Detailed Syllabus:

SEMESTER-I

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
(NEP-2023 COURSE)
DSCCH-101: INORGANIC CHEMISTRY - I

Total Credits: 04 **Total Lectures: 60Hrs**
Course Learning Outcomes:

After completing this course, student is expected to learn the following:

CO 1 : Understand chemistry of Hydrogen and its Compounds
CO 2 : Study extraction, properties and applications of Alkali and Alkaline earth elements
CO 3 : Study preparation structure and bonding of Boron group elements and its compounds.
CO 4 : Study allotropes, synthesis, and properties compounds of carbon compounds.
CO 5: Study synthesis properties and applications of Nitrogen group compounds
CO 6 : Study synthesis properties and applications of Oxygen group compounds
CO 7: Make aware of chemistry of Halogens & Noble gases
CO 8 : Understand types of solids, Band Theory, Intrinsic & photoexcited semiconductors, Impurity & defect semiconductors
CO 9 : Study of Inorganic Chains, Rings, Cages and Clusters
CO 10 : Study Applications of VSEPR theory, molecular orbitals and molecular structure ,Concept of hybridization

Course Content:

Chemistry of Main Group Elements

1. Hydrogen and its compounds

Position, Preparation of hydrogen, Properties of Molecular hydrogen, Types of Hydrides, Ionic, Covalent, Metallic hydrides Hydrogen bonding.

2. Alkali and Alkaline Earth Metals

General properties, reaction with oxygen, nitrogen, hydrides, Flame colors and Spectra, Complexes, crowns and Crypts, applications

3. Boron Group

General properties, Compounds of Boron and Oxygen, Boron Hydrides, preparation, structure of boranes, Reaction of boranes, Oxides of Aluminium.

4. Carbon Group

General properties ,Allotropes of carbon, Diamond, Graphite, Graphene, fullerenes, carbon nanotube synthesis, properties, Carbon dating, Silicates, occurrence, solubility, classification, applications, Zeolites

5. Nitrogen Group

General properties, structure, Nitrogen cycle, reactivity, hydrides of elements, applications of nitrogen and phosphorous compounds, PN and SN Compounds, Applications of PN and SN compounds

6. Oxygen Group

General properties ,Metal Selenides and Tellurides, oxyacids, and oxoanions of Sulphur and nitrogen. Ring, Cage and Cluster compounds of p-block elements.

7. Chemistry of Halogens & Noble gases

Introduction, Chemistry of Noble gases, bonding in noble gas halides, bond strengths in noblegas compounds Chemistry of halogens, Interhalogen compounds, oxyacids of heavier halogens,Halogen oxides & oxyfluorides, pseudohalogens

8. The Solid State

Structures of complex ionic compounds, Imperfections in crystals, conductivity in ionic solids, solids held together by covalent bonding: Types of solids, Band Theory, Intrinsic & photoexcited semiconductors, Impurity & defect semiconductors.

9. Structure of Covalent Compounds

Shapes of Covalent compounds, Helferich's rule, Effect of lone pairs on geometry of the molecules, VSEPR Theory, Examples, applications and limitations of VSEPR theory, Hybridization, Characteristics of hybrid orbitals, Bents rule and energetic of hybridization, geometry of different molecules.

References

1. Theoretical Inorganic chemistry : M.C. Day and J. Selbin. Reinhardt EWAP (1987).
2. Structural Inorganic Chemistry, A.F. Wells, 5th edition (1984).
3. Advanced Inorganic Chemistry, S.K Agarwala and Keemati Lal, Pragati Prakashan(2008)
4. Advanced Inorganic chemistry: F.A. Cotton, R.G.Willkinson (Wiely – Eastern).
5. Inorganic chemistry: A.G.Sharpe, ELBS edition (1984).
6. Concise Inorganic chemistry: J.D.Lee, 5th edition, ELBC (1986).
7. Inorganic Chemistry by Shriver and Atkins

M.Sc. I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-I
(NEP-2023 COURSE)
DSCCH-102: ORGANIC CHEMISTRY - I

Total Credits: 04 **Total Lectures: 60Hrs**
Course Learning Outcomes:

After completing this course, student is expected to learn the following:

CO 1 : Understand SN^1, SN^2 &SNi' with respect to mechanism and stereochemistry
CO 2 : Learn concept of Aromaticity, Arenium ion mechanism, orientation and reactivity in aromatic electrophilic substitutions.
CO 3 : Carry out SNAr and Aryne mechanism aromatic nucleophilic substitution
CO 4 : Mechanistic and stereochemical aspects of addition reactions of C-C multiple bonds including allenes, Ionic and free radical additions
CO 5 : Make students to understand E1, E2 & E1cB mechanisms and their orientation
CO 6 : Concept of chirality: Recognition of symmetry elements. enantiomers, diasteromers, racemic modification and their resolution, R/S nomenclature, geometrical isomerism, E & Z nomenclature,
CO 7 : Learn mechanism Rearrangements like Beckmann, Hoffmann, Schmidtetc
CO 8 : Non-Benzenoid Aromatics study

Course Content:

1. Aliphatic Nucleophilic substitutions:

SN1, SN2 & SNi' with respect to mechanism and stereochemistry. Nucleophilic substitutions at an allylic, aliphatic and vinylic carbons. Reactivity effect of substrate structure, effect of attacking nucleophiles, leaving groups and reaction medium. Ambient nucleophiles. Neighboring group participation by σ,π and aromatic ring systems

2. Aromatic Electrophilic Substitutions:

Introduction, concept of Aromaticity, Arenium ion mechanism, orientation and reactivity in Nitration, Sulphonation, Halogenation, Friedel – Craft reactions in aromatic systems. Energy profile diagrams. The ortho / para ratio, ipso attack orientation in ring systems, Diazo-Coupling, Jakobsen, Haworth, Henkel and halogen dance reaction

3. Aromatic Nucleophilic Substitution:

Introduction, specificity of the reactions, SNAr, Aromatic SN1 and Aryne mechanism. Effect of substrate structure, leaving group, attacking group, base & solvent

4. Addition Reaction:

Mechanistic and stereochemical aspects of addition reactions of C-C multiple bonds including allenes, Ionic and free radical, additions of halogens, halogen halides & hydration. Electrophilic addition involving Metal ions, Regio and chemo selectivity, orientation and reactivity, Conjugate addition.

5. Elimination Reaction:

The E1, E2 & E1cB mechanisms. Orientation in elimination reactions. Reactivity, effect of substrate structures, attacking base, leaving group, nature of medium and pyrolytic elimination reactions.

6. Stereochemistry:

Concept of chirality: Recognition of symmetry elements and chiral structures, prochiral relationship, enantiomers, diasteromers, racemic modification and their resolution, R/S nomenclature, geometrical isomerism, E & Z nomenclature, conformational analysis of disubstituted cyclohexanes.

7. Rearrangements:

Beckmann, Hoffmann, Schmidt, Curtius, Lossen, Claisen, Fries , Benzilicacid, Favorskii and wolf.

8. Structure and Reactivity:

Benzenoid and non-benzenoid compounds, Huckel's rule, antiaromaticity, Application to carbocyclic and heterocyclic systems, annulenes, azulenes, current concepts of aromaticity

References:

1. Advanced organic chemistry by Jerry March, 4th edition, Mc Graw – Hill, 1988.
2. Advanced organic chemistry (Part-A) by F.A.Carey and R.J. Sundberg, 3rd edition, plenum press, New York and London, 1990.
3. Modern synthetic reactions by H.O. House, 2nd edition, Benjamin / Cummings Publishing Company, 1976
4. Stereochemistry of Carbon Compounds by E.L.Eliel, 9th Reprints, Tata – McGraw Hill, 1985
5. Stereochemistry, Conformations and Mechanism by P.S.Kalsi, Wiley Eastern Ltd., 2nd edition, 1993
6. Organic Reactions & their mechanism by P.S.Kalsi, 2nd edition, New Age International, 1998

M.Sc I (ANALYTICAL/ORGANIC CHEMISTRY)
SEMESTER- I
(NEP-2023 Course)
DSCCH-103: INORGANIC CHEMISTRY PRACTICAL-I

Total Credits: 02 **Total Hours: 60**

Course Learning Outcomes:

After completing this course, student is expected to learn the following:

CO 1 :	Prepare solutions of given concentration and standardize the solutions
CO 2:	Preparation and purification of Metal complexes
CO 3:	Determine purity of the complexes using standard methods
CO 4:	Determine Isomerism in Metal complexes using experimental methods
CO 5:	Use Volumetric methods of analysis and its applications for estimation of elements from given sample of Ores
CO 6:	Use Volumetric methods of analysis and its applications for estimation of elements from given sample of Alloys
CO 7:	Use Gravimetric methods of analysis and its applications for estimation of elements from given sample of Ores
CO 8:	Use Gravimetric methods of analysis and its applications for estimation of elements from given sample of Alloys

Course Content:

