NEP and Learning Outcome-based Curriculum Framework (LOCF)

For

B.Sc. (Life Science- Chemistry, Botany, Zoology) Programme

Academic Session (w.e.f. 2024-2025)

I & II SEMESTERS

(CHEMISTRY, AEC, VAC)

INSTITUTE OF BASIC SCIENCES

MAHARAJA SURAJMAL BRIJ UNIVERSITY BHARATPUR

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Asstt. Registrar
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Dr. Nisha Chauhan

Dr. Rakhee Chaudhary

Dr. Anshu Dandi

Scheme of Examination (Chemistry, AEC and VAC)

The examination pattern comprises 20% internal assessment and 80% external assessment.

External Assessment

Theory Papers:

1. Each theory paper in the end-of-semester examination (EoSE) carries 80% marks.

2. The EoSE will be of 3 hours duration.

3. The questions will be designed in alignment with Bloom's Taxonomy.

Part A of the question paper shall contain 10 very short answer type questions covering the entire syllabus. Each question carries equal marks.

Part B of the question paper shall contain 04 descriptive type questions one from each unit with internal choice. Each question carries equal marks.

Value-Added Papers

1. Each theory paper in the end-of-semester examination (EoSE) carries 80% marks.

2. The EoSE will be of 2 hours duration.

3. Question paper shall contain 40 multiple choice questions covering the entire syllabus. Each question carries 1 mark.

Practical:

Internal: continuous evaluation (20%).

External: end term practical record (20%), written exam (40%) and viva-voce (20%).

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Dr. Rakesh Chaudhary

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SEMESTER-I (Chemistry, AEC and VAC)

Course Title	Course Code	L	T	P	L	T	P	Total Credits	MARKS				
		(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)													
Organic Chemistry-I	UCSC-02	3	0	0	3	0	0	3	15	60	0	0	75
Organic Chemistry-I Lab	UCSC-02L	0	0	2	0	0	1	1	0	0	5	20	25
Elective Course(s)													
Conductance and Electrochemistry	UCGE-01	2	0	0	2	0	0	2	10	40	0	0	50
Statistical Methods and Data Analysis-I	UCGE-02	2	0	0	2	0	0	2	10	40	0	0	50
Ability Enhancement Course(s)													
Environmental Science and Sustainable Development-I	UAEC-01	2	0	0	2	0	0	2	10	40	0	0	50
Value-added Course(s)													
Science and Society	UVAC-01	2	0	0	2	0	0	2	10	40	0	0	50

Note:- Students are required to choose one elective course out of two.

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UCSC-02: ORGANIC CHEMISTRY-1

(Basic Concepts and Aliphatic Hydrocarbons)

Course Outcomes:

On completion of the course, the student will be able to:

- Understand and explain the electronic displacements and reactive intermediates and their applications in basic concepts.
- Formulate the mechanistic route of organic reactions by recalling and correlating the fundamental concepts.
- Identify and comprehend mechanism for free radical substitution, electrophilic addition, nucleophilic substitution and elimination reactions.
- Understand the fundamental concepts of stereochemistry.
- Understand and suitably use the chemistry of hydrocarbons

Unit I: Basic Concepts of Organic Chemistry

Electronic displacements and their applications: inductive, electromeric, resonance and mesomeric effects and hyperconjugation. Dipole moment, acidity and basicity.

Homolytic and heterolytic fissions with suitable examples. Types, shape and relative stability of carbocations, carbanions, carbenes and free radicals.

Electrophiles & nucleophiles, and introduction to types of organic reactions: addition, elimination and substitution reactions.

Unit II: Stereochemistry-I

Stereoisomerism: Optical activity and optical isomerism, asymmetry, chirality, enantiomers, diastereomers. specific rotation; Configuration and projection formulae: Newman, Sawhorse, Fischer and their interconversion. Chirality in molecules with one and two stereocentres; meso configuration. Racemic mixture and their resolution. Relative and absolute configuration: D/L and R/S designations (CIP rules).

Unit III: Stereochemistry-II

Geometrical isomerism: cis-trans, syn-anti and E/Z notations.Conformational Isomerism: Alkanes (Conformations, relative stability and energy diagrams of Ethane, Propane and butane). Relative stability of cycloalkanes (Baeyer strain theory), Cyclohexane conformations with energy diagram. Conformations of monosubstituted cyclohexanes.

