV	NMR Spectroscopy	10	
	V	Mass spectroscopy	09	
	VI	Combined Problems based on UV, IR NMR and Mass Spectral data	06	
Grand total			45	

Paper XII: Analytical Chemistry (BCT 504)
(Elective Paper -I)

40 Marks

Subject	Unit No.	Title	Periods	Credits
Analytical Chemistry	I	Artificial intelligence	11	2
	II	Food and Body fluid Analysis	12	
	III	Theory of Titrimetric Analysis	07	
	IV	Flame Photometry	07	
	V	Chromatographic Techniques and Quality Control	08	
Grand total			45	

Paper XII: Analytical Chemistry (BCT 505)
(Elective Paper -II)

40 Marks

Subject	Unit No.	Title	Periods	Credits
Analytical Chemistry	I	Artificial intelligence	11	2
	II	Food and Body fluid Analysis	12	
	III	Thermal methods of Analysis	07	
	IV	Green techniques in chemistry	08	
	V	Atomic Absorption Spectroscopy	07	
Grand total			45	

Paper XII: Analytical Chemistry (BCT 506)
(Elective Paper -III)

40 Marks

Subject	Unit No.	Title	Periods	Credits
Analytical Chemistry	I	Artificial intelligence	11	2
	II	Food and Body fluid Analysis	12	
	III	Petroleum industry and eco - friendly fuels	07	
	IV	Green Synthesis	08	
	V	Silicate Industries	07	
Grand total			45	

Paper: Skill Enhancement compulsory course (SECCCT -507)

20 Marks

Subject	Unit No.	Title	Periods	Credits
Skill Enhancement	I	Mathematics	10	1
	II	Computer programming	10	
Grand total			20	

Practical V:

(BCP 508) (Section I Physical Chemistry, Section II Inorganic Chemistry, Project)

Practical VI:

(BCP 509) (Section I Organic Chemistry, Section II Analytical Chemistry, Project)

Practical: Skill enhanced compulsory course (SECCCP 510)

Semester - V
BCT 501 Paper - V
Physical Chemistry [45 Lectures]
40 Marks (2Credits)

Course Objectives: students should

1. Understand the basic concepts in Elementary Quantum Mechanics.
2. Learn basic concept and instrumentation of various spectroscopy.
3. Study the photochemical activation and deactivations of molecules.
4. Develop knowledge of types, factors and applications of adsorption.
5. Learn Electromotive force in reversible and irreversible cell.
6. Study the basic concepts in polymer chemistry.

Unit - I: Elementary Quantum Mechanics [08 L]

Introduction, Dual nature of matter and energy: de Broglie hypothesis. The Heisenberg's uncertainty principle. Concept of Operator, energy operators (Hamiltonian operator). Derivation of Schrodinger wave equation. Physical interpretation of the Ψ and Ψ^2. Particle in a one-dimensional box. Concept of Quantum numbers.

Unit - II: Spectroscopy [08 L]

Introduction, Electromagnetic radiation. Interaction of radiation with matter, Electromagnetic spectrum, Energy level diagram. Rotational spectra of diatomic molecules: Rigid rotor model; moment of inertia; energy levels of rigid rotor, selection rules; Intensity of spectral lines, determination of bond length; isotope effect, Microwave oven. Vibrational spectra of diatomic molecules: Simple Harmonic oscillator model, Vibrational energies of diatomic molecules, Determination of force constant, overtones. Raman spectra: Concept of polarizability, pure rotational and pure Vibrational Raman spectra of diatomic molecules, selection rules. Comparative study of IR and Raman spectra, rule of mutual exclusion- CO_2 molecule, Numerical problems.

Unit - III: Photochemistry [08 L]

Introduction, Difference between thermal and photochemical processes. Laws of photochemistry: i) Grotthus - Draper law, ii) Lambert law, iii) Lambert – Beer's law (with derivation), iv) Stark - Einstein law. Quantum yield, Reasons for high and low quantum yield. Factors affecting Quantum yield. Photosensitized reactions – Dissociation of H_2, Photosynthesis. Photo dimerization of anthracene, decomposition of HI and HBr. Jablonski

diagram depicting various processes occurring in the excited state: Qualitative description of fluorescence and phosphorescence. Photophysical and photochemical processes. Chemiluminescence, Electroluminescence. Numerical problems.

Unit - IV: Surface Chemistry [05 L]

Introduction: Adsorption, Mechanism of adsorption, Factors affecting adsorption. Types of adsorption: Physical and Chemical Adsorption. Types of adsorption isotherms. Freundlich adsorption isotherm, Langmuir adsorption isotherm with derivation. BET equation and determination of surface area of adsorbent by BET equation. Applications of adsorption.

Unit - V: Electromotive Force [08 L]

Introduction, Recapitulation of Nernst equation, Reversible and Irreversible cells.

i] Chemical cells without transference.

i] Concentration cells with and without transference.

iii] Liquid – Liquid junction potential: Origin, elimination and determination. Applications of emf measurements to determine Solubility and solubility product of sparingly solublesalts (based on concentration cell).

Introduction, Principle and example of

i] Dye sensitized cell ii] Nuclear Fuel cell

iii] Lithium ion battery. Numerical problems.

Unit - VI: Polymer Chemistry [08 L]

Basic terms: macromolecule, monomer, repeat unit, degree of polymerization. Classification of polymers: Classification based on source, structure, thermal response and physical properties. Types of polymer. Molar masses of polymers: Number average, Weight average, Viscosity average molar mass, Mono dispersity and Polydispersity. Method ofdetermining molar masses of polymers:

Viscosity method using Ostwald Viscometer. (Derivation expected) Applications-conducting polymer, structural adhesives, coatings, Packaging.

References:

1. Quantum Chemistry including molecular spectroscopy by B. K. Sen, Tata Mc Graw -Hill.
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill.
3. Quantum Chemistry by R.K. Prasad.

4. Banwell, C. N. &McCash, E. M. Fundamentals of Molecular. Spectroscopy 4thEd.Tata McGraw-Hill: New Delhi (2006).
5. Kakkar, R. Atomic & Molecular Spectroscopy: Concepts &Applications, Cambridge University Press (2015).
6. Electrochemistry by S. Glasstone.
7. Text Book of Physical Chemistry, Soni and Dharmarha.
8. Physical Chemistry by W. J. Moore.
9. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).
10. Advanced Physical Chemistry Gurdeep Raj GOEL Publishing House, 36th Edition.
11. Principles of Physical Chemistry B.R. Puri, L.R. Sharma, M.S. Pathania, Vishal publishing Company, 2008.
12. Fundamentals of Photochemistry, K. K. Rohatagi–Mukherjee, NewAge International.
13. Principles of Fluorescence Spectroscopy, J.R Lakowicz, Springer publ.
14. Textbook of Polymer Science, Fred W Bilmeyer, John Wiley & Sons (Asia) Ple. Ltd., Singapore, 2007.
15. Polymer Science, V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd., Publishers, 2005.

Course Outcomes:

After completion of the units students will be able to:

Unit I: Elementary quantum mechanics

1. Understand quantum chemistry, Heisenberg's uncertainty principle, concept of energyoperators (Hamiltonian).
2. Learn of Schrodinger wave equation. Physical interpretation of the ø and $ø^2$. Particle in a one-dimensional box.

Unit - II: Spectroscopy

1. Acquires knowledge about spectroscopy, Electromagnetic spectrum, Energy level diagram. Study of rotational spectra of diatomic molecules: Rigid rotor model; Microwave oven, vibrational spectra of diatomic molecules, simple Harmonic oscillator model, Raman spectra:
2. Understand concept of polarizability, pure rotational and pure Vibrational Raman spectra of diatomic molecules, related knowledge will be gained.

Unit - III: Photochemistry

1. Understand photochemical laws, reactions and various photochemical phenomena.
2. Apply the concepts of photochemistry to different chemical processes.

Unit - IV: Surface Chemistry

1. Learn adsorption, Study types of adsorption and adsorption isotherms,
2. Distinguish between physical and chemical adsorption,
3. Know the various applications of adsorption.

Unit - V: Electromotive force

1. Learn and understand the knowledge of emf measurements, different types of cells,
2. Study various applications of emf measurements.

Unit - VI: Polymer Chemistry

1. Understand the knowledge of polymer.
2. Classify the polymers.
3. Study and acquire knowledge of polymer applications.

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BCT - 502 Paper X Inorganic Chemistry
[45 Lectures]
40 Marks (2 Credits)

Course Objectives: Student should

1. Learn Metal ligand bonding in Transition metal complexes.
2. Learn properties of metal, semiconductors, superconductors and their applications.
3. Study the organometallic chemistry.
4. Learn types of catalysis and their industrial applications.
5. Study interhalogen compounds.

Unit - 1: Metal ligand bonding in Transition metal complexes [10 L]

Isomerism in complexes with C.N. 4 and 6, Geometrical Isomerism, Optical Isomerism, Structural Isomerism-Ionization Isomerism, Hydrate Isomerism, Coordination Isomerism, Linkage Isomerism and Co-ordination position Isomerism. Molecular orbital theory (MOT).

Introduction. MOT of octahedral complexes with sigma bonding such as $[Ti(H_2O)_6]^{3+}$, $[Ni(NH_3)_6]^{2+}$, $[CoF_6]^{3-}$, $[Co(NH_3)_6]^{3+}$. Merits and demerits of MOT.

Unit - 2: Metals, Semiconductors and Superconductors. [10 L]

Introduction. Properties of metallic solids. Theories of bonding in metal. i) Free electron theory. ii) Molecular orbital theory (Band theory). Classification of solids as conductor, insulators and semiconductors on the basis of band theory. Semiconductors.

Types of semiconductors - intrinsic and extrinsic semiconductors. Applications of semiconductors. Superconductors: Ceramic superconductors - Preparation and structures of mixed oxide $YBa_2Cu_3O_{7-x}$ Applications of superconductors.

Unit - 3: Organometallic Chemistry. [09 L]

Definition, Nomenclature of organometallic compounds. Synthesis and structural study of alkyl and aryl compounds of Li, Be and Al. Mononuclear carbonyl and nature of bondingin simple metal carbonyls.

Unit - 4: Catalysis [10 L]

Introduction, Types of catalysis (Homogenous & Heterogeneous). Industrial applications of inorganic complex, i) Hydrogenation (Wilkinson catalyst), ii) Hydroformalation, iv) Ziggler- Natta polymerization, v) Monsanto acetic acid synthesis

Unit - 5: Inter Halogen Compounds [06 L]

Introduction, Types of inter halogen compounds (AX, AX_3, AX_5, AX_7), Polyhalides, Basic properties of the halogens, Pseudo halogens and pseudo halides.