Preparation of Solutions and its Standardization

1 (a) Preparation of NaOH and HCl solution of different normalities and their standardization
(b) Preparation of $KMnO_4$ of given normality and its standardization
2 (a) Preparation of EDTA of given normality and its standardization
(b) Preparation of percent solutions of given compounds

Inorganic Synthesis and Purity Determination (Any Seven)

1 Synthesis of Chloropenta –aminocobalt(III) chloride
2 To determine purity of Chloropenta –aminocobalt(III) chloride
3 Synthesis of Trisethylene diammine nickel (II) thiosulphate
4 Preparation and purification of Reinecke's salt.
5 Synthesis of Nitropenta –aminocobalt(III) chloride
6 To determine purity of Nitropenta –aminocobalt(III) chloride
7 Synthesis of Potassium trisoxalato aluminate (III) trihydrate.
8 To determine purity of Potassium trisoxalato aluminate (III) trihydrate

Ore Analysis (any Four of the following)

1 Determination of Silica from Pyrolusite Ore
2 Determination of Manganese from Pyrolusite Ore usingVolumetric method
3 Determination of Copper from Chalcopyrite Ore
4 Determination of Iron from Chalcopyrite Ore

5 Determination of Silica from Haematite Ore
6 Determination of Iron from Haematite Ore using volumetric method
7 Determination of Iron from Haematite Ore using gravimetric method

Alloy Analysis (any two of the following)

1 Determination of Tin from Solder alloy
2 Determination of Lead from Solder alloy
3 Determination of Copper from Cupranickel alloy
4 Determination of Nickel from Cupranickel alloy

References:

1. Vogel's Textbook of Inorganic quantitative analysis, Svehla and Shivshankar.7th Edition, Pearson, 2012.

2. Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horwood publishing, Chichester) 1999.

M.Sc I (ANALYTICAL/ORGANIC CHEMISTRY)
Semester- I
(NEP-2023 Course)
DSCCH-104: ORGANIC CHEMISTRY PRACTICAL-I

Total Credits: 02 **Total Hours: 60**

Course Learning Outcomes:

After competing this course, student is expected to learn the following:

CO 1 : Summarize the purification technique, separation and identification technique i.e. Recrystallization, distillation fractional distillation, chromatography and solvent extraction are used for all types of organic compound.

CO 2 : Draw chemical structure using ChemDraw, Chemsketch software.

CO 3 : Design to make student aware of Green Chemistry and role of Green Chemistry in pollution reduction.

CO 4 : Make aware of carrying out different types of reactions and their workup methods. Judge the reaction mechanism and synthesis process.

Course Content:

1 **Techniques: - (Any Four)**

1. Crystallisation,
2. Column Chromatography,
3. Distillation
4. Thin Layer Chromatography.
5. Sublimation

2. Use of chemistry software like ChemDraw, Chemsketch (Any one)

3. Green Chemistry Experiments (any two)

1. Preparation of Schiff's bases in aqueous medium.
2. Preparation of acetanilide from aniline and acetic acid using Zn dust
3. Adoption of green method for functional group conversion

4. Single stage preparations. (Any eight)

1. Benzil to Benzilic acid.
2. Benzoin to Benzil.
3. Cyclohexanol to Cyclohexanone.
4. Cyclohexanone to Adipic acid.
5. Nitrobenzene to Aniline.
6. Benzaldehyde to Chalcone
7. 2-Naphthol to 2-Methoxy Naphthalene
8. Glycine to benzoyl glycine
9. Aniline to benzenediazonium chloride
10. Cyclohexanone to oxime

References:

1. A text-book of practical organic chemistry by A.I.Vogel,4th edition, ELBS / Longman.
2. A hand book of quantitative and qualitative analysis by H.T.Clarke, Orient Longman
3. Practical organic chemistry by Mann and Saunders.
4. Practical organic chemistry by O.P.Agarwal.

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-I
(NEP-2023 COURSE)
DSECH-105A: PHYSICAL CHEMISTRY - I

Total Credits: 04 **Total Lectures: 60Hrs**
Course Learning Outcomes:

After competing this course, student is expected to learn the following:

CO 1 : Basic understanding of physical chemistry
CO 2 : Use of thermodynamics and chemical kinetics in daily life.
CO 3 : Use of fuel cells and batteries in EVs.
CO 4 : Use of advanced and recent technologies in Batteries.
CO 5 : Knowledge of fundamentals of photophysical phenomena.
CO 6 : Application of Quantum mechanical tools in determining the wave functions and energies of moving particles.
CO 7 : Use of proper theoretical and instrumental methods of measurements of surface property.

Course content:

1. **Chemical Thermodynamics**

i) Recapitulation of fundamental concepts of thermodynamics, limitations of the first law–need for the second law, spontaneous or irreversible, processes, cyclic process, Carnot's cycle, efficiency of a heat engine, Carnot theorem (Heat engine)

ii) Concept of entropy, entropy change in an isothermal expansion of an ideal gas, entropy change in reversible and irreversible processes, calculation of entropy change of an ideal gas with change in P.V. and T, Entropy of mixing of ideal gases, physical significance of entropy.

iii) Work and free energy functions: Variation of free energy with T and P, Maxwell's relations & significance, criteria for reversible and irreversible processes, Gibbs-Helmholtz equation and its applications.

iv) Thermodynamics of open systems: Partial molar properties-chemical potential, Gibbs- Duhem equation, determination of partial molar properties- Partial molar volume and partial molar enthalpy; Third law of thermodynamics- Nernst heat theorem, Determination of Absolute Entropies of Solids, Liquids and Gases, entropy changes in the chemical reactions, derivation of the Boltzmann Entropy equations Residual Entropy, Problems

2. **Chemical kinetics- Molecular Reaction Dynamics:**

Recapitulation of basics of chemical kinetics. Molecular Reaction Dynamics: Mechanisms of complex reactions, collisions and encounters, effect of temperature on reaction rates, effect of a catalyst, Arrhenius equation.

Theories of reaction rates:

1) Collision theory of bimolecular gaseous reactions (Derivation expected)
2) Activated complex theory (Transition state theory or theory of absolute reaction rates) of bimolecular gaseous reactions, Eyring equation (derivation expected)

Kinetics of reactions in solution:

Diffusion- controlled reactions in solution, experimental technique of studying molecular reaction dynamics i.e. Molecular beam method, potential energy surfaces, problems.

3. **Surface chemistry and catalysis:**

A) Adsorption by solids, chemisorption, Adsorption of gases on solids, factors affecting adsorption.

Types of Adsorption: Physical (van der Waals) Adsorption or physisorption and chemical (Activated) Adsorption or chemisorption.

Adsorption Isotherms-

i) Freundlich adsorption isotherm
ii) Langmuir adsorption isotherm
iii) BET adsorption isotherm

Various equations of adsorption isotherm-Freundlich, Langmuir (Derivation expected) and BET (derivation expected)

Derivation of the BET equitation, types of adsorption isotherm, Determination of surface area of solid adsorbents using- BET method, Point-B method and Harkins- Jura absolute method, Adsorption from solutions- Gibb's adsorption equation. Applications of adsorption,

Modern techniques for examining surfaces- Low energy electron diffraction (LEED), photoelectron spectroscopy (PES), ESCA, scanning probe microscopy, Auger electron spectroscopy, SEM and TEM

B) Catalysis:

Characteristics of catalytic reactions, types of catalysis – Homogeneous and Heterogeneous catalysis, Acid-Base Catalysis, Enzyme catalysis- Enzyme catalyzed reactions, Heterogeneous catalysis- Bimolecular surface reactions according to Langmuir- Hinshelwood mechanism

4. **Quantum Chemistry:**

Classical mechanics and its limitations- Need of quantum mechanics, wave- particle duality of electron (de Broglie relation), Heisenberg's Uncertainty principle, Postulates of quantum mechanics, Schrodinger wave equation, solution of the Schrodinger wave equation for some simple systems viz.

1) Particle in a one-dimensional box
2) Particle in a three - dimensional box
3) One- Dimensional Simple Harmonic Oscillator (S.H.O.)
4) The Rigid Rotar (or Rotator)
5) The Hydrogen Atom.

5. **Applied Electrochemistry:**

Electrochemistry Applications: -Fuel cells, batteries and supercapacitors- as Energy storage devices, Battery- (Electrochemical energy converter) Current- potential relation, power output and efficiency, factors affecting the electrochemical energy conversion,

Fuel Cell- Electrochemical electricity generator, like H_2-O_2 Fuel Cell, Hydrocarbon-air fuel cells, and natural gas, CO-air fuel cells, Dry cell batteries- like Zn-Carbon, Alkaline- Cell and Hg- batteries, supercapacitors rechargeable batteries like Na-ion, Li-ion, Pb-acid, Ni-metal hydride and Ni-Cd batteries, charging and discharging of battery, important quantities in Electricity storage- like electricity storage density, energy density, and power.