Unit IV: Aliphatic Hydrocarbons

Alkanes: Preparation, Halogenation of alkanes, Concept of relative reactivity v/s selectivity.

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Alkenes and Alkynes: Methods of preparation of alkenes using Mechanisms of E_1, E_2, E_1cb reactions, Saytzeff and Hoffmann eliminations. Electrophilic additions, mechanism with suitable examples, (Markownikoff/Anti-markownikoff addition), *syn* and *anti*-addition; addition of H_2, X_2, oxymercuration- demercuration, hydroboration-oxidation, ozonolysis, hydroxylation, Reactions of alkynes; acidity, Alkylation of terminal alkynes, electrophilic addition: hydration to form carbonyl compounds, Relative reactivity of alkenes and alkynes, 1,2-and 1,4-addition reactions in conjugated dienes, Diels Alder reaction (excluding stereochemistry)

References:

1. Morrison, R.N., Boyd, R.N., Bhattacharjee, S.K. (2010), Organic Chemistry, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.

2. Finar, I.L. (2002), Organic Chemistry, Volume 1, 6th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.

3. Eliel. E.L., Wilen, S.H. (1994), Stereochemistry of Organic Compounds; Wiley: London.

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UCSC-02L: ORGANIC CHEMISTRY–I LAB

Course Outcomes:

• Calibrate laboratory thermometers and accurately determine melting and boiling points using standard techniques.

• Apply the concept of mixed melting point and recrystallization for the purification and identification of organic compounds.

• Perform separation and identification of compounds using paper and thin layer chromatography.

• Detect extra elements in organic compounds through systematic laboratory procedures.

List of Practical's

1) Calibration of a thermometer and determination of the melting points of the organic compounds using any one of the following methods-Kjeldahl method, electrically heated melting point apparatus and BODMEL).
2) Concept of melting point and mixed melting point.
3) Concept of recrystallisation using alcohol/water/alcohol-water systems (Any two).
4) Determination of boiling point of liquid compounds (boiling point lower than and more than 100 °C by distillation, capillary method and BODMEL method)
5) Separation of a mixture of two amino acids/sugars by radial/ascending paper chromatography.
6) Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC).
7) Detection of extra elements

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

References

1. Mann, F.G., Saunders, B.C. (2009), Practical Organic Chemistry, 4th Edition, Pearson Education.

2. Ahluwalia, V.K., Dhingra, S. (2004), Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press.

3. Furniss, B.S., Hannaford, A.J., Smith, P.W.G.; Tatchell, A.R (2004), Vogel's Textbook of Practical Organic Chemistry, Pearson.

4. Leonard, J., Lygo, B., Procter, G. (2013) Advanced Practical Organic Chemistry, 3rd Edition, CRC Press.

5. Pasricha, S., Chaudhary, A. (2021), Practical Organic Chemistry: Volume–I, I K International Publishing house Pvt. Ltd, New Delhi.

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UCGE-01: CONDUCTANCE AND ELECTROCHEMISTRY

Course Outcomes:

By the end of the course, the students will be able to:

- Understand factors influencing conductance and ionic mobility.
- Apply conductance measurements to determine physical and chemical properties.
- Explain electrochemical cells, electrode potentials, and EMF.
- Use EMF and potentiometric methods for titrations and pH determination.

Unit I: Fundamentals of Conductance

Quantitative aspects of Faraday's laws of electrolysis. Arrhenius theory of electrolytic dissociation. Conductivity: equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes, Kohlrausch Law of independent migration of ions. Wein Effect and Debye–Falkanhegan Effect.

Unit II: Applications of Conductance

Transference number and its experimental determination using Hittorf and moving boundary methods. Ionic mobility, applications of conductance measurements: determination of degree of ionization of weak electrolytes, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid base).

Unit III: Basics of Electrochemistry

Reversible and irreversible cells with Examples, concept of EMF of a cell, measurement of EMF of a cell, Nernst equation and its importance, types of electrodes, standard electrode potential (reduction Potential) and its application to Gas–ion half-cell. Electrochemical series.

Unit IV: Applications of Electrochemistry

Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference, liquid junction potential; determination of activity coefficients and salt bridge, pH determination using hydrogen electrode. Potentiometric titrations qualitative treatment (acid-base and oxidation-reduction only).