Reference Books: (Use recent editions)

1. Concise Inorganic Chemistry (ELBS, 5th Edition) – J. D. Lee.
2. Inorganic Chemistry (ELBS, 3rd Edition) D. F. Shriver, P. W. Atkins, C. H. Lang Ford, Oxford University Press, 2nd Edition.
3. Basic Inorganic Chemistry: Cotton and Wilkinson.
4. Advanced Inorganic Chemistry (4thEdn.) Cotton and Wilkinson.
5. Concepts and Models of Inorganic Chemistry: Douglas and Mc. Daniel. 3rd Edition. John Wiley publication.
6. Fundamental concepts of Inorganic Chemistry by E. S. Gilreath.
7. Structural principles in inorganic compounds. W. E. Addison.
8. T. B. of Inorganic analysis – A. I. Vogel.
9. Theoretical principles of Inorganic Chemistry – G. S. Manku.
10. Theoretical Inorganic Chemistry by Day and Selbine.
11. Co-ordination compounds S. F. A. Kettle.
12. New guide to Modern Valence Theory by G. I. Brown.
13. Essentials of Nuclear Chemistry by H. J. Arnikar.
14. Organometallic Chemistry by R. C. Mahrotra A. Sing, Wiley Eastern Ltd. New Delhi.
15. Inorganic Chemistry by A. G. Sharpe, Addision – Wisley Longman – Inc.
16. Principles of Inorganic Chemistry by Puri, Sharma and Kalia, Vallabh Publication. Pitampur Delhi.

17. Text book of Inorganic Chemistry by K. N. Upadhyaya Vikas Publishing House – New Delhi.
18. Progress in inorganic polymer by Laport and Leigh.
19. Co-ordination compounds by Baselo and Pearson.
20. Organometallic Chemistry by P. L. Pauson

Course Outcomes:

After completion of the units, students are able to:

Unit -1: Metal ligand bonding in Transition metal complexes

i. Understands different types of isomerism.
ii. Learn Molecular orbital diagram.
iii. Understands merits and demerits of Molecular orbital diagram.

Unit - 2: Metals, Semiconductors and Superconductors.

i. Learn about the importance of metals from the periodic table and the type of bonding in metals.
ii. Know about semiconductors & their methods of preparation.
iii. Understands super conductors and its application in various fields.

Unit - 3: Organometallic Chemistry.

i. Learn nomenclature of organometallic compounds.
ii. Learn synthesis and structural study of alkyl and aryl compounds of Li, Be and Al.
iii. Understands nature of bonding in simple metal carbonyls.

Unit - 4: Catalysis

i. Learn different types of catalysis.
ii. Knows about Industrial applications of catalysis.

Unit - 5: Inter Halogen Compounds

i. Learn about the inter halogen compounds.
ii. Understands basic properties of halogens.
iii. Learn about pseudo halogens and pseudo halides

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BCT 503 Paper No. XI, Organic Chemistry
[45 Lectures]

40 Marks **(2 Credits)**

Course Objectives: Students should

1. Understand the basic principles of spectroscopy where electromagnetic radiation interacts with chemical substances.
2. Know the different regions of the spectrum and the type of molecular transitions that correspond. UV-spectroscopy.
3. Learn fundamental concepts of IR spectroscopy.
4. Study basic concept of NMR spectroscopy and find chemical shifts of protons.
5. Learn instrumentation of Mass spectrometry.
6. Learn combined problems based on UV, IR, NMR and Mass spectroscopy.

Unit - I: Introduction to Spectroscopy [03]

Meaning of spectroscopy, Nature of electromagnetic radiation: wavelength, frequency, energy, amplitude, wave number and their relationship, Different units of measurement of wavelength and frequency, Different regions of electromagnetic radiations. Interaction of radiation with matter: absorption, emission, fluorescence and scattering. Types of spectroscopy and advantages of spectroscopic methods. Energy types and energy levels ofatoms and molecules.

Unit - II: UV Spectroscopy [08]

Introduction, Beer - Lamberts law, absorption of UV radiation by organic molecules leading to different excitation, Terms used in UV Spectroscopy - Chromophore, Auxochrome, Bathochromic shift, hypsochromic shift, hyperchromic and hypochromic effect, Modes of electromagnetic transitions, Effect of conjugation on position of UV band, Calculation of λ - max by Woodward and Fisher rules for dienes and enones systems, Colour and visible spectrum, Applications of UV Spectroscopy

Unit - III: IR Spectroscopy [09]

Introduction, Principle of IR Spectroscopy, IR Instrumentation, schematic diagram- Fundamental modes of vibrations types and calculation – Condition for absorption of IR radiations Regions of IR Spectrum, fundamental group region, finger print region, Hooks Law for Calculation of vibrational frequency,Factors affecting on IR absorption frequency, Characteristic of IR absorption of following functional groups

a] Alkanes, alkenes, alkynes b] Alcohol and phenols c] Ethers
d] Carbonyl compounds e] Amines f] Nitro compounds
g] Aromatic Compounds

Unit - IV : NMR Spectroscopy [10]

Introduction, Principles of PMR Spectroscopy, NMR - Instrumentation, Schematic diagram, Magnetic and nonmagnetic nuclei, Chemical shift- definition, measurement, calculation, Factors affecting Chemical shift , Shielding & deshielding, Peak Integration, Merits of TMS as PMR reference compounds , Coupling Constant, Types of CouplingConstant, Spin-spin splitting (n +1 rule), Applications

Unit - V : Mass spectroscopy. [09]

Introduction, Principle of mass spectroscopy, Mass spectrometer - schematic diagram, Types of ions produced in mass spectrum , Fragmentation patterns of- alkanes, alkenes, aromatic hydrocarbons, alcohols, phenols, amines and carbonyl compounds , McLaffrety rearrangement, Applications

Unit - VI : Combined Problems based on UV, IR NMR and Mass Spectral data [06]

Reference Books :

1. "NMR Spectroscopy" by Harald Günther
2. Spectroscopy of Organic compounds - P. S. Kalsi.
3. Spectroscopy - V. M. Parikh.
4. Introduction to spectroscopy - Donald Pavia.
5. "Mass Spectrometry" by Gross Jurgen H
6. "Organic Structures from Spectra" by L D Field and S Sternhell
7. "NMR Data Interpretation Explained: Understanding 1D and 2D NMR Spectra of Organic Compounds and Natural Products" by Neil E Jacobsen
8. "Interpretation of Mass Spectra of Organic Compounds" by Herbert Budzikiewicz
9. Spectrometric Identification of Organic Compounds" by Robert M Silverstein and Francis X Webster
10. Essential Practical NMR for organic chemistry by S. A. Richards, J. C. Hollerton andpublished by John Wiley & Sons, Ltd in 2011.
11. Organic Chemistry - Cram D. J. and Hammond G.S. McGraw Hill book Company New York.

Course Outcomes:

After completion of the units, students are able to:

1. Understand basic principle and types of electromagnetic radiation.
2. Understand different types and advantages of spectroscopy.
3. Understand basic terms and interpretation of UV-Visible spectroscopy,

4. Calculate the λ - max by Woodward and Fisher rules for dienes and enones systems.
5. Explain basic principles, interpretation of IR spectroscopy.
6. Solve problems based on IR Spectroscopy.
7. Explain basic principles, chemical shift, splitting pattern of NMR spectroscopy.
8. Find out chemical shift values of protons of compounds based on spectral data of NMR spectroscopy,
9. Understand Principle and schematic diagram of mass spectroscopy.
10. Understand molecular ion, fragmentation pattern and different types of ions produced.
11. Predict the structure of organic compound with the help of provided spectral data.
12. Solve combined problems based on UV, IR, NMR and Mass Spectral data.

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BCT 504 Paper No. XII Analytical Chemistry (Elective Paper I)
[45 Lectures]

40 Marks **(2 Credits)**

Course Objectives : Students should

1. Understand basic concepts on Artificial intelligence.
2. Understand food and body fluid analysis.
3. Enable to learn the titrimetric analysis
4. Understand basic concept and instrumentation of flame photometry.
5. Study the chromatographic techniques such as column, ion exchange and gas chromatography. Also study the quality control practices in analytical industries and laboratories.

Unit - I : Artificial intelligence [11L]

Introduction, fundamentals: classical/symbolic approach to Artificial Intelligence and serves as a basis for more in depth treatment of specific theories and technologies for building complete A.I. systems integrating different approaches and methods.- Advanced search - Constraint satisfaction problems - Knowledge representation and reasoning - Non -standard logics - Uncertain and probabilistic reasoning (Bayesian networks, fuzzy sets). - Foundations of semantic web : semantic networks and description logics.- Rules systems: use and efficient implementation.- Planning systems, AR VR introduction fundamentals etc.

Unit - II : Food and Body fluid Analysis [12L]

Food analysis: Determination of moisture, ash content, fibres, protein, carbohydrates, and fat in different food items. Body Fluid analysis: Analysis of blood for hemoglobin,

biochemical properties of glucose and carbohydrates Protein, lipid and cholesterol analysis. Urine analysis: physical and chemical.

Unit - III : Theory of Titrimetric Analysis. [07L]

Acid - Base titrations. Introduction. Theory of indicators w.r.t. color change interval and Ostwald's Quinoid theory. Neutralization curves and choice of indicators for the following titrations i) Strong acid and strong base. ii) Strong acid and weak base. iii) Strong base and weak acid.

Complexometric titration: General account. Types of EDTA titrations. Metalochromic indicators w.r.t. Eriochrom Black T.

Unit - IV : Flame Photometry. [07L]

Introduction, General principles of flame photometry, Instrumentation: Block diagram, Burners (Premix and Lunder graph burners), mirror, slits, filters, detector (Photomultiplier tube), Effect of solvent in flame photometry, Experimental procedure of analysis (Standard addition and internal standard), Interference and Factors that influence the intensity of emitted radiation in a flame photometer, Application of flame photometry in real sample analysis, Limitationsof flame photometry.

Unit - V : Chromatographic Techniques and Quality Control [08L]

Introduction, Developments in chromatography, Classification of chromatography, **Column chromatography** : Introduction, types, Principle of adsorption column chromatography, solvent system, stationary phases, Methodology-Column packing, applications of sample, development, detection methods, recovery of components, Applications. **Ion exchange chromatography** : Introduction, Principle, Types and propertiesof ion exchangers, Methodology- Column packing, application of sample, elution, detection/ analysis, Applications. **Gas chromatography** : Principal, Methodology-Column packing,application of sample, elution, detection/analysis, Applications.