6. **Photochemistry:**

Introduction, absorption of light, types of chemical reactions, laws of photochemistry, consequences of light-absorption: primary and secondary processes, electronic transitions in molecules, potential energy curves for primary photochemical processes, excited states- singlet and triplet states, quantum yield or quantum efficiency of photochemical reactions, experimental determination of quantum efficiency, photoluminescence-fluorescence and phosphorescence, chemiluminescence, photochemical equilibrium, photosensitization, flash photolysis, photochemistry in life process- photosynthesis, photoconductivity, photopolymerization, Hot Atom Reactions, Mechanism of photochemical reactions, problems.

References:

1. Atkins Physical Chemistry, P. Atkins, J. Paula, Oxford University Press.
2. Physical Chemistry, D.A. McQuarrie, Viva Book Pvt. Ltd.
3. Chemical Kinetics, K.j. Laidler, Pearson Education Inc.
4. Physical Chemistry, G.M. Barrow, Tata McGraw Hill.
5. Quantum Chemistry, D.A. Mc\Quarrie, Viva Books.
6. Quantum Chemistry, I.N. Levine, Prentice Hall.
7. Fundamentals of Photochemistry, K.K. Rohatgi-Mukherjee, New Age International.
8. Physical Chemistry of Surfaces, W. Adamson, Wiley Intercedences.
9. Catalytic Chemistry, B.C. Gates, John Wiley and Sons Inc.
10. Electrochemical Methods, A.J. Bard, L.R. Faulkner, John Wiley and Sons.
11. Electrode Potentials, R.G. Compton, Giles H.W. Sanders, Oxford University Press.
12. Modern Electrochemistry Vol. I and Vol. IX. John O.M. Bockris, Amulya K.W. Reddy, Plenum Press.
13. Principles of Physical Chemistry, maron and Prutton, Macmillan Company.
14. An Introduction to Electrochemistry, S. Glass tone, East-West Press.
15. Advanced Physical Chemistry, D.N. Bajpai, A.S. Chand Co. Ltd.,
16. Essential of Physical Chemistry, B.S. Bahl, G.D. Tuli, Arun Bahl, S.Chand.
17. Physical Chemistry, T. Engel, Philip Reid, Pearson Education.
18. Advanced Physical Chemistry, J.N. Gurtu, A. Gurtu, Pragati Edition.
19. Principles of Physical Chemistry, Puri, Sharma, Pathania, Vishal Publishing Co.
20. Physical Chemistry, B.K. Sharma, Goel Publishing House.
21. Quantum Chemistry, R.K. Prasad.
22. Fundamentals of Quantum Chemistry James E. House.
23. Physical Chemistry, Gilbert W. Castellan, Narsosa.

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-I

(NEP-2023 COURSE)

DSECH-105B: FUNDAMENTALS OF ANALYTICAL CHEMISTRY

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

After competing this course, student is expected to learn the following:

CO 1: Basic understanding of concepts of analytical chemistry and development of alternate analytical methods

CO 2: Understand Chromatographic Techniques.

CO 3: Understand Ion Exchange Chromatographic Techniques.

CO 4: : Demonstrate safe laboratory skills (including proper handling of materials and chemical waste) for particular laboratory experiments.

CO 5: To understand importance of safety and health in laboratory.

CO 6: Learn and observe the safety and laboratory rules

CO 7: To study safety management guidelines.

CO 8: To describe hazard information: material safety data sheets (MSDSS), understand and communicate about laboratory hazards

CO 9: To study Chemical Management: Inspections, Storage, Waste and Security.

Course Content:

1. Analytical chemistry- an overview:

Introduction, basic concepts, classification of analytical methods, types of instrumental methods, instruments for analysis and its different domains. Factors affecting choice of analytical methods, interferances. Analytical methods on the basis of sample size, sampling, sampling statistics.

2. Fundamental of Quantitative Analysis:

Introduction, Methods of expressing concentrations, Methods of preparation of standard solutions, primary and secondary standard substances, indicators, indicator theory, choice of indicators,

a) Complexometric Titration- stability of complexes, metal-ion buffer, titrations involving unidentate and multi-dentate ligands.

b) Precipitations Titrations: Precipitations Titrations and solubility equilibria, indicators, factors affecting solubility, applications of precipitation titrations.

c) Argentiometry: Theory of precipitation titration, Mohr's method, Fazan's method, Preparation and standardization of silver nitrate solution, Determination of chloride, bromide and iodide individually and in a mixture.

3. Chromatography :

General principles, Classification, Partition Chromatography, Adsorption Chromatography. Principles, Techniques and applications of Paper Chromatography , Thin-Layer Chromatography, Column Chromatography, HPLC, Gas Chromatography and Electro Chromatography.

4. Ion-Exchange Chromatography :

Cation and Anion exchangers, Action of ion exchange resins. Ion-exchange equilibria and ion exchange capacity. Strongly and weakly acidic cation exchangers. Strongly and weakly basic anion exchangers. Liquid ion exchangers, chelating ion exchangers, techniques of ion exchange and application in analytical Chemistry. Separation using solvent mixtures.

5. Good Laboratory Practices -I

a) Different types of Hazards at workplace handling chemicals:
Physical, chemical, biological, allergens, Effect of hazards on health

b) Personal Protective and other safety equipment and their uses:
Various safety goggles, types of gloves, apron, masks, different filters for masks, face shield, full body suit, safety shoes, helmet, breathing apparatus suit, safety belt, and earmuffs along with inspection methods. Emergency exit, its location and approach path, fire extinguishers, and their periodic inspection, first aid kit, its contents and need for monitoring. Eye wash fountains and safety showers, fire drill, and chemical accident drills, accident-free days and incentives to follow safety rules, accident recording and investigation for future controls

c) Material Safety Data Sheets, Globally Harmonised System (GHS) Signs (hhtp://www.calstatela.ed/univ/ehs/msds.php)
Inventory Management, Storage, waste Classification, Hazardous waste, Non-Hazardous waste, mixed waste, waste Disposal.

6. Good Laboratory Practices –II

Introduction and principles of GLP, performance of Lab studies and calibration using Standard Operating Procedures (SOPs), Instrument validation, reagent certification, Lab notebook maintenance to contemporary standards, maintenance of lab records based on instrument and reagent certification. Introduction to ISO and NABL accreditation.

References

1. Chemical Applications of Group Theory – F.A. Cotton
2. Elemental Analysis of Airborne Particles, Ed.S.Landberger and M.Creatchman, Gordon and breach Science Publication.
3. Day & Underwood : Quantitative Analysis (Prentice Hall India Limited).
4. A.I.Vogel A text book of quantitative inorganic Chemistry, ELBS, London.
5. Strouts Galfillal: Analytical Chemistry (Clarendon Press).
6. Strouts Wilson & Parry Jones: Chemical Analysis Vol.I (Clarendon Press).
7. Meite4s and Thomas: Advanceds Analytical Chemistry, (McGraw Hill).
8. Willard Merritt and Dean: Instrumental methods of Analysis (Can Nostrand).
9. B.L.Kraayer, H.H.Willard, L.Merrit, J.A.Dean & F.A.Settle: Instrumental Methods of Analysis (CBS Pulishers, Delhi, 1986).
10. F.J.Wicher Robert : Standard Methods of Chemical Analysis.
11. Dr.G.L.David Krupadanam, D.Vijay Prasad, K.Varaprasad Rao, KLN. Reddy, C.Sudhakar, Analytical Chemistry.
12. Chemical Laboratory Safety and Security: A Guide to Prudent Chemical Management, Lisa Moran and Tina Masciangioli, Editors, THE NATIONAL ACADEMIES PRESS Washington, DCwww.nap.edu. Page 10 of 20
13. Safety in Academic Chemical Laboratory, Vol. II, ACS Publication, 7th Edition (2003).
14. OECD Series on Principles of Good Laboratory Practices and Compliance Monitoring, 1997.
15. Handbook of Good Laboratory Practices, TDR, WHO, UNICEF, UNDP (2009).
16. A Primer for Good Laboratory Practices and Good Manufacturing Practices, L. Huber, Agilent Technologies, 2002.
17. What went wrong By Trevor Kletz, Gulf professional Pubisher.

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-I
(NEP-2023 COURSE)
DSECH-105C: GREEN CHEMISTRY & GREEN ENERGY

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

After competing this course, student is expected to learn the following:

CO 1: Basic understanding of Green Chemistry and its principles.

CO 2: Development of alternate and new eco-friendly synthetic pathways to chemicals.

CO 3: Use of advanced and recent green technologies in organic synthesis.

CO 4: Use of Greener and renewable catalysis and their applications.

CO 5: Skills for developing industrially important eco-friendly methods.

CO 6: Skills for analyzing and developing new sustainable methods.

Course contents:

1. Introduction to Green Chemistry

Definition, needs and goals, limitations in pursuit of the goals of Green Chemistry. The Twelve principles of Green Chemistry, and their explanations with examples. The concept of Atom Economy in chemical synthesis and its important techniques and directions in practicing green chemistry.

i) Microwave assisted reactions in water (like Oxidation of toluene and alcohols, methyl benzoate to benzoic acid, Hofmann elimination)

ii) Ultrasound assisted reactions sonochemical reactions

iii) Photochemical reactions using sunlight, flow techniques.