References/Books:

1. Castellan, G.W. (2004), Physical Chemistry, Narosa.

2. Kapoor, K.L. (2015), A Textbook of Physical Chemistry,Vol 1, 6th Edition, McGraw Hill Education.

3. Kapoor, K.L. (2013), A Textbook of Physical Chemistry,Vol 3, 3rd Edition, McGraw Hill Education.

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UCGE-02: STATISTICAL METHODS AND DATA ANALYSIS-I

Course Outcomes:

By the end of the course, the students will be able to:

- Familiar with interpretation and use of analytical data collected by different techniques.
- Significance of different analytical techniques and their applications.
- Reliability and presentation of data for reporting to different forum.

Unit I: Basics of Chemical Analysis

Analytical Chemistry, Qualitative and quantitative analysis, Analytical methodology. Calibration of glass wares, recording laboratory data.

Unit II: Different Methods of Chemical Analysis

Titrimetric method: volumetric titremetry, standard solution, titrimetric curve, calculation;

Gravimetric method: precipitation gravimetry, calculation and applications of gravimetry; and

Spectrometric methods: introduction, principle and instrument, working quantitative aspects absorbance, applications in chemical analysis

Unit III: Accuracy and Precision

Comparison of precision, Errors, Distribution of random errors, propagation of errors, measurement of errors, significant figure, inter laboratory error.

Unit IV: Statistical Method of Chemical Analysis

Methods of least square analysis of variance, Q test, Z test, T test, statistical treatment of finite sample, recommendations for treating outliers. Minimising errors in analytical procedure.

References/Books:

1. Dey, R. A. and Underwood, A. L., Quantitative Analysis, 6th Edition, Pearson.

2. Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R., Fundamental analytical chemistry, Thomson Asia Ltd.

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UAEC-01: ENVIRONMENTAL SCIENCE AND SUSTAINABLE DEVELOPMENT-I

Course Outcomes:

After completing this course, students will be able to:

• Gain in-depth knowledge on natural processes and resources that sustain life and govern economy.

• Understand the consequences of human actions on the web of life, global economy, and quality of human life.

• Develop critical thinking for shaping strategies (scientific, social, economic, administrative, and legal) for environmental protection, conservation of biodiversity, environmental equity, and sustainable development.

• Acquire values and attitudes towards understanding complex environmental- economic-social challenges, and active participation in solving current environmental problems and preventing the future ones.

Unit I

Introduction to Environmental Studies: Multidisciplinary nature of environmental studies; components of environment: atmosphere, hydrosphere, lithosphere, and biosphere; Scope and importance; Concept of sustainability and sustainable development; Brief history of environmentalism.

Unit II

Ecosystems: Definition and concept, Structure of ecosystem (biotic and abiotic components); Functions of Ecosystem: Physical (energy flow), Biological (food chains, food web, ecological succession), and Biogeochemical (nutrient cycling) processes. Concepts of productivity, ecological pyramids and homeostasis, Types of Ecosystems: Tundra, Forest, Grassland, Desert, Aquatic (ponds, streams, lakes, rivers, oceans, estuaries); importance and threats with relevant examples from India, Ecosystem services (Provisioning, Regulating, Cultural, and Supporting); Ecosystem preservation and conservation strategies; Basics of Ecosystem restoration

Unit III

Natural Resources: Land resources- Minerals, soil, agricultural crops, natural forest products, medicinal plants, and forest-based industries and livelihoods; Land cover, land use change, land degradation, soil erosion , and desertification; Causes of deforestation; Impacts of mining and dam building on environment, forests, biodiversity, and tribal communities; Water resources-Natural and man-made sources; Uses of water; Over exploitation of surface and ground water resources; Floods, droughts, and international &interstate conflicts over water; Energy resources-Renewable and non-renewable energy sources; Use of alternate energy

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sources; Growing energy needs; Energy contents of coal, petroleum, natural gas and bio gas; Agro-residues as a biomass energy source.

Unit IV

Case studies: Contemporary Indian issues related to mining, dams, forests, energy, etc (e.g ., National Solar Mission, Cauvery river water conflict, Sardar Sarovar dam, Chipko movement, Appiko movement, Tarun Bharat Sangh, etc)

References/ Books:

1. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y., and Berg , L.R. (2015). Environment, 9th Edition. Wiley Publishing, USA.

2. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

3. Odum, E.P., Odum, H.T., and Andrews, J. (1971). Fundamentals of Ecology. Saunders, Philadelphia, USA.

4. Brusseau, M.L., Pepper, I.L. and Gerba, C.P. (2019). Environmental and Pollution Science, 3rd Edition. Academic Press, USA.

5. Carson, R. (2002). Silent Spring. Houghton Mifflin Harcourt, USA. Pp. 1-264.

6. Gadgil, M. and Guha, R. (1993). This Fissured Land: An Ecological History of India. University of California Press, Berkeley, USA.

7. McCully, P. (1996). Rivers no more: the environmental effects of dams, In: Silenced Rivers: The Ecology and Politics of Large Dams, Zed Books, New York, USA.

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UVAC-01: SCIENCE AND SOCIETY

Course Outcomes:

After successful completion of the course, a student will be able to:

• Understand and apply the principles of scientific thinking and the scientific method to differentiate facts from myths.

• Analyse contributions of ancient science and technology in water management, sustainable construction, and agriculture.

• Evaluate the role of modern science in addressing public health challenges and ensuring food security in society.

• Examine the impact of modern technologies, including IT, renewable energy, and space exploration, on environmental sustainability and governance.

Unit I

Philosophy of science, the scientific method, importance of observation, questions and experimental design, rational thinking, myths vs. Facts.

Unit II

Ancient Science and Technology in Society: Water harvesting structures and Practices; Construction, architecture and design - use of natural environment-friendly designs and materials; Agriculture including domestication of plants and animals.

Unit III

Modern Science in Society: Public Health: Nutrition, Hygiene, Physical and Mental Health, Vaccines and Antibiotics, Anti-microbial resistance; Food Security: Green Revolution, White Revolution.

Unit IV

Modern Technology in Society: IT Revolution, E-Governance; Clean Energy, Renewable Energy; Space Science and Exploration; Evolution, Ecology and Environment.

References/Books:

1. Basu and Khan (2001). Marching Ahead with Science. National Book Trust
2. Gopalakrishnan (2006). Inventors who Revolutionised our Lives. National Book Trust
3. Yash Pal and Rahul Pal (2013) Random Curiosity. National Book Trust
4. Hakob Barseghyan, Nicholas Overgaard, and Gregory Rupik. Introduction to History and Philosophy of Science
5. John Avery {2005). Science and Society, 2nd Edition, H.C. Ørsted Institute, Copenhagen.
6. Dharampal (2000). Indian Science and Technology in the Eighteenth Century, OIP.

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SEMESTER-II (Chemistry, AEC and VAC)

Course Title	Course Code	L	T	P	L	T	P	Total Credits	MARKS				
		(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)													
Organic Chemistry-II	UCSC-05	3	0	0	3	0	0	3	15	60	0	0	75
Organic Chemistry-II Lab	UCSC-05L	0	0	2	0	0	1	1	0	0	5	20	25
Elective Course(s)													
Coordination and Organometallic Compounds	UCGE-03	2	0	0	2	0	0	2	10	40	0	0	50
Statistical Methods and Data Analysis-II	UCGE-04	2	0	0	2	0	0	2	10	40	0	0	50
Ability Enhancement Course(s)													
Environmental Science and Sustainable Development-2	UAEC-02	2	0	0	2	0	0	2	10	40	0	0	50
Value-added Course(s)													
Indian Knowledge System	UVAC-02	2	0	0	2	0	0	2	10	40	0	0	50

Note:- Students are required to choose one elective course out of two.

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UCSC-05: ORGANIC CHEMISTRY –II

(Haloalkanes, Arenes, Haloarenes, Alcohols, Phenols, Ethers and Epoxides)

Course outcomes:

On completion of the course, the student will be able to:

- Explain and use reactions of arenes, haloarenes and some oxygen containing functional groups for practical applications.
- Apply the concept of protection and deprotection in organic synthesis.
- Use the synthetic chemistry learnt in this course to do functional group transformations.
- Propose plausible mechanisms for the reactions under study.