Concepts in Quality control : Introduction and Concept of quality, Quality control, Quality assurance, ISO series, Good laboratory practices.

References:

1. Text Book of Quantitative inorganic analysis – A. I. Vogel
2. Instrumental methods of chemical analysis –Willard, Merit & Dean
3. Instrumentals methods of chemical analysis – Chatwal & Anand
4. Fundamentals of analytical chemistry – Skoog and West
5. Basic concepts of analytical chemistry – S.M. Khopkar

6. Instrumental methods of chemical analysis – H. Kaur
7. Green solvents for organic synthesis, - V. K. Ahluwalia & R. S. Verma
8. Industrial Chemistry - B. K. Sharma
9. www.rsc.org
10. "Artificial Intelligence : A Modern Approach" by Stuart Russell and Peter Norvig
11. "Artificial Intelligence : A New Synthesis" by Nils J Nilsson
12. "Artificial Intelligence" by Negnevitsky
13. "INTRO. TO ARTIFICIAL INTELLIGENCE" by AKERKAR RAJENDRA

Course Outcomes:

After completion of the units, students are able to:

1. Understand the basic concept of Artificial Intelligence.
2. Understand role of Artificial Intelligence in chemistry.
3. Understand the analysis of food by using different tests.
4. Understand analysis of blood and urine.
5. Understand the titrimetric analysis by acid-base titrations.
6. Understand concept of Complexometric titrations.
7. Understand principle and instrumentation of flame photometry.
8. Improve the knowledge of instrumental analysis of alkali and alkaline earth elements by flame photometry.
9. Understand various chromatographic techniques.
10. Understand role of Quality control practices in analytical industries and laboratories.
11. Plan the experimental projects and execute them.

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BCT 505 Paper No. XII Analytical Chemistry
(Elective Paper II)
[45 Lectures]

40 Marks **(2 Credits)**

Course Objectives : Students should

1. Understand basic concepts on Artificial intelligence.
2. Understand food and fluid analysis.
3. Learn principle of thermal analysis and its classification.
4. Develop the student's understanding of green chemistry.
5. Understand theory of Atomic Absorption Spectroscopy

Unit - I : Artificial intelligence [11L]

Introduction, fundamentals: classical/symbolic approach to Artificial Intelligence and serves as a basis for more in depth treatment of specific theories and technologies for building complete A.I. systems integrating different approaches and methods.-Advanced search - Constraint satisfaction problems - Knowledge representation and reasoning - Non-standard logics-Uncertain and probabilistic reasoning(Bayesian networks, fuzzy sets).-Foundations of semantic web: semantic networks and description logics.-Rules systems: use and efficient implementation. Planning systems., AR VR introduction fundamentals etc.

Unit - II : Food and Fluid analysis [12L]

Food analysis: Determination of moisture, ash content, fibres, protein, carbohydrates, and fat in different food items. Body Fluid analysis : Analysis of blood for hemoglobin, biochemical properties of glucose and carbohydrates. Protein, lipid and cholesterol analysis. Urine analysis: physical and chemical

Unit - III : Thermal methods of Analysis (TGA & DTA) [07L]

Classification of thermal methods. Thermogravimetric analysis, Derivative thermogravimetric analysis DTG, Differential thermal analysis DTA

Unit - IV : Green techniques in chemistry [08L]

Introduction; Principles of green Chemistry; Emerging green technologies-Microwave chemistry, Sonochemistry, photochemistry, Electro chemistry, Mechanochemistry. Green organic Synthesis by use of Zeolites, Natural catalysts and Biocatalysts. Green Synthesis ofpolycarbonate, carbaryl Pesticide, Ibuprofen.

Unit - V : Atomic Absorption Spectroscopy [07L]

Principles of AAS, Difference between AAS and flame Photometry, Instrumentation of single beam for atomic absorption spectrometer (Source, chopper, nebulizer, monochromator, detector, amplifier), Interference: Spectral and chemical, Applications of AAS.

References :

1. Text Book of Quantitative inorganic analysis – A. I. Vogel.
2. Instrumental methods of chemical analysis –Willard, Merit & Dean.
3. Instrumentals methods of chemical analysis – Chatwal & Anand.
4. Fundamentals of analytical chemistry – Skoog and West.
5. Basic concepts of analytical chemistry – S.M. Khopkar.
6. Instrumental methods of chemical analysis – H. Kaur.

7. Green solvents for organic synthesis, - V. K. Ahluwalia & R. S. Verma.
8. Industrial Chemistry - B.K. Shrama.
9. www.rsc.org
10. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig.
11. "Artificial Intelligence: A New Synthesis" by Nils J Nilsson.
12. "Artificial Intelligence" by Negnevitsky.
13. "INTRO. TO ARTIFICIAL INTELLIGENCE" by AKERKAR RAJENDRA.

Course Outcomes :

After completion of the units, students are able to :

1. Understand the basic concept of Artificial Intelligence.
2. Understand role of Artificial Intelligence in chemistry.
3. Understand the analysis of food by using different tests.
4. Understand analysis of blood and urine.
5. Understand the thermal analysis and its classification.
6. Understand analysis by using DTG and DTA.
7. Understand green chemistry techniques.
8. Understand Green organic Synthesis
9. Understand theory and instrumentation of Atomic Absorption Spectroscopy.
10. Plan the experimental projects and execute them.

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BCT 506 Paper No. XII Analytical Chemistry
(Elective Paper III)
[45 Lectures]

40 Marks **(2 Credits)**

Course Objectives : Students should

1. Understand basic concepts on Artificial intelligence.
2. Understand analysis of food and fluid analysis.
3. Study the process of petrochemical industry and eco -friendly fuels.
4. Develop the green methodology for organic synthesis.
5. Study the manufacturing process in term of principle, flow chart and working of silicate industries.

Unit - I : Artificial intelligence [11L]

Introduction, fundamentals: classical/symbolic approach to Artificial Intelligence and

serves as a basis for more in depth treatment of specific theories and technologies for building complete A.I. systems integrating different approaches and methods.- Advanced search-Constraint satisfaction problems. Knowledge representation and reasoning Non-standard logics-Uncertain and probabilistic reasoning(Bayesian networks, fuzzy sets). Foundations of semantic web: semantic networks and description logics. Rules systems: use and efficient implementation. Planning systems. AR VR introduction fundamentals etc.

Unit - II : Food and Body fluid Analysis [12L]

Food analysis : Determination of moisture, ash content, fibres, protein, carbohydrates, and fat in different food items. Body Fluid analysis : Analysis of blood for hemoglobin, biochemical properties of glucose and carbohydrates Protein, lipid and cholesterol analysis. Urine analysis : physical and chemical.

Unit - III : Petroleum industry and eco-friendly fuels [07L]

A] Petroleum industry

Introduction, occurrence, composition of petroleum, resources, processing of petroleum, calorific value of fuel, cracking, octane rating (octane number), cetane number, flash point, petroleum refineries, applications of petrochemicals, synthetic petroleum, lubricating oils & additives.

B] Fuels

Fuels and eco-friendly fuels: liquid, gaseous fuel (LPG, CNG), fossil fuels, diesel, bio diesel, gasoline, aviation fuels. Use of solar energy for power generation.

Unit - IV : Green Synthesis [08L]

Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to Strecker synthesis), citral, ibuprofen, paracetamol, furfural.

Unit - V : Silicate Industries [07L]

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

References :

1. Text Book of Quantitative inorganic analysis – A. I. Vogel

2. Instrumental methods of chemical analysis –Willard, Merit & Dean
3. Instrumentals methods of chemical analysis – Chatwal & Anand
4. Fundamentals of analytical chemistry – Skoog and West
5. Basic concepts of analytical chemistry – S.M. Khopkar
6. Instrumental methods of chemical analysis – H. Kaur
7. Green solvents for organic synthesis, - V. K. Ahluwalia & R. S. Verma
8. Industrial Chemistry - B.K. Shrama
9. www.rsc.org
10. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig
11. "Artificial Intelligence: A New Synthesis" by Nils J Nilsson
12. "Artificial Intelligence" by Negnevitsky
13. "INTRO. TO ARTIFICIAL INTELLIGENCE" by AKERKAR RAJENDRA

Course Outcomes :

After completion of the units, students are able to :

1. Understand the basic concept of Artificial Intelligence.
2. Understand role of Artificial Intelligence in chemistry.
3. Understand the analysis of food by using different tests.
4. Understand analysis of blood and urine.
5. Understand the process of petrochemical industry .
6. Understand basic concept of fuels and eco -friendly fuels.
7. Understand the role of green synthesis process for manufacturing of different compounds.
8. Carry out the different reaction by using green synthesis approach.
9. Explain different types of clays, ceramics.
10. Understand the manufacture process and its applications.
11. Plan the experimental projects and execute them.

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SECCCT - 507:
[20 Lectures]

20 Marks **(1 Credit)**

Course Objectives : Students should

1. Empower the tools of mathematics to solve different chemical problems.
2. Understand the key concepts of computer operation and its importance.

I. Mathematics [10L]

Fundamentals, mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion 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 : themethod of least squares (regression). Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation indifferent 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 ofwater, 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).

II. Computer programming : [10L]

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 additionand multiplication. Statistical analysis. BASIC programs for curve fitting, numerical differentiation and integration (Trapezoidal rule, Simpson's rule), finding roots (quadraticformula, iterative, Newton-Raphson method).

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 Math's 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) Chapt. 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).

Course Outcomes :

After completion of the units, students are able to :

1. Understands the graphical representation and processing.
2. Understands and uses the rules and differentiation and integration in chemical derivations.
3. Understand importance and use of algorithm and flowchart drawing.
4. Learn algorithm writing and flowchart drawing.

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Practical V BCP - 508
Section I - Physical Chemistry

Course Objective : Students should

1. Study different principles and instrumentation techniques.
2. Study chemical kinetics of reaction
3. Study conductometric acid - base titrations.
4. Study the determination of pH by potentiometry.
5. Learn the principle and operation of refractometry.

I. Chemical Kinetics :

1. To determine energy of activation of the reaction between potassium persulphate and potassium iodide (equal concentration).
2. To determine energy of activation of the reaction between potassium persulphate and potassium iodide (Unequal concentration).