2. Green Synthesis (Green Chemical Reactions)

i) Green Chemical products- Green synthesis of – Polylactic acid (PLA) Polymer vs traditional route, Recycling of PET (Polyethylene Terephthalate) plastic by green route, Green Synthesis of TPA (Thermal Polyaspartate polymers vs Polyacrylate) Plastic by green route, Carolactam)

ii) Use of Harpin as a replacement of fumigants and pesticides, The Molting Accelerators as Insecticides to replace more toxic environmentally hazardous insecticides, Disodium imino-diacetate (in herbicide).

iii) Green synthesis of Adipic acid (Used in the production of nylon polymer) catechol, BHT vs. traditional.

3 Green catalysis and Renewable Raw Materials

Catalysis by coordination compounds- organometallic compounds in organic synthesis on industrial scale, Heterogeneous Catalysis: Use of Zeolites, Silica, Alumina, Clay, Polymers, Cyclodextrin and supported

catalyst, Phase-transfer catalysis, Biocatalysts using enzymes, Biomass conversion to fine chemicals.

4 Green solvent and Green Reagent

Definition and examples, Reactions under aqueous medium: Enhancement of selectivity, efficiency and industrial applicability, Ionic liquids, supercritical fluids, solvent free reactions in solid and liquid phase, alternatives in extraction and chromatography.

5 **Green Technology**

Green Technology (i.e. Biotechnology) to control industrial pollution- use of ecofriendly Bio-technology to replace the existing chemical technology. Biomethanization reactions used in waste water treatment

6 **Green sources of Energy:**

i) Use electrical energy in Electric vehicles (EV)- Electrochemical cells and batteries, fuel cells, Green H_2 as a fuel.

ii) Solar Energy:

Biomass based energy- production of alcohol (ethanol) from biomass, Biogas and Gobar gas

References

1. Green Chemistry- Theory and practice, P.T. Anastas, J.C. Warner, Oxford University Press.
2. Environmental Chemistry with Green Chemistry, A.K. Das, Books and Allied Pvt. Ltd.
3. New Trends in Green Chemistry, V.K. Ahuluwalia, M. Kidwai, Anamalaya Publishers.
4. Real-world cases in Green Chemistry, M.C. Can, M.E. Connelly, D.C. Washignton, American Chemical Society.
5. Introduction to Green Chemistry, A.S. Matlack, Marcel Dekker.
6. Green Chemistry: An Introductory Text, M. Lancaster, 3rd Ed. Royal Society of Chemistry.
7. Catalyst free Organic Synthesis, G.Brahmachari, Royal Society of Chemistry.
8. Alternative solvents for Green Chemistry,F.M. Kerton, Royal Society of Chemistry.
9. Green Chemistry and Catalysis, R.A. Sheldon, I. Arends, U. Hanefield, Wiley-VCH.

10. Introduction to Green Chemistry, M.A. Rayan, M. Tinnes, American Chemical Society.

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-I
(NEP-2023 COURSE)
DSECH-106: PHYSICAL CHEMISTRY PRACTICAL-I

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

After competing this course, student is expected to learn the following:

CO 1: Basic understanding of practical physical chemistry.
CO 2: Use of viscosity, adsorption, solubility in daily life.
CO 3: Skills for analyzing and developing new sustainable methods
CO 4: Skills for developing industrially important practical methods.
CO 5: Development of alternate analytical methods.
CO 6: Use of advanced and recent techniques in experimental chemistry.

Course contents: (Any 15 Experiments)

A) **Colorimetry and Spectrophotometry**

1. Determination of amount of copper by photometric titration with EDTA
2. Determination of Indicator constant of an acid base indicator spectrophotometrically
3. Study the kinetics of iodination of acetone, Spectro photometrically

B) **pH Metry**

4. Determination of Dissociation constant of a weak acid using Henderson's equation
5. Determination of Dissociation constant of a tribasic acid.

C) **Conductometry**

6. Determination of equivalent conductivity at infinite dilution and dissociation constant of acetic acid
7. Determination of ΔG, ΔH, and ΔS of silver benzoate.

D) **Potentiometry**

8. Determination of the Dissociation constant of monobasic or dibasic acid by potentiometric titration with sodium hydroxide.
9. Determination of concentrations of strong and weak acid present in the mixture with strong base.
10. Determination of Degree of Hydrolysis and Hydrolysis constant of Aniline hydrochloride.

E) **Chemical Kinetics**

11. Study the kinetics of Iodination of Acetone.
12. Investigate the influence of ionic strength on the rate constant of reaction between

potassium persulphate and potassium iodide. (Bronsted primary salt effect)

13. Determination of the temperature coefficient and energy of activation of acid catalyzed ester hydrolysis

F) **Partial Molar Quantities**

14. Determination of the partial molar volume of urea or sodium chloride and ethanol in aqueous solution from density measurements.

G)

15. Determination of Radius of Glycerol molecule by Viscosity measurements.

H) **Adsorption**

16. Investigate the adsorption of Oxalic or Acetic acid on activated charcoal and test the validity of Freundlich and Langmuir isotherms.

17. Study the adsorption of certain dyes (Methyl violet or Malachite Green) on activated charcoal.

References

1. Experiments in Chemistry, D.V. Jahagirdar, Himalaya Publishing House.
2. Practical Physical Chemistry, S.W. Rajbhoj, T.K. Chondhekar, Anjali Publications.
3. Systematic Experimental Physical Chemistry, S.W. Rajbhoj, T.K. Chondhekar, Anjali Publications.
4. Experimental Physical Chemistry, V.D. Athawale, Parul Mathur, New Age International.
5. Advanced Practicals in physical Chemistry, Datar, Doke, Bhadane, Pande, Manali Prakashan.
6. Senior Practical Physical Chemistry, B.D. Khosala, V.C.Garg. Adarsh Gulati, S. Chand & Co.
7. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing House.
8. Physical Chemistry Practical, S.K. Maity, N.K. Ghosh, New Central Book Agency.
9. Experiments in Physical Chemistry, Shoemarker and Garland, McGraw Hill.
10. Experiments in Physical Chemistry, R.C. Das and B. Behara, Tata McGraw Hill.
11. Experiments in Physical Chemistry, G.P. Mathews, Oxford University Press.
12. Findley's Practical Physical Chemistry, B.P. Levitt, Longman Group Ltd.,
13. Practical physical chemistry, A.M. James and F.E.Princhard, Longman.

14. General Chemistry Experiments, Anil J. Elias, University Press.

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-I
(NEP-2023 COURSE)
DSECH-107: RESEACH METHODOLOGY

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

After completing this course, student is expected to learn the following:

CO 1: Understand the basic concepts of Research.

CO 2: Understand the importance of literature review and define research problem.

CO 3: Understand the research design and its need

CO 4: Analyze the data using statistical tools

CO 5: Test the hypothesis and draw the inferences.

CO 6: Develop the process of scientific documentation

Course Contents:

1. **Basic concepts of Research**

   Research-definition, objective. Motivation, Types of Significance of research, Research methods vs methodology, Research process, Criteria for good research.

2 **Literature Review**

   Introduction of Resources or search engines available for searching literature in related area, critical review of available literature and its consolidation, finding research gaps and thrust areas, introduction of h-index, and i-index, Impact factor etc.

3. **Defining a research problem**

   Defining the research problem, Necessity and technique of defining a research problem

4. **Design of research**

   Defining research design. Need of research design, Important features of good research design, Important concept related to research design, basic principles of experimental design.

5. **Methods of data collection**

   primary and secondary data. Different methods for data collection.

6. **Analysis and interpretation of data**

   Statistical methods for data analysis- Measure of central tendency, measures of

dispersion, skewness and kurtosis, correlation and regression analysis, association of attributes and other measures.

7. **Hypothesis Testing**

   Defining hypothesis, Test of hypothesis, Important parametric test, Hypothesis testing of mean, Chi – square test as a non-parametric test

8. **Report writing**

   Pre writing considerations, Thesis writing, Formats of report writing, Formats of publications in Research journals, plagiarism, research ethics.

9. **Introduction to Intellectual Property Rights**

   Nature of intellectual property, patents, designs, trademarks and copyright, process of patenting and development, technological research, innovation, patenting, development.

References

1. Kothari C.R., Research Methodology- methods and Techniques, New Wiley Eastern Ltd., Delhi.
2. Panneselvam, R., Research Methodology Prentice Hall of India, New Delhi.
3. Fisher, Hafner, Design of Experiments.
4. Ranjit Kumar., Research Methodology.
5. Day Robert A., How to write and publish a scientific paper.
6. GibaldiJoseph:, MLA Handbook for writers of Research papers.
7. MOOC: online courses for self-learning.

SEMESTER-II

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-II
(NEP-2023 COURSE)

DSCCH-201: INORGANIC CHEMISTRY - II

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

After completing this course, student is expected to learn the following:

CO 1 : Learn bonding in transition metal complexes, Valence bond theory, Crystal field theory, Molecular orbital theory

CO 2 : Study of structural trends, mononuclear oxocomplexes, polyoxometallates, intermediate oxidation states, metal-metal bonded compounds

CO 3 : Understand reaction mechanisms of d-metal complexes, Ligand substitution reactions. classification & theory of redox reactions, photochemical reactions

CO 4 : Study of structure, properties, reactions and synthesis of d-block carbonyls, Reactivity of d- and f-block organometallic compounds

CO 5 : Introduction, methods of separation and applications of Lanthanides, Actinides

CO 6 : Make aware of energy sources for life, metalloporphyrins, photosynthesis and Respiration, metalloenzymes, Nitrogen fixation basics of bioinorganic chemistry

Course Content:

1. Coordination Chemistry :

Introduction, Bonding in transition metal complexes, Valence bond theory, Crystal field theory, Molecular orbital theory. Detection of complex ion in solution,Electronic spectra and magnetic properties of transition metal compounds.

2. Chemistry of Transition elements:

Introduction, occurrence & recovery, High oxidation states, structural trends, mononuclear oxocomplexes, polyoxometallates, intermediate oxidation states, metal-metal bonded compounds, noble character.

3. Reaction mechanisms of d-metal complexes:

Introduction, Ligand substitution reactions, classification of mechanisms. The substitution of square-planar complexes, substitution of octahedral complexes, Rate law and their interpretation, Activation of octahedral complexes, stereochemistry, Isomerization reactions, Redox reactions, classification & theory of redox reactions, photochemical reactions, d-d and charge-transfer reactions, Transitions in metal-metal bonded systems.

4. Organometallic compounds:

Organometallic Compounds of Li, Mg, Si, Pb, As, with Classification, Nomenclature, Synthesis, Structure Properties and Uses,

d-block carbonyls Bonding, valence electron count, , synthesis of carbonyls, structure, properties and reactions, Derivatives, Metal Nitrosyls, complexes, homogeneous catalysis Hydroformylation, Monsanto acetic acid process, Wacker Process, Hydrognation by Willkinsons catalyst

5. f-block elements:

Lanthaindes: Introduction, methods of separation of Lanthanides, Lanthanide contraction, applications of Lanthanides.

Actindes: Introduction, methods of preparation and separation of actinides, applications of actinides.

Transactinide elements: Introduction, applications of transactinide elements.

6. Basics of Bioinorganic Chemistry:

Introduction, Essential trace elements in biological systems, Biochemistry of Iron

and other transition metals, Metalloenzymes, Metalloporphyrins, Photosynthesis and Respiration, Nitrogen fixation, , Biochemistry of non-metals.

References

1. Concise Inorganic chemistry, J.D.Lee, 5th Edition, ELBS (1986).
2. Inorganic Chemistry: A.G.Sharpe, ELBS Edition (1984).
3. Inorganic Chemistry: D.F.Shriver, P.W.Atkins, 3rd Edition, Oxford University press (1999).
4. Inorganic Chemistry - Principles of structure and reactivity: J.E.Huheey, 3rd Edition (1983).
5. Organometallics by Christoph Elschenbroich
6. Organometallics by A Concise Introduction by Christoph Elschenbroich and Albrecht Salzer
7. Basic Organometallic Chemistry by B. D. Gupta and A. J. Elias
8. Inorganic Chemistry: D.F. Shriver, P.W.Atkins, C.H.Langford, ELBS, Oxford University press (1991).
9. Structural Inorganic Chemistry: A.F. Wells, 5th Edition (1984)
10. Principle of Bioinorganic Chemistry by S.J. Lippard and J. M. Berg
11. Bioinorganic Chemistry: Inorganic Elements in Chemistry of Life by W.Kaim and B. Schwederski

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-I
(NEP-2023 COURSE)
DSCCH-202: ORGANIC CHEMISTRY - II

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

After completing this course, student is expected to learn the following:

CO 1 : Learn Oxidation and reduction of organic compounds using variety of reagents

CO 2 : Understand Mechanism & Applications of different name reactions of Perkin, Michael, Mannich, Stobbe condensation etc
CO 3 : Determine and study of preparation of stabilized and destabilized 'P' and 'S' ylids. Their Reactions, applications
CO 4 : Study of organometallics of Mg, Li, Zn and Ti with applications
CO 5 : Study and solve problems of Ultraviolet and Visible spectroscopy of organic molecules
CO 6 : Understand Infrared spectroscopy and its applications to structural problems.
CO 7 : Important terms and theory of Nuclear Magnetic Resonance spectroscopy. Its applications to structural problems.
CO 8 : Principle, working of Mass spectrometer, formation of different ions, McLafferty rearrangement, fragmentation of alkanes, alkyl aromatics, alcohols, ketones and applications
CO 9 : Problems solved based on UV,IR, NMR & MS Spectroscopy to interpret structure.

1. Oxidation – Reduction

Oxidation:-

(A) Olefin:- Alkaline KM_nO_4, OsO_4, Peracid, H_2O_2 and NaOH
(B) Alcohol:- Jone's reagent, Collin's reagent, MnO_2 and Oppenauer oxidation.
(C) Glycol – LTA.
(D) Ketone:- Baeyer – Villiger oxidation and SeO_2.

Reduction:-

$LiAlH_4$, $NaBH_4$, Clemmenson's reduction, Wolf Kishner reduction, Birch, Lindlar and MPV.

2. Name Reactions

Mechanism & Applications of –:
Perkin, Michael, Mannich, Stobbe condensation, Dieckmann Condensation, Vilsmayer, Dakin & Gatteamann – Koch.

3. Phosphorous , Nitrogen & sulfur ylids

Preparation of stabilized and destabilized 'P','N' and 'S' ylids. Reactions, applications, stereochemistry and Emmons modification.

4. Organometallics

Mg, Li, Zn and Tl with applications.

5. Ultraviolet and Visible spectroscopy (UV-VIS)

Introduction, Beer Lamberts law, instrumentation, Calculation for absorption maxima of dienes, enones and aromatic ketones. Applications of UV

6. Infrared spectroscopy (IR)

Introduction, instrumentation, Sampling technique selection rule, types of bonds,absorption of common functional groups, Factors affecting on IR group frequencies. Application to structural problems.

7. Nuclear Magnetic Resonance spectroscopy (NMR)

Magnetic & non-magnetic nuclei, Larmor frequency, absorption of radio frequency, sample preparation, chemical shift, anisotropic effects, spin–spin coupling, coupling constants, applications to structural problems.

8. Mass spectroscopy (MS)

Principle, working of Mass spectrometer, formation of different ions, Mclafferty rearrangement, fragmentation of alkanes, alkyl aromatics, alcohols, ketones and applications.

9. Problems based on UV,IR, NMR & MS Spectroscopy

Simple structural problems based on IR, UV, NMR and MS.

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References

1. Advanced organic chemistry by Jerry March, 4th edition, Mc Graw – Hill, 1988.
2. Advanced organic chemistry (Part-A) by F.A.Carey and R.J. Sundberg, 3rd edition, plenum press, New York and London, 1990.
3. Modern synthetic reactions by H.O. House, 2nd edition, Benjamin / Cummings Publishing Company, 1976.
4. Spectroscopic methods in organic chemistry by Williams & Fleming, Tata – McGraw Hill, 4th edition, 1988.
5. Spectroscopy of organic Compounds by P.S.Kalsi, New Age International, 2nd edition, 1995

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-II
(NEP-2023 COURSE)
DSCCH-203: INORGANIC CHEMISTRY PRACTICAL - II

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

At the end of course student will be able to –

CO 1 : Use classical analytical techniques and its applications for estimation of elements from given sample
CO 2 : Use Volumetric methods of analysis and its applications for estimation of elements from given sample of Ores
CO 3 : Use Volumetric methods of analysis and its applications for estimation of elements from given sample of Alloys
CO 4 : Use Gravimetric methods of analysis and its applications for estimation of elements from given sample of Ores
CO 5: Use Gravimetric methods of analysis and its applications for estimation of elements from given sample of Alloys
CO 6 : Prepare Coordination compounds and its purification

Course Content:

Synthesis and Determination of Isomerism in Metal complexes

1 Synthesis of Cis potassium di aquodioxaloto chromate(III) dihydrate
2 Synthesis of Trans potassium di aquodioxaloto chromate(III) dihydrate

Synthesis and Purity determination of Metal Complexes

3 Synthesis of Nitritoopenta –aminocobalt(III) chloride
4 Determination of Purity of Nitritoopenta –aminocobalt(III) chloride

Ore and Alloy analysis

1. Determination of of Iron from Stainless steel
2. Determination of of Chromium from Stainless steel

Synthesis of solid state materials / nano-materials (Any Two)

1 Synthesis of ZnO, TiO_2, Fe_2O_3 nanoparticles powder XRD, SEM, TEM (at least one spectral analysis should be done) Ref 2,6
2 Synthesis of Fe2O3 nanoparticles sol-gel/coprecipitation/hydrothermal (any one method)
3 Synthesis of Colloidal silver nanoparticles and determine band gap by absorption spectroscopy Ref 2,6
4 Synthesis of ZnO from zinc oxalate - precursor method and determine band gap by absorption spectroscopy Ref 2,6