II. Conductometry :

1. To determine the percentage composition (by weight) of strong acid and weak acid in a given mixture by titrating against strong base conductometrically.
2. To determine the normality of oxalic acid by titrating it with strong alkali conductometrically.

III. Potentiometry :

1. To determine the normality of the strong acid by titrating it with strong alkali by potentiometric method.
2. To prepare buffer solutions and determine their pH experimentally and theoretically using Henderson's equation.

IV. Refractometry :

1. To determine specific refractivities of pure liquids Aand B and of their mixtures and to determine percentage composition of the unknown mixture.
2. To determine the molar refractivities of methyl acetate, ethyl acetate, n- hexane andcarbon tetrachloride and calculate the refraction equivalents of C, H and Cl atoms.

V. Any other suitable experiments as per requirement.

Course Outcomes :

After completion of the experiments, students are able to :

1. Explore variety of instrumental experiments.
2. Determine energy of activation of reaction of equal and unequal initial concentration.
3. Determine percentage composition of mixture of solution by conductometry.
4. Determine pH and normality by using potentiometric instruments.
5. Determine specific and molar refractivity by refractometry.

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Section - II - Inorganic Chemistry Practical

Course Objective : Students should

1] Study the gravimetric analysis technique.
2] Study the Inorganic preparations
3] Learn analytical skill of titrimetric analysis.

I. Gravimetric Estimations (G).

G1. Gravimetric estimation of barium as barium sulphate from the given solution containing barium chloride, ferric chloride and free hydrochloric acid.

G2. Gravimetric estimation of nickel as bis (dimethyl glyoximato) nickel (II) from the given solution containing nickel sulphate, ferrous ammonium sulphate and free Sulphuric acid. [For the gravimetric experiments, stock solution should be given in the range of 10 to 15 cm^3 and asked to dilute to 100 cm^3 (or the stock solution should be given in the range of 20 to 30 cm^3 and asked to dilute to 250 cm^3). Use 50 cm^3 of this diluted solution for estimation.]

II. Inorganic Preparations (P).

P_1. Preparation of sodium cuprous thiosulphate.
P_2. Preparation of potassium trioxalato ferrate (III).
P_3. Preparation of potassium trioxalato aluminate (III).
P_4. Preparation of tris (ethylene diamine) nickel (II) thiosulphate.
P_5. Preparation of bis (ethylene diamine) copper (II) thiosulphate.

III. Titrimetric Estimations :

A) Percentage Purity

V_1. Determination of percentage purity of ferrous ammonium sulphate.
V_2. Determination of percentage purity of Nickel (II) complexometrically using muroxide indicator.

Course Outcomes :

After completion of the experiments, students are able to :

1] Determine amount of Ni and Ba by gravimetric analysis technique.
2] Understand preparative skills for Inorganic preparations.
3] Determine percentage purity by titrimetric analysis.

Practical - VI BCP - 509
Section I Organic Chemistry

Course Objectives : Students should

1. Study the separation of binary mixture and identify components.
2. Understand structure determination of compounds by using NMR spectroscopy.

1. Qualitative analysis Separation of binary mixture and Identification of one component.(At least 08 mixtures) Nature 1) Solid – Solid : 4 mixtures 2) Solid – Liquid : 2 mixtures 3) Liquid – Liquid : 2 mixtures 1) Solid – Solid Mixtures : One mixture from each the following types should be given : i) Acid+Phenol ii) Acid + Base iii) Acid+Neutral iv) Phenol +Base v) Phenol+Neutral vi) Base +Neutral 2) Solid – Liquid Mixtures Mixture of type Neutral + Neutral or Acid + Neutral should be given. 3) Liquid – Liquid Mixtures Mixture of type Neutral + Neutral or Base + Neutral should be given. Following compounds should be used for preparation of mixtures

Acids : Benzoic acid, Phthalic acid, Salicylic acid, Cinnamic acid, Aspirin, Oxalic acid.

Phenols : α -naphthol, β -naphthol, resorcinol,

Bases : o-nitroaniline, m-nitroaniline, p-nitroaniline, aniline, o-toluidine and N, N-dimethylaniline, diphenylamine,

Neutrals : Anthracene, acetanilide, m-dinitrobenzene, chloroform, carbon tetrachloride, acetone, nitrobenzene, ethyl acetate, ethyl benzoate, bromobenzene, urea and thiourea.

NB: 1. For Solid - Liquid and Liquid - Liquid mixtures avoid detection of type of mixture. Instead the weightage is given to detection of nature and separation of mixture. 2. Separation and qualitative analysis of the binary Mixtures should be carried out on microscale usingmicroscale kits.

2. Determination of structure of organic compound from given NMR spectra.

Ethanol, Ethyl acetate, Benzyl alcohol, Propanoic acid, Butaraldehyde, Ethyl benzoate, Isopropyl benzene, Propyl ether, n - pentane, Propene, Diethyl amine, 2- chloro butane etc.

Course Outcome:
After completion of the experiments, students are able to:

1. Separate the binary mixture and identify each component by quantitative analysis .
2. Understand structure determination of organic compounds by NMR spectra.
3. Implements the knowledge of NMR spectroscopy .

Section - II Analytical Chemistry

Course Objectives : Students should

1. Study the volumetric analysis of various experiments.
2. Study the quantitative analysis of commercial sample.
3. Study the instrumentation analysis.

Experiments :

Estimation and Preparation.

1. To determine the amount of acid and amide present in the given mixture of acid and amide.
2. Determination of Molecular weight of monobasic/dibasic acid by volumetric method.
3. Preparation of Picric acid from phenol

Analysis of Commercial Sample.

4. Determination of percentage of magnesium in the given sample of talcum Powder.
5. Determination of amount of aluminum in the given solution of potash alum. (Standard succinic or oxalic acid solution to be prepared to standardize the given sodium hydroxide solution.)

Colorimetry:

6. Draw calibration curve (absorbance at λ max vs. concentration) for various concentrations of a given colored compound ($KMnO_4$/ $CuSO_4$) and estimate the concentration of the same in a given solution.(Verification of Lambert Beer's Law)
7. To estimate Fe^{+3} ions using salicylic acid by colorimetric titration (static method)

Reference Books:

1. Findlay's Practical Physical Chemistry (Longman)
2. Advanced Practical Physical Chemistry by J. B. Yadav, Goel publishing house.
3. Practical Physical Chemistry by B. D. Khosla, V. C. Garg (R. Chand and Co.)
4. Systematic experimental Physical Chemistry by Rajbhoj, Chandekar (AnjaliPublication) Aurangabad.
5. Practical Physical Chemistry: Nandkumari, Kothari and Lavande.
6. Practical Physical Chemistry by Gurtu (S. Chand).
7. Text Book of Qualitative Inorganic Analysis by A. I. Vogel (ELBS Longman).

8. A text book of quantitative Inorganic Analysis – A. I. Vogel.
8. Text book of Quantitative Inorganic Analysis – Kolthoff and Sandell.
10. Experimental Inorganic Chemistry – Palmer W. G.
11. Advanced Practical Inorganic Chemistry – Adams and Raynor.
12. Manual in Dairy Chemistry – I.C.A.R. Sub-Committee on Diary Education.
13. Chemical methods for environmental analysis – R. Ramesh and M. Anbu.
14. Practical Organic Chemistry by – A.I. Vogel.
15. Practical Organic Chemistry by – O. P. Agarwal

Course Outcome:

After completion of the units, students are able to:

1. Determine molecular weight of monobasic acids by qualitative analysis.
2. Determine percentage of metals from commercial samples.
3. Determine percentage of metals by colorimetry.
4. Plan the experimental projects and execute them.

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Practical SECCCP – 510

Course objectives : - Students should

1. Understand the interdisciplinary nature of chemistry and to integrate knowledge of mathematics to a wide variety of chemical problems.
2. Understand mathematical tools to tackle common problems in physical chemistry, including solving ordinary and partial differential equations, calculating differentials, solving multiple integrals etc.
3. Understand the mean, median, S.D, for a set of data they collected.
4. Calculate the pH of weak acid, roots of volume and unit conversion.
5. Understand computer programs based on numerical methods.
6. Understand the role of computers in simulating chemical processes and analyzing data.

1 Find the mean, error, percent deviation and standard deviation for given sets of result (e.g. i to iii)

i] The boiling point of a liquid which has a theoretical value of 54°C, was measured by a student four times. Determine mean, for each measurement the error and percent deviation. Observed values are 54.9, 54.4, 54.1, 54.2

i] The student has measured the % of chlorine in an experiment a total of six times. The values are 18.92, 19.56, 19.75, 18.25, 19.60, and 18.70. Calculate the mean and standard deviation?

iii] A student analyzing a sample for bromine makes five trials with the following results:36.1, 35.9, 36.5, 35.9, and 36.3. The theoretical value is 36.2. Calculate the mean, error and percent deviation for each trial, the standard deviation

2. Conversion of the given unit into other unit (e.g. i and ii)

i] The temperature outside is measured to be 95°F. Given that Fahrenheit and Celsius are linked by the equation: C = 5/9 x (F- 32) and Celsius and Kelvin are linked by the equation: K = C + 273 Calculate the outside temperature in Kelvin.

i] An industrial chemist produces $2.5x10^5$ dm^3 of fertilizer in a reaction. How much is that in m^3?

3. Calculate the pH of weak acid by using quadric equation.

Formic acid is a weak acid with a dissociation constant Ka of $1.8 x10^4$. The Ka relates the concentration of the H^+ ions denoted $[H^+]$ and the amount of acid dissolved denoted N by the equation: $Ka = [H^+]^2 / N - [H^+]$ Given that there is 0.1 moles of formic acid dissolved, calculate the pH of the solution.

4. Application of numerical methods in finding root of volume

(Vander waal's gas equation e.g. i - ii)

i] What is the volume of exactly one mole of oxygen gas at a pressure of 10.00 atm. and a temperature of 300.0 K.? For oxygen *a* is 1.360 $liter^2$ atm / mol^2 and *b* is 0.003183 liter / mol. Take *R* to be 0.0820578 liter - atm /mol - K.

i] For benzene, *a* = 18.00 $liter^2$ atm / mol^2 and *b* is 0.1154 liter / mol. Find the volume of 1.400 moles of benzene vapor at 500°C and a pressure of 40.00 atm.

5. Computer programs based on numerical methods for

i] Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

i] Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid).

iii] Matrix operations. Application of Gauss-Siedel method in colorimetry.

iv] Simple exercises using molecular visualization software.