Conductometry (Any Two)

1 To verify the Debye Huckel theory of ionic conductance for strong electrolytes KCl, $BaCl_2$, K_2SO_4 and $[K_3Fe(CN)_6]$ (Ref-3)
2 Structural determination of metal complexes by conductometric measurement. (Ref-3)
3 Determination of Pb(II) in solution with Na_2SO_4 solution and determination of solubility product of $PbSO_4$ (Ref-4)

Colorometry (Any Two)

1 Simultaneous determination of Chromium and Manganese ($K_2Cr_2O_7$+ $KMnO_4$)
2 Determination of the composition of the complex formed between Fe(III) and Sulphpsalicylic acid by Job's continuous variation method and thereafter to find the stability constant of the complex
3 Determination of Fe3+ by solvent extraction using 8-hydroxy quinolone(Oxine)

Thermochemistry

1 Determination of heat of dissolution and hence lattice energy of the salts NaCl, KCl, $CaCl_2$
2 Determination of heat of neutralization of strong base(NaOH) and strong acides (HCl and H_2SO_4) and also strong base(NaOH) and weak acid (CH_3COOH) and thereby find the heat of ionization of weak acid(CH_3COOH)

Miscellaneous: (Any One)

1 Solution state preparation of $[Ni(en)_3]S_2O_3$, $[Ni(H_2O)_6]Cl_2$, $[Ni(NH_3)_6]Cl_2$. Record absorption spectra in solution of all three complexes and calculate 10 Dq. Arrange three ligands according to their increasing strength depending on your observations. (Ref. -5)
2 Kinetics of substitution reaction of $[Fe(Phen)_3]^{2+}$ (Ref-3)
3 Kinetics of formation of Cr(III)-EDTA complex (Ref-3)

References:

1. Vogel's Textbook of Inorganic quantitative analysis, Svehla and Shivshankar.7th Edition, Pearson, 2012.

2. . Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horwood publishing, Chichester) 1999.
3. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House

4. General Chemistry Experiments, Anil. J Elias, University Press (2002)

5. Practical physical Chemistry, B. Vishwanathan and P. S. Raghwan, Viva Books
6. Nanotechnology by S. K. Kulkarni
7. General Chemistry Experiments, Anil. J Elias, University Press (2002)

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-II
(NEP-2023 COURSE)
DSCCH-204: ORGANIC CHEMISTRY PRACTICAL-II

Total Credits: 02 **Total Hours: 60**
Course Learning Outcomes:

After completing this course, student is expected to learn the following:

CO 1 : Learn and understand separation of Binary mixtures using Ether.

CO 2 : Analyze the preparation process such as nitration, oxidation and reduction, esterification, and chalcone formation

CO 3 : Preparation of organic compounds and derivatives, their purifications and run TLC

CO 4 : Judge the reaction mechanism and synthesis process.

CO 5 : Determination of physical constant: Melting point, Boiling point.

CO 6 : Learn and understand different separation techniques.

Course contents:

1. **Binary mixtures (Ether separation only) (Any Eight).**

Separation & characterization of two Components.

Solid –Solid, Solid – Liquid, Liquid – Liquid (non-volatile)

2. **Prepare the following (Any Seven)**

1. [4+2] cycloaddition reaction in aqueous medium at room temperature

2. Ultrasound-assisted synthesis of 7-hydroxy-4-methylcoumarin

3. Eco-friendly nitration of phenols and its derivatives using Calcium nitrate

4. Bromination of acetanilide using ceric ammonium nitrate in aqueous medium

5. Green approach for preparation of benzopinacolone from bezopinacol using iodine catalyst

6. Solvent free aldol condensation

7. solation of Trimyristin from nutmeg

8. Microwave-assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid and Decarboxylation reaction (any one)

9. Green Synthesis of the following compounds: adipic acid, catechol (any one)

References

1. A text-book of practical organic chemistry by A.I.Vogel,4th edition, ELBS / Longman.

2. A hand book of quantitative and qualitative analysis by H.T.Clarke, Orient

Longman.

3. Practical organic chemistry by Mann and Saunders.

4. Practical organic chemistry by O.P.Agarwal.

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-II
(NEP-2023 COURSE)
DSCCH-205A: PHYSICAL CHEMISTRY - II

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

After completing this course, student is expected to learn the following:

CO 1: Basic understanding of molecular spectroscopy.

CO 2: Applications of Spectroscopy, radioanalytical techniques in chemistry and interdisciplinary fields.

CO 4: Summarize different molecular spectroscopic concepts and rules to determine the molecular structure.

CO 5: Use of advanced and recent techniques in molecula spectroscopy.

CO 6: Acquire skill in solving numerical problems.

CO 7: Physical and chemical principles that involved under each spectroscopic technique.

Review and corelate the concepts involved in different spectroscopic techniques

Course contents:

1. Microwave (Rotational) Spectroscopy

Basics of molecular spectroscopy- Electromagnetic radiation and its region, representation of spectra, signal to noise ratio, resolving power, width and intensity of spectral lines. Rotation of molecules, classification of molecules based on their moments of inertia, Rotational spectra of Rigid diatomic molecule, effect of isotopic substitution, Rotational Spectra of Non-rigid diatomic molecule, Linear Polyatomic molecular, symmetric and asymmetric top molecules, Applications of microwave spectroscopy.

2. Infra-Red (Vibrational and Rotational) Spectroscopy

Vibration in diatomic molecule, simple Harmonic Oscillator, Anharmonic Oscillator, Diatomic Vibrating Rotator, Vibration- Rotation Spectrum of Carbon Monoxide, Breakdown of the Born-Oppenheimer Approximation, Fundamental Vibrations and their Symmetry, Overtone and Combination frequencies, Linear Molecules, Applications of Infra-Red spectroscopy.

3. Raman Spectroscopy:

Introduction- Scattering of light and Raman Spectrum, Rayleigh Scattering and Raman effect: Quantum Theory of Raman effect, classical theory of the Raman effect: Molecular Polarizability, Pure Rotational Raman Spectra- Linear molecules, symmetric top molecules, Asymmetric top molecules, rule of mutual exclusion, Overtone and combination vibrations, Vibrational Raman Spectra, Rotational Fine Structure, Polarization of Light and the Raman effect, Application of Raman and Infra-Red spectroscopy in structure determination.

4. Electronic spectroscopy of Molecules

Electronic spectra of Diatomic Molecule- Born-Oppenheimer Approximation, Vibration coarse structure, Franck-Condon Principle, Dissociation Energy and Dissociation Products, Rotational Fine Structure of Electronic- Vibration Transitions, Fortrat Diagram, Predissociation.

5. Electron Spin Resonance Spectroscopy (ESR)

Introduction: Electron Spin, Interaction with magnetic field, The 'g' factor, fine structure and hyperfine structure, double resonance in ESR, techniques of ESR Spectroscopy, Analytical applications of ESR.

6. Mossbauer Spectroscopy

Basic principles, Doppler effect, chemical shift, recording of spectrum, applications, quadrupole effect, effect of magnetic field.

7. **Radioactivity:**

(**A)** Radioactive elements, types of radioactive decay, decay kinetics, units of radioactivity, measurement of radioactivity- G.M. counter and Scintillation counters.

(B) Elements of Radiation chemistry :Radiation chemistry- absorption of nuclear radiation, interaction of radiation with matter, passage of neutrons through matter, Interaction of Gamma radiation with matter- photoelectric effect, Compton scattering, units for measuring absorption of radiation- Absorption coefficients.

i **Radiation Dosimetry**- measurement of radiation dose, units for expressing the radiation dose inthe form of amount of radiation energy absorbed by unit mass of substance, chemical Dosimeter- Fricke dosimeter and Ceric sulphatic dosimeter.

ii **Radiolysis of Water-** Primary radiolytic products and final products yield of the final products (G value) and LET value (Linear energy transfer) of the substance for the given radiation, effect of LET on molecular yields, chain reactions. Hydrated electron- formation, detection by Hart and Boag's pulse radiolysis experiment, structure and properties of hydrated electron, Distribution of primary radiolytic products of water- explained by

i) Samuel and Magee model and

ii) Lea-Gray-platzman model.

Scavenging of free radicals:

8. Applications of Radioisotopes

Use of radioisotopes as trarcers, typical applications of radioisotopes as tracers-

1. Isotope dilution analysis (IDA)
2. Neutron activation analysis (NAA)
3. Radiometric titrations
4. Reaction mechanisms and structure determination.
5. Determination of solubility, surface area, rates of diffusion.

References

1. Fundamentals of Molecular spectroscopy C.N. Banewell, Tata McGraw Hill.

2. Instrumental Approach to chemical Analysis A.K. Srivastava, P.C.Jain, S.Chand & Co. Delhi.

3. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, CBS College Publishing.