References :

1. Levie, R. D. (2001), How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge University Press.
2. Noggle, J. H.(1985), Physical Chemistry on a Microcomputer, Little Brown & Co.
3. Venit, S.M. (1996), Programming in BASIC : Problem solving with structure and style, Jaico Publishing House. Teaching Learning Process :

Course Outcomes : -

After completion of practical's the student will be able to

1. Apply mathematical formulae for problems in physical chemistry.
2. Calculate the mean, median, Standard deviation for any set of data.
3. Use quadric equation to finding pH of weak acid.
4. Apply numerical methods in finding root of volume (Vander waal's gas equation).
5. Solve basic chemistry- related mathematical problems using the Mathematica computer algebra system.

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Semester VI
Paper XIII: Physical Chemistry (BCT 601)

40 Marks

Subject	Unit No.	Title	Periods	Credits
Physical Chemistry	I	Distribution law	06	2
	II	Thermodynamics	10	
	III	Solid state chemistry	11	
	IV	Chemical kinetics	08	
	V	Nanomaterials	10	
Grand total			45	

Paper XI - V : Inorganic Chemistry (BCT 602)

40 Marks

Subject	Unit No.	Title	Periods	Credits
Inorganic Chemistry	I	Co- ordination chemistry	12	2
	II	Nuclear chemistry	07	
	III	Iron and steel	10	
	IV	Acids and bases and non-aqueous solvents.	08	
	V	Inorganic polymers.	08	
Grand total			45	

Paper XV: Organic Chemistry (BCT 603)

40 Marks

Subject	Unit No.	Title	Periods	Credits
Organic Chemistry	I	Name reactions	10	2
	II	Reagents in Organic Synthesis	08	
	III	Stereochemistry	06	
	IV	Natural Products	08	
	V	Pharmaceuticals and Agrochemicals	07	
	VI	Heterocyclic Chemistry	06	
Grand total			45	

Paper XVI: Industrial Chemistry (BCT 604)
Elective Paper I

40 Marks

Subject	Unit No.	Title	Periods	Credits
Industrial Chemistry	I	Small scale Industries	11	2
	II	Entrepreneurship Development And Management	12	
	III	Sugar Industry	06	
	IV	Manufacture of Industrial Heavy Chemicals	08	
	V	Electroplating	07	
Grand total			45	

Paper XVI: Industrial Chemistry (BCT 605)
Elective Paper II

40 Marks

Subject	Unit No.	Title	Periods	Credits
Industrial Chemistry	I	Small scale Industries	11	2
	II	Entrepreneurship Development And Management	12	
	III	Synthetic Polymer	06	
	IV	Glass Industry	08	
	V	Batteries	07	
Grand total			45	

Paper XVI: Industrial Chemistry (BCT 606)
Elective Paper III

40 Marks

Subject	Unit No.	Title	Periods	Credits
Industrial Chemistry	I	Small scale Industries	11	2
	II	Entrepreneurship Development And Management	12	
	III	Dairy Chemistry	06	
	IV	Soil chemistry	08	
	V	Leather Chemistry	07	
Grand total			45	

Paper: Skill Enhancement
(SECCCT 607)

20 Marks

Subject	Unit No.	Title	Periods	Credits
Skill Enhancement	I	Entrepreneurship, Creativity & Opportunities	06	1
	II	Business Finance & Accounts	05	
	III	Enterprise Management and Modern Trends	05	
	IV	Chemistry Entrepreneurs	04	
Grand total			20	

Practical VII : (BCP 608)

(Section I Physical Chemistry, Section II Inorganic Chemistry, Project)

Practical VIII : (BCP 609)

(Section I Organic Chemistry, Section II Industrial Chemistry, Project)

OR Internship/ Industrial training

Practical : (SECCCP 610)

Semester - VI
Paper XIII Physical Chemistry (BCT 601)
[45 Lectures]

40 Marks **(2 Credits)**

Course Objectives : Students should

1. Learn basic concept of distribution Law and its applications.
2. Study the concepts of thermodynamics and apply it to physical and chemical systems.
3. Insight into the fascinating area of solid state chemistry and material science.
4. Learn the third order reaction with examples.
5. Learn the preparative skill of nanomaterials.
6. Develop problem solving skills in students.

Unit - 1 : Distribution law [06L]

Introduction, solute, solvent and solution, miscible and immiscible liquids Nernst distribution law and its limitations. Modification of distribution law with respect to change in molecular state of solute (association and dissociation of solute in one of the solvent). Applications of the distribution law

i] Process of extraction (derivation expected)
i] Determination of solubility of solute in particular solvent
iii] Distribution indicators iv. Determination of molecular weight of solute in different solvents. Numerical problems

Unit - II : Thermodynamics [09L]

Introduction, Free energy : Gibbs function (G) and Helmholtz function (A), Criteria for thermodynamic equilibrium and spontaneity. Relation between ΔG and ΔH : Gibbs Helmholtz equation. Phase equilibria : Clapeyron – Clausius equation and its applications. Thermodynamic derivation of law of mass action, van't – Hoff isotherm and isochore. Fugacity and activity concepts. Partial molar quantities, Partial molar volume, Concept of chemical potential, Gibbs-Duhem equation. Numerical problems.

Unit - III : Solid State Chemistry [12L]

Introduction Space lattice, lattice sites, Lattice planes, Unit cell. Laws of crystallography:

i] Law of constancy of interfacial angles
i] Law of rational indices
iii] Law of crystal symmetry. Weiss indices and Miller indices. Cubic lattice and types of cubic lattice, planes or faces of a simple cubic system, spacing of lattice planes.

Diffraction of X - rays, Derivation of Bragg's equation. Determination of crystal structure by Bragg's method. Determination of crystal structure of NaCl and KCl on the basis of Bragg's equation. Numerical problems. Determination of particle size, Debye Scherer formula, Calculation of *hkl* values from XRD, Numerical problems

Unit - IV : Chemical Kinetics [08L]

Introduction, Third order reactions – derivation of rate constant, Characteristics of Third-order reactions, Examples of third order reaction. Simultaneous reactions such as i] Opposing reaction: (Derivation of rate equation for first order opposed by first order expected) ii] Side reaction iii] Consecutive reactions iv] Chain reaction v] Explosive reaction (Derivation of rate equation and Numerical problems are not expected).

Unit - V : Nanomaterials [10L]

Introduction: Nanomaterial and Nanotechnology. Size dependent properties of Nanomaterials - Optical properties and semiconducting properties. Approaches for preparation of nanomaterials a. Top-down Approach b. Bottom-up Approach Nanoparticle **Synthesis :** Physical Methods, Chemical Method, Sol gel Method Characterization of **Nanomaterial :** Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM), Applications of Nanomaterial

Course Outcome:

After completion of units, Students are able to:

Unit - I : Distribution law

1. Understand the knowledge of distribution law, its modifications,
2. Understand applications of distribution laws.

Unit - II : Thermodynamics

1. Understand the basic concept of Thermodynamics, free energy, Gibbs Helmholtz equation and its applications,
2. Gain the problem related knowledge.

Unit - III : Solid state chemistry

1. Understand Space lattice, Unit cell. Laws of crystallography, Weiss indices and Miller indices, Cubic lattice and its types, planes or faces of a simple cubic system, Diffraction of X- rays,
2. Determine of crystal structure by Bragg's method. Study crystal structure of NaCl and KCl on the basis of Bragg's equation.

Unit - IV : Chemical kinetics

1. Determine, third order reaction, Simultaneous reactions such as

i] opposing reaction
i] side reaction
iii] consecutive reactions,
iv] Chain reaction
v] Explosive reaction

Unit - V : Nanomaterials

1. Understand and learn of nanotechnology including classification, optical properties,synthesis routes.
2. Understand the characterization techniques and applications of nano-materials.

References :

1. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co. Ltd.
2. Physical Chemistry, P.C. Rakshit, 6th Edition, 2001, Sarat Book Distributors, Kolkota.
3. Physical Chemistry, R.J. Silbey, & R.A. Alberty, 3rd edition, John Wiley & Sons, Inc [part 1]
4. Physical Chemistry, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House.
5. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition, Oxford University Press Oxford.
6. Principles of Physical Chemistry B.R. Puri, L.R. Sharma, M.S. Pathania, Vishal publishing Company, 2008.
7. Basic Chemical Thermodynamics by V. V. Rao (Macmillan).
8. Nanotechnology: Principles and Practices – Sulbha Kulkarni

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Paper XIV Inorganic Chemistry (BCT 602)
[45 Lectures]

40 Marks **(2 Credits)**

Course Objectives : Students should

1] Understand the mechanism of the reactions involved in inorganic complexes of transitionmetals.
2] Understand generation of nuclear power with the help of nuclear reactions and applications of radio isotope.
3] Understand techniques involve in ore dressing and extraction of cast iron from its ore.
4] Understand theories, classifications and applications of Acids and bases.
5] Understand basic concepts, classifications of polymers.

Unit - 1 : Coordination Chemistry **[12 L]**

A. Inorganic Reaction mechanism

Introduction, Classification of Mechanism : Association, dissociation, interchange and the rate determining steps, SN^1 and SN^2 reaction for inert and labile complexes, Mechanism of substitution in cobalt (III) octahedral complexes, Trans effect and its theories, Applications of trans effect in synthesis of Pt (II) complexes.

B. Thermodynamic and Kinetic aspects of metal complexes.

Introduction, Thermodynamic stability, Kinetic Stability, Relation between thermodynamic and kinetic stability, Stepwise stability constant, Factor affecting the stability of complexes, Determination of Stability constant by Job variation, Mole ratio and Slope ratio method

Unit - 2 : Nuclear Chemistry. [07 L]

Nuclear reactions and energetic of nuclear reactions. Types of nuclear reactions
i] artificial transmutation.
i] Artificial radioactivity.
iii] Nuclear fission and its application in Heavy water nuclear reactor.
vi] Nuclear fusion.

Applications of radio - isotopes as tracers.

i] Chemical investigation – Esterification.
i] Structural determination – Phosphorus pentachloride.
iii]Analytical Chemistry – Isotopic dilution method for determination of volume of blood.
iv] Age determination – Dating by C14.

Unit - 3 : Iron and steel [10 L]

Occurrence, and ores of iron, Definition of the Terms - Ore , Mineral, Slag, Flux, Gangue , Matrix, Calcinations, Reduction, Roasting, Smelting and Leaching, Extraction of iron by Blast furnace, Steel : Definition and types, Conversion of cast iron in to steel by

i] Bessemer process.

i] L.D. process, Heat treatment on steel.

Unit - 4 : Acid Bases and Non aqueous Solvents [08 L]

Introduction to Theories of Acids and bases - Arrhenius concept, Bronsted - Lowry concept, Lewis Concept, Lux - Flood Concept (definition and examples), Hard and Soft Acids and Bases. (HSAB Concept)

i] Classification of acids and bases as hard, soft and borderline

i] Pearson's HSAB concept

iii] Acid – Base strength and hardness - softness.

iv] Application and limitations of HSAB principle.

Chemistry of Non aqueous Solvents

i] Introduction, definition and characteristics of solvents

i] Classification of solvents,

iii] Physical properties and Acid base reactions in Liquid Ammonia (NH_3) and liquid Sulphur Dioxide (SO_2)

Unit - 5 : Inorganic Polymers. [08 L]

Introduction, Basic concept and definition, Classification of polymers - Organic and Inorganic polymers, Comparison between organic and inorganic polymers. Polymer back bone, Homoatomic polymer containing –

i] Phosphorus.

i] Fluorocarbons.

Heteroatomic polymers -

i] Silicones

ii] Phosphonitrilic compounds.

Course outcomes :

After completion of units , Students are able to:

Unit - 1 : Coordination Chemistry

A] Inorganic Reaction mechanism

i] Understands reaction mechanism and its classification.

i] Learns about inert and labile complexes.

iii] Learns about substitution in cobalt (III) octahedral complexes.

iv] Understands trans effect and its theory.
v] Learns about application of trans effect.

B] Thermodynamic and Kinetic aspects of metal complexes.

i] Learn about thermodynamics and kinetic stability and the relation between them.
i] knows about the factors affecting the stability of complexes

Unit - 2 : Nuclear Chemistry.

i] Understands Nuclear reactions and the theory behind such reactions.
i] Understands various types of nuclear reaction.
iii] Understands applications of radioactive isotopes in everyday life.

Unit - 3 : Iron and steel

i] Learns about importance of metals, steps involved in metallurgy.
i] Understand Us extraction of cast iron by blast furnace.
iii] Learns about types of steel and conversation of cast iron into steel.
iv] Understands heat treatment on steel.

Unit - 4 : Acid Bases and Non aqueous Solvents

i] Learns about Lewis acids and bases.
i] Classify acids and bases as hard, soft and borderline.
ii] Learns about physicalproperties and acid base reaction ofliquid ammonia and liquidSO_2.

Unit - 5 : Inorganic Polymers.

i] Understands different types and classification of polymers.
i] Understands the methods of preparations of polymers.

Reference Books: (Use recent editions)

1] Concise Inorganic Chemistry (ELBS, 5th Edition) – J. D. Lee.
2] Inorganic Chemistry (ELBS, 3rd Edition) D. F. Shriver, P. W. Atkins, C. H. Lang Ford, Oxford University Press, 2nd Edition.
3] Basic Inorganic Chemistry: Cotton and Wilkinson.
4] Advanced Inorganic Chemistry (4th Edn.) Cotton and Wilkinson.
5] Concepts and Models of Inorganic Chemistry : Douglas and Mc. Daniel. 3rd Edition. John Wiley publication.
6] Fundamental concepts of Inorganic Chemistry by E. S. Gilreath.
7] Structural principles in inorganic compounds. W. E. Addison.
8] T. B. of Inorganic analysis – A. I. Vogel.

9] Theoretical principles of Inorganic Chemistry – G. S. Manku.
10] Theoretical Inorganic Chemistry by Day and Selbine.
11] Co-ordination compounds SFA Kettle.
12] New guide to Modern Valence Theory by G. I. Brown.
13] Essentials of Nuclear Chemistry by H. J. Arnikar.
14] Organometallic Chemistry by R. C. Mahrotra A. Sing, Wiley Eastern Ltd. New Delhi.
15] Inorganic Chemistry by A. G. Sharpe, Addision – Wisley Longman – Inc.
16] Principles of Inorganic Chemistry by Puri, Sharma and Kalia, Vallabh Publication. Pitampur Delhi.
17] Text book of Inorganic Chemistry by K. N. Upadhyaya Vikas Publishing House – New Delhi.
18] Progress in inorganic polymer by Laport and Leigh.
19] Co-ordination compounds by Baselo and Pearson.
20] Organometallic Chemistry by P. L. Pauson.

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Paper. XV Organic Chemistry (BCT 603)
[45 Lectures]

40 Marks **(2 Credits)**

Course Objectives : students should

1. Study the mechanism of name reactions.
2. Study the preparation and applications of reagents in organic synthesis.
3. Study the conformational analysis, stereoselective and stereospecific reactions.
4. Learn structure determination of natural products.
5. Study the synthesis of pharmaceuticals compounds and agrochemicals .
6. Learn synthesis and reactions of heterocyclic compounds.

Unit - I : Name reactions. [10L]

Statement, General Reaction, Mechanism and Synthetic applications

1. Diels - Alder reaction
2. Oppenauer Oxidation
3. Meerwein – Pondorff - Verley reduction
4. Schmidt rearrangement
5. Hofmann rearrangement
6. Wittig reaction
7. Wagner - Meerwein rearrangement
8. Favorskii rearrangement
9. Michael reaction

10. Dieckmann's reaction or condensation
11. Benzilic acid rearrangement
12. Benzidine rearrangement
13. Problem based on above reactions.

Unit - II : Reagents in Organic Synthesis. [08L]

Preparation and Applications of following reagents.

1. Lithium aluminium hydride $LiAlH_4$, Osmium tetraoxide (OsO_4), Dicyclohexyl Carbodiimide (DCC)
2. Raney Nickel
3. 2,3 - Dichloro - 5,6 - dicyano – 1, 4 - benzoquinone (DDQ)
4. Polyphosphoric acid (PPA)
5. Diazomethane
6. Cerric ammonium nitrate (CAN)
7. N-Bromosuccinamide (NBS)
8. Selenium dioxide (SeO_2)
9. Sodium borohydride ($NaBH_4$)

Unit - III : Stereochemistry. [06L]

Introduction, Baeyer's strain theory. Theory of strainless rings. Conformation and stability of cyclohexane and monosubstituted cyclohexanes: cyclohexanol, bromocyclohexane and methyl cyclohexane. Locking of conformation in t-butyl cyclohexane. Stereoselectiveand stereospecific reactions :

i] Stereochemistry of addition of halogens to alkenes : syn and antiaddition. Example – Addition of bromine to 2 - butene. (Mechanism not expected)

i] Stereochemistry of elimination reaction : syn and anti- elimination Example – Dehydrohalogenation of 1-bromo -1, 2 - diphenylpropane. (Mechanism not expected)

Unit - IV : Natural Products [08L]

A] Terpenoids :

1. Introduction, Occurrence, Isolation, General Characteristic, Classification.
2. General Methods for structure determinations.
3. Isoprene rule.
4. Analytical evidences and synthesis of Citral.

B] Alkaloid :

1. Introduction, Occurrence, Isolation, Classification, Properties.
2. General Methods for structure.
3. Analytical evidences and synthesis of Ephedrine.

Unit - V : Pharmaceuticals and Agrochemicals [07L]

Introduction, Classification, Qualities of ideal drug, Synthesis and uses: ethambutal, phenobarbitone, isoniazide, benzocaine, Chloramphenicol, paludrine.

Agrochemicals General idea of agrochemicals including pyrethroides. Synthesis and uses of the agrochemicals : Indole - 3 - acetic acid**,** Endosulphan. Ethophan, Carbaryl.

Unit - VI : Heterocyclic Chemistry [06L]

Pyridine. Methods of synthesis.

i] From acetylene and hydrogen cyanide.

i] From piperidine. Physical properties. Chemical reactions

i] Basic character.

ii] Electrophilic substitution (Nitration, sulphonation & bromination) reactions.

iii] Nucleophilic substitution – General mechanism. Reactions with sodamide, sodium hydroxide and n - Butyl lithium. Quinoline, Synthesis - Skraup's synthesis, Physical properties.

Reactions of quinoline :

i] Electrophilic substitution reactions – Nitration and sulphonation.

i] Nucleophilic substitution reactions – Reactions with sodamide, alkylation and arylation.

iii] Reduction. Indole Synthesis – Fischer Indole Synthesis. Physicalproperties. Chemical reactions : Elecrophilic substitution reactions (Nitration, bromination, Friedel Craft's acylation), diazo coupling, Mannich reaction, oxidation and reduction.

Reference Books :

1. Stereochemistry of Carbon Chemistry – Eliel.
2. Chemicals for crop improvement and pest management - Green, Hartly and West.
3. Chemistry of pesticides - K. H. Buchel (T. W.).
4. Medical Chemistry – Burger.
5. Principles of Organic Chemistry - M. K. Jain.
6. Organic Chemistry - Cram D. J. and Hammond G.S, McGraw Hill book Company New York.
7. Organic Chemistry - Finar I. L.
8. A Guide Book to mechanism in Organic Chemistry - Peter Sykes
9. Organic Chemistry - R. T. Morrison and R. N. Boyd
10. Text book of organic Chemistry - Furguson L. N. D. Van
11. Organic Chemistry Vol. I, II and III - S. M. Mukherjee, S. P. Singh,
12. Atext book of organic Chemistry - K. S. Tewari, S. N. Mehrotra, N. K. VishnoiVikas
13. A text book of Organic Chemistry – Arun Bahl and B. S. Bahl S. Chand

14. Heterocyclic Chemistry Synthesis, Reactions and Mechanism - Raj K. Bansal
15. Reaction Mechanism and reagents in Organic Chemistry - G. R. Chatwal
16. Stereochemistry conformation and mechanism - P. S. Kalsi
17. Organic Chemistry Volume I and II - I. L. Finar
18. Organic Chemistry Volume I and II - William Kemp
19. Advanced Organic Chemistry - Jerry March
20. Organic Chemistry - Fieser and Fieser.

Course Outcomes :

After completion of units, Students are able to :

1. Understand the mechanism of name reactions.
2. Apply this mechanism for other such type of reactions.
3. Understand the preparation of reagents.
4. Understand the applications of reagents in their project work.
5. Illustrate the conformational analysis of cyclohexane.
6. Determine the stereospecific and stereoselective reactions.
7. Understand general methods of structure determination of terpenoids.
8. Understand general methods of structure determination of alkaloids.
9. Understand the qualities of ideal drugs, synthesis of pharmaceuticals.
10. Understand the general idea of agrochemicals and their preparations.
11. Understand synthesis and chemical reactions of five membered heterocyclic compounds.
12. Understand synthesis and chemical reactions of six membered heterocyclic compounds.