4. Instrumental Analysis, D.A. Skoog, F.James Hollier, S.R.

5. Introduction of Instrumental Analysis, R.D. Brown, Mc Graw Hill.

6. Instrumental Methods of Analysis, H.H. Willard, L.L. Meritt, J.A. Dean, Affiliated East-West Press.

7. Introduction to Instrumental Analysis R.D. Braun, Poharmamed Press, Indian Reprint.

8. Analytical Chemistry, G.D. Christian, P.K. Dasguta, K.A. Schug, Wiley.

9. Basic concepts of Analytical Chemistry, S.M. Khopkar, New Age International.

10 Instrumental Methods of Chemical Analysis, G.R. Chatwal, S.K. Anand, Himalaya Publishing House

11. Instrumental methods of Chemical Analysis, H.K. Kaur, pagati Edition.

12 Molecular and Laser Spectroscopy advances and Applications, V.P. Gupta, Elsevier.

13. Commercial Methods of Analysis, F.D. Snett, F.M.Biffen, Tata McGraw Hill Book Company.

14. Modern Analytical Chemistry, David Harvey.

15. Principles of Analytical Chemistry, M. Valcarcel, Springer.

16. Analytical Chemistry, Principles and Techniques, Larry Harg's.

17. Essentials of Nuclear Chemistry, H.J. Arnikar, Wiley Eastern Ltd.

18. Nuclear and Radio Chemistry, G. Fried lander, J.M. Kennedy, J.M. Miller, John Wiley.

19. 1. Chemical Applications of radioisotopes, H.J.M. Brown Buffer and Jammer Ltd.,

20. Nuclear Chemistry and its Applications, M. Haissinsky, Addison Wesley Publication Co.

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-II
(NEP-2023 COURSE)

DSCCH-205B: Applied Analytical Chemistry

Total Credits: 04 **Total Lectures: 60Hrs**

Course Learning Outcomes:

After completing this course, student is expected to learn the following:

CO 1: Basic understanding of concepts of analytical chemistry.
CO 2: Skills for analyzing, and developing new sustainable methods.
CO 3: Development of alternate analytical methods.
CO 4: Skills for developing industrially important analytical methods.
CO 5: Explain the methods of purification.
CO 6: Select the proper analytical method that is based on the particular physical property measured.
CO 7: Use of advanced and recent techniques in analytical chemistry.
CO 8: Understand the errors in measurements and results in chemical analysis.

Course Contents:

1. **Purification Techniques:**
   Purification of Solid: a) Crystallization: Simple crystallization, Fractional crystallization,
   b) Sublimation,
   Purification of Liquid: Distillation, Fractional Distillation, Steam Distillation, Distillation under reduced pressure
2. **Calibration:**
   Calibration of instrument: Definition, types of calibration, importance and advantages, calibration curve, standard addition, working curve (standard calibration) internal standard methods.
   Calibration of Glass waves- Analytical standards, primary and secondary standards, analytical balances and their use, techniques of weighing and errors.
3. **Errors, Measurements and Results:**
   Definition of errors, types and sources of errors, errors in measurement, absolute and relative errors, accuracy and precision, statistical treatment of data (average, deviation, probability, normal distribution curve (Gaussian curve)
4. **Ultraviolet spectroscopy:**
   Introduction, origin and theory of Ultraviolet spectra, types of transitions in Inorganic molecules, types of transitions in Organic Molecules, shape of UV absorption curves, transition probability, chromophore and related terms, effect of conjugation, effect of solvents, choice of solvent, calculating absorption Maxima, Instrumentation- components and their functions, applications of spectroscopy to organic compounds, general applications of UV Absorption Spectroscopy.
5. **X-ray diffraction techniques:**
   Introduction, General theory, interaction of X-ray with matter, production of X-rays, detection of X-rays, X-ray diffraction- theory, diffraction of X-rays by crystals, determination of crystal structure (powder as well as single crystals), instrumentation, determination of lattice parameters, X-ray intensity calculations, applications of X-rays.
6. **Potentiometry:**

Introduction, electrochemical cells, fundamentals of potentiometry, instrumentation, electrode system in potentiometry, direct potentiometric measurements, potentiometric titrations, methods of end point location, types of potentiometric titrations, advantages of potentiometric titrations.

References:

1. Elements of x-ray diffraction, B.D. Culity, Addison- weily.
2. Diffraction methods, Wormald, Oxford University Press.
3. Basic concepts of Analytical chemistry, S.M. Khopkar, New Age International.
4. Fundamentals of Analytical chemistry, D.A. Skoog, D.M. West, Cengage Learning.
5. Crystal structure Analysis, M.J. Berger.
6. Instrumental Methods of Analysis, Willard, Merit, Dean.
7. Analytical Chemistry, J.G.Dick.
8. Modern Methods of Chemical Analysis, R.L. Peacock, L.D. Shield.
9. Quantitative Analytical Chemistry, J. Fritz, G.H.Schenk, Allyn and Bacon Inc.
10. Principles of Instrumental Analysis, D.Skoog, D. West, Holl seamlers.
11. Instrumental methods of Chemical Analysis, Pragati Prakashan, Meerut.
12. Instrumental methods of chemical analysis, G. Chatwal, S. Anand, Himalaya Publishing.

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-II
DSCCH-205C INTRODUCTION TO NANOMATERIALS AND NANOTECHNOLOGY

Total Credits; 04 **Total Lecturers: 60 Hrs.**

Course learning outcomes:

After completing this course, student is expected to learn the following: -

At the end of course student will be able to –

CO 1 : Basic understanding of nanomaterials.

CO 2 : Understand the dramatic changes in properties that occur by reducing the size to nano scale.

CO 3 : Characterization of nano materials.

CO 4 : Understand the classification of nano materials in terms of dimensionality.

CO 5 : Preliminary knowledge of nanotubes, nanorods and nanoplates

CO 6 : Exposure of wonder materials such as Graphene and carbon nanotubes.

Course contents:

1. **Nanomaterials**

   Introduction, elementary consequences of small particle size-surface of nanoparticles, classification of nanomaterials- OD, 1D, 2D and 3D nanomaterials, fundamental physicochemical principles- size dependence.

2. **Properties of Nanomaterials:**
   Mechanical structural, optical (Luminescence), Magnetic, electrical, thermal, physical and chemical, catalytic etc.

3. **Synthesis of Nanomaterial:**
   Top-down and bottom-up approach of synthesis of nanomaterials- Sol-Gel, Colloidal precipitation, co-precipitation, hydrothermal, vapour deposition, sonochemical method, microwave synthesis, nanolithography, thermal decomposition, Laser beam, Gas-phase synthesis, Langmuir-Blodgett (LB) Method; spin coating, sputtering, self Assembly technique, biological methods.

4. **Types and structure of Nanomaterials-**
   Carbon based, inorganic based (metal and metal oxide), organic based and composite based nanomaterials.

   Types of nanostructures-

   OD (Nanoparticles and quantum dots, nanospheres, nanoclusters).

   1B (Nanorods, nanofibers, nanowires, nanotubes)

   2D (Nanosheets, nanoplates, nano-pores, nanofilms, nanolayers and nano-coatings)

   3D (Nanocomposites, nanocrystals)

   It includes dispersions of nano particles, bundles of nanowires and nanotubes as well as multi-nanolayers (polycrystals) in which OD, 1D and 2D structural elements are in close contact with each other and form interfaces. Introduction and their synthesis and applications.

5. **Characterization/Analytical Techniques:**

   (I) Electron microscopies: Scanning electron microscopy (SEM), Transmission Electron Microscopy (TEM), High Resolution TEM.

   (II) Scanning Probe Microscopies:
   Atomic Force Microscopy (AFM),Scanning Tunnelling Microscopy (STM)

scanning tunnelling electron microcopy) (STEM).

(III) Diffraction techniques: X-ray methods: X-ray diffraction(XRD), X-ray photoelectron spectroscopy (XPS), Energy Dispersive X-ray spectroscopy (EDAX) X-ray fluorescence (XRF).

(IV) Spectroscopic Techniques:
IR spectroscopy forsurface functionalization of nanoparticles, UV-Visible-Diffused reflectance spectroscopy, photoluminescence, Raman Spectroscopy (Basic understanding of each technique with special emphasis on characterization at nano scale)

6. **Applications in Different Fields.**

i) Electronics:

In the manufacturing of very large scale integration (VLSI) of electronic circuits and devices on a single 'Chip' (Semiconductor chip).For making memory storage devices- Non-volatile memory, flash memory devices in computers. For making Quantum computers, which are more powerful than existing computers For manufacturing flat panel displays for television or computer monitors.

ii) Energy and Power:

Energy needs for future mobile devices, basics of battery and power source technology, energy harvesting-storage in portable system:

Solar energy- solar cells- Dye sensitized solar cell.