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Paper - XVI Industrial Chemistry
(BCT 604) Elective Paper - I
[45 Lectures]

40 Marks **(2 Credits)**

Course Objectives : Students should

1. Introduce and aspects of small scale industries.
2. Learn basic concepts in Entrepreneurship Development and Management.
3. Learn the concepts of sugar Industry
4. Familiar about manufacturing industrial chemicals.
5. Get basic knowledge of electroplating.

Unit - I : Small scale Industries [11L]

Introduction and aspects of small scale industries, safety matches, Agarbatties, naphthalene balls, Wax candles, Shoe polishes, gum paste, writing and fountain pain ink, plaster of paris, silicon carbide crucibles, How to remove stains

Unit - II : Entrepreneurship Development and Management [12L]

Entrepreneurship, Concept/Meaning, Need, Competencies/qualities of an entrepreneur, Entrepreneurial Support System, District Industry Centres (DICs) Commercial Banks State Financial Corporations, Small Industries Service Institutes (SISIs), Small Industries Development Bank of India (SIDBI), National Bank for Agriculture and Rural Development (NABARD), National Small Industries Corporation (NSIC) and other relevant institutions/ organizations at State level.

Unit - III : Sugar Industry [07L]

Introduction Manufacture of cane sugar in India : Extraction of juice, Clarification, Concentration, crystallization, centrifugation and other details of industrial process By products of sugar industry Manufacture of Ethyl Alcohol from Molasses: Introduction, Preparation of wash, Fermentation and Distillation.

Unit - IV : Manufacture of Industrial Heavy Chemicals [08L]

Introduction,

1] Manufacture of Ammonia by Haber's process; (NH_3) :
i] Physico - chemical principles, ii] Plant and process.

2] Manufacture of Sulphuric acid by Contact process; (H_2SO_4) :
i] Physico - chemical principles, ii] Plant and process.

3] Manufacture of Nitric acid by Ostwald's (Ammonia oxidation process);(HNO_3):
i] Physico - chemical principles, ii] Plant and process.

4] Manufacture of Sodium carbonate (Washing soda) by Solvay process. (Na_2CO_3):
i] Physico - chemical principles, ii] Plant and process.

Unit - V : Electroplating [07L]

Electrolysis, Faraday's laws, Cathode current efficiency; Basic principles of electroplating, cleaning of articles; Electroplating of Nickel and Chromium; Anodizing.

References :

1. Industrial Chemistry - B. K. Sharma
2. Chemical process industries – Shreve & Brink
3. Industrial chemistry – Kent
4. Industrial chemistry – Rogers
5. Industrial chemistry – R. K. Das
6. Outline of Dairy Technology - Oxford University press By - Sukumar De.
7. Introduction to Agronomy and soil, water management, V.G. Vaidya, K.R. SahashtraBuddhe (Continental Prakashan)

Course Outcomes :

After completion of units, Students are able to:

1. Understand of basic concepts in small scale industries.
2. Understand preparation methods of small scale products.
3. Understand of basic concepts Entrepreneurship Development.
4. Understand financial support system for entrepreneurship development.
5. Understand the whole process of manufacture of cane sugar.
6. Understand the byproducts of sugar industry and their preparations.
7. Understand of physico-chemical principles of production of ammonia, sulfuric acid, nitric acid and sodium carbonate.
8. Understand the manufacturing plants of ammonia, sulfuric acid, nitric acid and sodium carbonate.
9. Demonstrate basic concept of electroplating.
10. Understand the use of electroplating in industries.

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Paper. XVI, Industrial Chemistry (BCT 605)
Elective Paper II
[45 Lectures]

40 Marks **(2 Credits)**

Course Objectives : Students should

1. Learn Introduction and aspects of small scale industries.
2. Learn basic concepts in Entrepreneurship Development and Management.
3. Understand basics concept in polymer and their synthesis.
4. Study manufacturing of glass in terms of Principle, flow chart and working.
5. Study the components, characteristics , different types and working of batteries

Unit - I : Small scale Industries [11L]

Introduction and aspects of small scale industries, safety matches, Agarbatties, naphthalene balls, Wax candles, Shoe polishes, gum paste, writing and fountain pain ink, plaster of paris, silicon carbide crucibles, How to remove stains.

Unit - II : Entrepreneurship Development and Management [12L]

Entrepreneurship, Concept/Meaning, Need, Competencies/qualities of an entrepreneur, Entrepreneurial Support System, District Industry Centres (DICs) Commercial Banks State Financial Corporations Small Industries Service Institutes (SISIs), Small Industries Development Bank of India (SIDBI), National Bank for Agriculture and Rural Development

(NABARD), National Small Industries Corporation (NSIC) and other relevant institutions/ organizations at State level.

Unit - III : Synthetic Polymer [08L]

Introduction, Classification: Based on origin; Based on composition - organic, inorganic polymers; Based on method of preparation; Based on general physical properties; Based on structure. Addition Polymerization: Free radicaladdition and ionic addition polymerization, Zigler Nata polymerization, Method of preparation and applications of some organic polymers: Polyethylene, polystyrene, polyvinyl chloride, Phenol-formaldehyde resin, conducting organic polymers: Synthesis and properties of Polyaniline, polypyrrol, Applications of conducting organic polymers.

Unit - IV : Glass Industry. [06L]

Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses:

i] Soda lime glass,
i] lead glass,
iii] armored glass,
iv] safety glass,
v] borosilicate glass, vi)fluorosilicate, vii) coloured glass, viii) photosensitive glass.

Unit - V : Batteries. [08L]

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

References :

1. Industrial Chemistry-B.K. Sharma
2. Chemical process industries – Shreve& Brink
3. Industrial chemistry – Kent
4. Industrial chemistry – Rogers
5. Industrial chemistry – R. K. Das
6. Outline of Dairy Technology- Oxford University press By- Sukumar De.

7. Introduction to Agronomy and soil, water management, V.G. Vaidya, K.R. Sahashtra Buddhe (Continental Prakashan)

Course Outcomes :

After completion of units, Students are able to:

1. Understand of basic concepts in small scale industries.
2. Understand preparation methods of small scale products
3. Understand of basic concepts Entrepreneurship Development.
4. Understand financial support system for entrepreneurship development.
5. Understand the classification, synthesis of various polymers.
6. Understand applications of polymers.
7. Understand the manufacturing of glasses.
8. Understand different compositions and properties of glasses.
9. Understand different types of batteries and working process of batteries.
10. Understand different uses of batteries in the market.

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Paper. XVI, Industrial Chemistry (BCT 606)
Elective Paper - III
[45 Lectures]

40 Marks **(2 Credits)**

Course Objectives : Students should

1. Learn Introduction and aspects of small scale industries.
2. Learn basic concepts in Entrepreneurship Development and Management.
3. Learn the dairy chemistry, composition of milk.
4. To make student familiar with soil chemistry including properties, fertility, colloids of soil.
5. Learn regarding leather manufacture, leather processing.

Unit - I : Small scale Industries [11L]

Introduction and aspects of small scale industries, safety matches, Agarbatties, naphthalene balls, Wax candles, Shoe polishes, gum paste, writing and fountain pain ink, plaster of paris, silicon carbide crucibles, How to remove stains.

Unit - II : Entrepreneurship Development and Management [12L]

Entrepreneurship, Concept/Meaning, Need, Competencies/qualities of an entrepreneur, Entrepreneurial Support System, District Industry Centres (DICs) Commercial Banks State Financial Corporations Small Industries Service Institutes (SISIs), Small Industries

Development Bank of India (SIDBI), National Bank for Agriculture and Rural Development (NABARD), National Small Industries Corporation (NSIC) and other relevant institutions/ organizations at State level.

Unit - III : Dairy Chemistry [06L]

Definition and structure of milk, factors affecting composition of milk, Nomenclature and classification of milk proteins, Casein : Isolation, fractionation and chemical composition, physico chemical properties of casein,Whey proteins: Preparation of total wheyproteins:

Unit - IV : Soil chemistry [08L]

Chemical (elemental) composition of the earth's crust and soils, Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics, Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/ flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions.

Unit - V : Leather Chemistry [08L]

Principles of pre tannagep 1. Curing: - Definition; necessity; principles and different state of cured hides and skins. 2. Soaking: -Physico-Chemical explanation of wetting; objectives and different controls in soaking operation. 3. Liming:- Chemistry of unhairing; unhairing by different methods; objectives of liming; effects of liming on collagen; controls in liming operation to achieve different physical properties of leather. 4. Deliming and Drenching: - Objectives, principles and controls of deliming and drenching. 5. Bating: - Chemistry of Proteolytic enzymes used for bating; necessity of bating; its preparation and controls for desired properties of leather. 6. Pickling: - Acid binding capacity of collagen; use of organic acids or salts in pickling; its necessity and controls; concept of Depickling. 7. Degreasing: - Objectives and necessity of degreasing; different degreasing systems and method.

References :

1. Industrial Chemistry - B. K. Sharma
2. Chemical process industries – Shreve & Brink
3. Industrial chemistry – Kent
4. Industrial chemistry – Rogers
5. Industrial chemistry – R. K. Das

6. Outline of Dairy Technology - Oxford University press By - Sukumar De.
7. Introduction to Agronomy and soil, water management, V.G. Vaidya, K.R. Sahashtra Buddhe (Continental Prakashan)

Course Outcome :

After completion of units, Students are able to :

1. Understand of basic concepts in small scale industries.
2. Understand preparation methods of small scale products
3. Understand of basic concepts Entrepreneurship Development.
4. Understand financial support system for entrepreneurship development.
5. Provide the practical training to the students in the dairy chemistry.
6. Knowimportance of the subject from the rural economypoint of view.
7. Understand basic concept of soil, soil profile, properties of soil.
8. Understand soil colloidal matter and soil organic matter.
9. Understand the process used in leather manufacture.
10. Understand basic concepts used in leather processing.

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Paper : Skill enhancement compulsory course
(SECCCT 607)
[20Lectures]

20 Marks **(1 Credits)**

Course Objectives : Students should.

1. learn Entrepreneurship education focuses on the development of skills.
2. Enable the realization of opportunity.
3. Motivate for entrepreneurial career and to make him capable of perceiving and exploiting successfully opportunities for enterprises.
4. know how to start their own enterprise and approach various institutions for finance.
5. Learn Management education, is focused on the best way to operate existing hierarchies.