Solar batteries, solar panels.

iii)Space and defense

a) Developing various types of sensors, NBC protection/detection devices and developing paint with camouflage characteristics.

b) Creation of miniaturized, lighter devices and instruments used for space vehicles.

c) Nanomaterials can make guns lighter, with more ammunition.

d) Creating high strength, low weight composites, improved electronics and displays with low power consumption, large surface area materials and novel filters and membranes for air purification.

iv) Medical field

Drug delivery, fluorescent biological label, bio detection of pathogens, tumor destruction via heating, constructing nano-biomaterials, MRI shielding, Luminescent biomarkers, surface disinfectant.

v) Sensors and Biosensors

To detect very small amounts of chemical vapors (Gas sensors) nanomaterials as biosensors- due to large surface area and high free surface energy, nanoparticles strongly adsorb biomolecules to their surface and play an important role in stabilizing biomolecules at the biosensor surface, ex-glucose nano sensors,

vi) Automobiles

High power rechargeable batteries, sensors, thermoelectric materials, tyres

manufacturing.

vii) Catalysts and Adsorbents

Catalytic aspect of nanocrystals, metal.Nanomaterials as catalyst: because of high surface area to volume ratio, helps the catalyst at the nanoscale to interact better with the reactants due to the availability of a large number of atoms on the surface.

viii) Composite material

Nanoscale additives in polymer composite materials used to make cars, airplanes and spacecraft, space vehicles.

ix) Smart fabrics-

Garments (textile industries)

x) Industrial waste water treatment.

xi) Construction materials

xii) Agriculture

Nano formulations of agrochemicals for applying pesticides and fertilizers for crop improvement nano sensors-used for detections of deceases and residues of agrochemicals seed coating In food-nano biosensors to detect pathogens in food.

References:

1. Nanotechnology: Principles and practices, S.K.Kulkarni, Capital publishing company.
2. Introduction to nanoscience and nanomaterials, D.C. Agarwal, World scientific.
3. Nanomaterials: An introduction to synthesis, properties and Applications, D. Vollath, Wiley-VCH.
4. Encyclopedia of Nano-technology, Hari Singh Nalwa, American Scientific Publishers.
5. Nanostructured materials: Processing properties and applications, C.C.Kouch, William Andrew Publications, New York.
6. Essential in Nanoscience and Nanotechnology, W. Kumar, S. Kumbhath, Wiley.
7. Fundamentals of Nanotechnology, G.L. Hornyak, J.K.Moore, H.F. Tibbals, J-Dutta, CRC Press.
8. Introduction to Nanotechnology, C.P. Poole, Jones Wiley India.
9. Nanoscale materials in chemistry, K.J. Kalbunde, John Wiley & Sons.
10. Organic and Inorganic – Nanostructures, A. Nabok, Artech House, Boston.
11. Semiconductor for solar cells, H.J. Moller, Artech House, Inc. USA.
12. Environmental Nanotechnology; Applications and Impacts of Nanomaterials, M.R. Wiesner, J.Y. Bottero, McGraw-Hill, new York.
13. Environmental and Human Health Impacts of nano-technology, J-Lead, E-Smith, John-Wiley & Sons.
14. Nanomaterials Handbook, Yury Gogotsi, CRC Press,
15. Nanomaterials and Nanochemistry, C. Brechignac, P.Houdy, M.Lahmani Springer Publication.

16. Introduction to Nanotechnology, C.P. Poole, F.J. Owens, Wiley Interscience, New Jersey, M.Schwartz, Smart materials, CRC Press.
17. Introduction to Nano-scale science and technology, M.Di.Ventra, S.Evoy, J.R. Heflin, Jr.Publisher, Springers.
18. Nanotechnology for Future mobile devices, Tapanir, M.A.Unsitulo, Cambridge University Press.

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-II
DSCCH-206 PHYSICAL CHEMISTRY PRACTICAL -II

Total Credits; 04 **Total Lecturers: 60 Hrs.**

Course learning outcomes:

After completing this course, student is expected to learn the following:

CO 1: Basic understanding of practical physical chemistry.
CO 2: Use of viscosity, adsorption, solubility in daily life.
CO 3: Skills for analyzing and developing new sustainable methods.

CO 4: Skills for developing industrially important practical methods.
CO 5: Development of alternate analytical methods
CO 6: Use of advanced and recent techniques in experimental chemistry

Course contents:

A Colorimetry and Spectrophotometry

1. Verification of the Beer-Lambert's Law and determination of unknown concentration of solution.
2. Determination of specific rate constant for the oxidation of ethanol by Potassium dichromate.
3. Simultaneous determination of cations from their binary mixture (Co^{2+} and Ni^{2}+ or Cr^{6+} and Mn^{7+})

B pH Metry

4. Determination of the acidic and basic dissociation constants of an amino acid and hence the isoelectric point of the acid.
5. Determine pH valves of various mixtures of Sodium acetate and acetic acid in aqueous solutions and hence find out the dissociation constant of the acid.

C Conductometry

6. Study the hydrolysis of ammonium chloride or sodium acetate conductometrically
7. Verification of Ostwald's dilution law and determine the dissociation constant of weak acid.
8. Determination of hydrolysis constant of Aniline Hydrochloride.

D Potentiometry

9. Determination of solubility and solubility product of a sparingly soluble salt.
10. Determination of amount of chloride, bromide and iodide present in the mixture.
11. Determination of the concentration of a Reducing or an oxidizing agent by redox titration.

E Chemical Kinetics

12. Study the kinetics of oxidation of ethanol by Potassium dichromate.
13. Investigate the rate constant of an autocatalytic reaction between potassium permanganate and oxalic acid.

14 Determination of individual order of reaction of iodide and persulphate ion and overall order of Oxidation reaction of iodide ion by persulphate ion.

F Thermochemistry

15. Determination of the heat of neutralization of sulphuric acid using Dewar's Vacuum Flak as the calorimeter.
16. Determination of the heat of ionization of a weak base i.e. NH_4OH using Dewar's Vacuum Flask as the calorimeter.

G Thermodynamics:

17. Determination of latent heat of fusion of naphthalene in Benzene or Toluene.

References:

1 Experiments in Chemistry, D.V. Jahagirdar, Himalaya Publishing House.

2 Practical Physical Chemistry, S.W. Rajbhoj, T.K. Chondhekar, Anjali Publications.

3 Systematic Experimental Physical Chemistry, S.W. Rajbhoj, T.K. Chondhekar, Anjali Publications.

4 Experimental Physical Chemistry, V.D. Athawale, Parul Mathur, New Age International.

5 Advanced Practicals in physical Chemistry, Datar, Doke, Bhadane, Pande, Manali Prakashan.

6 Senior Practical Physical Chemistry, B.D. Khosala, V.C.Garg. Adarsh Gulati, S. Chand & Co.

7 Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing House.

8 Physical Chemistry Practical, S.K. Maity, N.K. Ghosh, New Central Book Agency.

9 Experiments in Physical Chemistry, Shoemarker and Garland, McGraw Hill.

10 Experiments in Physical Chemistry, R.C. Das and B. Behara, Tata McGraw Hill.

11 Experiments in Physical Chemistry, G.P. Mathews, Oxford University Press.

12 Findley's Practical Physical Chemistry, B.P. Levitt, Longman Group Ltd.,

13 Practical physical chemistry, A.M. James and F.E.Princhard, Longman.

14 General Chemistry Experiments, Anil J. Elias, University Press.

M.Sc.I (ANALYTICAL / ORGANIC CHEMISTRY)
SEMESTER-II
(NEP-2023 COURSE)
OJT/FP/INS-207: ON JOB TRAINING /FIELD PROJECT/INTERNSHIP

Total Credits; 04 **Total Lecturers: 60 Hrs.**

Course learning outcomes:

After competing this course, student is expected to learn the following:

CO 1 : Acquire practical skills and first hand experience about the industry.

CO 2 : Bridge the gap between the theoretical knowledge obtained and practical working in the industry.

CO 3 : Identify, formulate and design the problem and find the solution based on theoretical and practical knowledge.

CO 4 : Become a technologist with good knowledge, management, leadership and entrepreneurship skills.

Course content:

Students shall undertake On-Job Training or Field Project or Internship in an Institute or Industry or Laboratory relevant to the Chemistry after completion of the first semester of the first year. Each student will have a mentor who will monitor the activity of a student during OJT/Field Project/Internship. The student is expected to learn the day-to-day activities, processes etc. in the OJT/Field Project/Internship.

The report is to be prepared in the consultation with the mentors from the department and industry both, for evaluation at the end of the second semester. They are required to submit a neatly typed and bound report and a soft copy to the department. The department shall arrange for a presentation session of 15min.

Each for all the students to share their experience during the OJT/Field Project/Internship. The spiral bound report should include information about the industry, work process, products etc. and also specific information of the work done or experience gained by the student in the industry.

For the purpose of term end examination, a hard bound report must be duly signed by both the mentors, HoD and Principal. The students are required to attach an original certificate, mentioning the successful completion of training, issued by the competent authority from the industry where he/she has undergone training.

Assessment shall be done jointly by the internal and external examiner based on the knowledge/skills gained by the student during the OJT/Field Project/Internship and the report.