Unit - I : Entrepreneurship, Creativity & Opportunities [06L]

Concept, Classification & Characteristics of Entrepreneur, Creativity and Risk taking, Risk Situation, Types of risk & risk takers, Business Reforms, Process of Liberalization, Reform Policies, Impact of Liberalization, Emerging high growth areas, Business Idea Methods and techniques to generate business idea, Transforming Ideas in to opportunities transformation involves, Assessment of idea & Feasibility of opportunity SWOTAnalysis Information and Support Systems.

Information needed and Their Sources : Information related to project, Information related to support system, Information related to procedures and formalities, Support Systems Small Scale Business Planning, Requirements, Govt. & Institutional Agencies, Formalities Statutory Requirements and Agencies.

Market Assessment

Marketing: Concept and Importance Market Identification, Survey Key components Market Assessment

Unit - II : Business Finance & Accounts [05L]

Business Finance: Cost of Project Sources of Finance Assessment of working capital Product costing Profitability Break Even Analysis Financial Ratios and Significance Business Account: Accounting Principles, Methodology Book Keeping Financial Statements Concept of Audit.

Business Plan: Business plan steps involved from concept to commissioning, Activity Recourses, Time, Cost.

Project Report : Meaning and Importance, Components of project report/profile (Give list),

Project Appraisal:

1] Meaning and definition.
2] Technical, Economic feasibility.
3] Cost benefit Analysis.

Unit - III : Enterprise Management and Modern Trends [05L]

Enterprise Management : Essential roles of Entrepreneur in managing enterprise.

Product Cycle : Concept and importance Probable Causes of Sickness.

Quality Assurance: Importance of Quality, Importance of testing E - Commerce : Concept and Process.

Unit - IV : Chemistry Entrepreneur [04L]

Current challenges and opportunities for the chemistry - usingindustries, Assess yourself - are you an entrepreneur? Prepare project report for Chemistryand study its feasibility.

References :

1. G. N. Pandey, A complete guide to successful entrepreneurship, Vika.
2. Alpana Trehan, Entrepreneurship, Wiley India.

Course Outcome :

After completion of units, students are able to :

1. Know oral and visual presentation skills .

2. Establish a foundation of confidence in the skills necessary to cause others to act.
3. Improve skills in customer development, customer validation.
4. Understand competitive analysis while utilizing design thinking and process tools to evaluate in real - world problems and projects.
5. Mobilize people and resources. Students identify and secure customers, stakeholders, and team members through networks, primary customer research.
6. Understand competitive and industry analyses in order to prioritize and pursue an initial target market in real-world projects.
7. Create presentations and business plans that articulate and apply financial, operational, organizational, market.
8. Understand sales knowledge to identify paths to value creation
9. Increase their awareness and deliberately practice the skills and disciplines necessary to increase confidence and agency.
10. Improve communication and problem-solving skills.

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Practical VII: (BCP 608)
(Section I Physical Chemistry, Sec II Inorganic Chemistry)
Section I Physical Chemistry

Course Objective: Students should

1. Study the chemical kinetic of the reaction .
2. Study principle and titration by using conductometric analysis.
3. Learn handling and working of potentiometer.
4. Learn different steps of gravimetric analysis.
5. Learn preparative skill in inorganic preparations.
6. Develop analytical skill of titrimetric estimations.

Experiments :

I. Chemical kinetics :

1. The study of energy of activation of first order reaction i.e. hydrolysis of methyl acetate in presence of 0.5 N HCl / 0.5 N H_2SO_4.
2. To study the effect of addition of electrolyte (KCl) on the reaction between $K_2S_2O_8$ and KI (Equal concentrations).

II. Viscosity :

3. To determine the average molecular weight of a polymer.

III. Adsorption :

4. To investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich & Langmuir isotherms.

IV. Conductometry :

5. To study the effect of substituent on dissociation constant of weak acid with respect to acetic acid and monochloroacetic acid (cell constant to be given).
6. To determine concentration of sodium acetate solution by titrating it conductometrically with standard HCl solution.

V. Potentiometry :

7. Determination of standard electrode potential of Zn/Zn^{++}, Cu/Cu^{++}, Ag/Ag^{+} (Any two).
8. Titration of ferrous ammonium sulphate using $K_2Cr_2O_7$ solution and to calculate redox potential of Fe^{++}, Fe^{+++} system.

Section - II Inorganic Chemistry

I] Gravimetric Estimations (G).

G_1. Gravimetric estimation of iron as ferric oxide from the given solution Containing ferrous ammonium sulphate, copper sulphate and free sulphuric acid.

G_2. Gravimetric estimation of barium as barium chromate from the given solution containing barium chloride, ferric chloride and free hydrochloride acid.

[For the gravimetric experiments, stock solution should be given in the range of 10 to 15 cm^3 and asked to dilute to 100 cm^3 (or the stock solution should be given in the range of 20 to 30 cm^3 and asked to dilute to 250 cm^3). Use 50 cm^3 of this diluted solution for estimation.]

II] Inorganic Preparations (P).

P_1. Preparation of ammonium diamine tetrathiocynato chromate (III) (Reineck's salt).
P_2. Preparation of hexammine nickel (II) chloride.
P_3. Preparation of tris (thiourea) cuprous sulphate.
P_4. Preparation of potassium diaquo bis oxalatocuprate (II).
P_5. Preparation of chromium acetato dihydrate.

III] Titrimetric Estimations :

A] Percentage Purity

V_1. Determination of percentage purity of potassium trioxalato - aluminate (III).
V_2. Determination of percentage purity of potassium trioxalato ferrate (III).

References:

1. Findlay's Practical Physical Chemistry (Longman)
2. Advanced Practical Physical Chemistry by J. B. Yadav, Goel publishing house.
3. Practical Physical Chemistry by B. D. Khosla, V. C. Garg (R. Chand and Co.)
4. Systematic experimental Physical Chemistry by Rajbhoj, Chandekar (Anjali Publicaiton)
5. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
6. Text book of Quantitative Inorganic Analysis – By A. I. Vogel (ELBS and Longman 3rd Edition).
7. Text book of Quantitative Inorganic Analysis - Kolthoff and Sandell.
8. Experimental Inorganic Chemistry - Palmer W. G.
9. Advanced Practical Inorganic Chemistry - Adams and Raynor.
10. Vogel's text book of Quantitative Inorganic Analysis by Basssett and Denny etc. ELBS and Longman 4th edition.

Course Outcome :

After completion of experiments, students are able to :

1. Determine rate of reactions by using chemical kinetics.
2. Determine the average molecular weight of a polymer.
3. Determine dissociation constant of weak acid and concentration of salt by using conductometer.
4. Understand operating process, titration by using potentiometer.
5. Understand the preparations of various inorganic complex molecules.
6. Determine quantitative analysis by using gravimetric analysis.
7. Enhance titrimetric skill.

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Practical VIII: (BCP 609)
(Section I Organic Chemistry, Section II Industrial Chemistry)
Section I Organic Chemistry

Course Objectives : Students should

1. Study qualitative and quantitative analysis of organic compounds.
2. Study the preparation of organic compounds by green chemistry .
3. Learn chromatographic technique.
4. Understand instrumental analysis.

I] Quantitative analysis: Organic Estimations:

1. Estimation of sucrose.
2. Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method.

II] Organic Preparations :

Radical coupling reaction - Preparation of 1, 1, 2 bis-2naphthol.
Diels Alder reaction- Reaction between Furan and Maleic acid.
Benzil- Benzilic acid rearrangement reaction.
Oxidation reaction – Preparation of Methyl phenyl sulfone.

III] Preparation of Derivatives :

Iodoform (Acetone).
Osazone of Carbohydrates (Glucose).
Nitrate derivative of Urea
2, 4-Dinitro phenyl hydrazone (carbonyl compounds)
Oxime derivatives (carbonyl compounds)

IV] Any other suitable experiments as per requirement.

Section II Industrial Chemistry

Experiments :

1. Estimation of unsaturation –to estimate the percentage purity of given olefin compound by brominating method. Note: Double burette method should be used for titration.
2. Saponification value of oil.
3. Oxalic acid from cane sugar.
4. Methyl orange, Aniline yellow dye preparation.

Ion exchange method.

5. Determination of amount of sodium present in the given solution of common salt using cation exchange resin (By Acid Base titration).
6. Determination of amount of magnesium in the given solution containing (Mg^{2+} and Zn^{2+}) using anion exchange resin and standard solution of EDTA.
7. Determination of amount of zinc in the given solution containing (Mg^{2+} and Zn^{2+}) using anion exchange resin and standard solution of EDTA.

pH – metry:

8. To determine the dissociation constant of monobasic acid (Acetic acid).
9. To determine the pH values of various mixtures of sodium acetate and acetic acid in aqueous solutions and hence find out the dissociation constant of the acid.

OR

Internship/ Industrial training

Reference Books:

1. Findlay's Practical Physical Chemistry (Longman)
2. Advanced Practical Physical Chemistry by J. B. Yadav, Goel publishing house.

3. Practical Physical Chemistry by B. D. Khosla, V. C. Garg (R. Chand and Co.)
4. Systematic experimental Physical Chemistry by Rajbhoj, Chandekar (Anjali Publication) Aurangabad.
5. Practical Physical Chemistry: Nandkumari, Kothari and Lavande.
6. Practical Physical Chemistry by Gurtu (S. Chand).
7. Text Book of Qualitative Inorganic Analysis by A. I. Vogel (ELBS Longman).
8. A text book of quantitative Inorganic Analysis - A. I. Vogel.
9. Text book of Quantitative Inorganic Analysis - Kolthoff and Sandell.
10. Experimental Inorganic Chemistry - Palmer W. G.
11. Advanced Practical Inorganic Chemistry - Adams and Raynor.
12. Manual in Dairy Chemistry - I.C.A.R. Sub-Committee on Diary Education.
13. Chemical methods for environmental analysis - R. Ramesh and M. Anbu
15. Practical Organic Chemistry by – A.I. Vogel.
16. Practical Organic Chemistry by – O. P. Agarwal

Course Outcomes:

After completion of experiments, students are able to:

1. Obtain knowledge about qualitative and quantitative analysis.
2. Understand the organic preparation with mechanism.
3. Understand preparation of derivatives to identify compounds.
4. Understand green chemistry approach in experiments.
5. Develop analytical skill by using ion exchange chromatography.
6. Plan the experimental projects and execute them.

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Practical : (SECCCP 610)
30 Marks
Course Work : 20

15 Days internship program and report writing

Visit to Chemical industry
Internship
Report writing
Presentation

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