Unit I: Haloalkanes

Alkyl halides: Methods of preparation and properties, nucleophilic substitution reactions – S_N1, S_N2, and S_Ni mechanisms with stereochemical aspects and effect of solvent; Nucleophilic substitution v/s elimination. Organometallic compounds of Mg (Grignard reagent) – Use in synthesis of organic compounds.

Unit II: Aromatic Hydrocarbons

Concept of Aromaticity and anti-aromaticity; Electrophilic aromatic substitution: halogenation, nitration, sulphonation, Friedel Crafts alkylation/acylation with their mechanism. Directing effects of groups in electrophilic substitution.

Unit III: Aryl Halides

Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl, benzyl, vinyl, and aryl halides towards nucleophilic substitution reactions.

Unit IV: Alcohols, Phenols, Ethers & Epoxides

Alcohols: Relative reactivity of 1°, 2°, 3° alcohols, reactions of alcohols with sodium, HX (Lucas test), esterification, oxidation (with PCC, alkaline $KMnO_4$, acidic dichromate, conc. HNO_3). Oppenauer oxidation; Diols: oxidation of diols by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement.

Phenols: Preparation using Cumene hydroperoxide, acidity and factors affecting it, Kolbe's–Schmidt reactions, Riemer-Tiemann reaction, Houben–Hoesch condensation, Schotten–Baumann reaction, Fries and Claisen rearrangements and their mechanism.

Ethers and Epoxides: Acid and base-catalyzed cleavage reactions.

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1. Morrison, R. N., Boyd, R. N., Bhattacharjee, S.K. (2010), Organic Chemistry, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.

2. Finar, I.L. (2002), Organic Chemistry, Volume 1, 6th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.

3. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), Intermediate for Organic Synthesis, I.K. International.

4. Solomons, T.W.G., Fryhle, C.B., Snyder, S.A. (2017), Organic Chemistry, 12th Edition, Wiley.

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UCSC-05L: ORGANIC CHEMISTRY–II LAB

Course Outcomes

• Perform acetylation and benzoylation of amines and phenols using both conventional and green methods, demonstrating an understanding of reaction mechanisms and sustainable practices.

• Execute electrophilic aromatic substitution reactions such as bromination and nitration, using both traditional and green chemistry techniques.

• Carry out classic organic transformations including the haloform reaction and oxidation of alcohols to carboxylic acids, applying fundamental synthetic skills.

• Identify and estimate functional groups in organic compounds through qualitative tests and quantitative analysis methods like acetylation and bromate-bromide titration.

List of Practical's

1. Acetylation of any one of the following compounds: amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and phenols (β-naphthol, salicylic acid) by any one method:

i. Using conventional method ii. Using green approach

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

3. Bromination of acetanilide/aniline/phenol by anyone of the following:

(a) Green method b) Conventional method

4. Nitration of nitrobenzene/chlorobenzene/phenols.

5. Haloform reaction of ethanol.

6. Oxidation of benzyl alcohol to benzoic acid

7. Estimation of the given sample of phenol/amine by:

a) Acetylation b) Bromate-Bromide method

8. Functional group tests for alcohols, phenols, carboxylic acids, phenols, carbonyl compounds, esters.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

References:

1. Mann, F.G., Saunders, B.C. (2009), Practical Organic Chemistry, 4th Edition, Pearson Education.

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2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. (2005), Vogel's Textbook of Practical Organic Chemistry, Pearson.

3. Ahluwalia, V.K., Aggarwal, R. (2004), Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press.

4. Ahluwalia, V.K., Dhingra, S. (2004), Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press.

5. Pasricha, S., Chaudhary, A. (2021), Practical Organic Chemistry: Volume–I, I K International Publishing house Pvt. Ltd, New Delhi

6. Pasricha, S., Chaudhary, A. (2021), Practical Organic Chemistry: Volume–II, I K International Publishing house Pvt. Ltd, New Delhi.

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UCGE-03: COORDINATION AND ORGANOMETALLIC COMPOUNDS

Course Outcomes

By the end of the course, the students will be able to:

- Familiarize with different types of organometallic compounds, their structures and bonding involved.
- Apply 18-electron rule to rationalize the stability of metal carbonyls and related species
- Apply standard rules to name coordination compounds
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes
- Explain the meaning of the terms Δ_o, Δ_t, pairing energy, CFSE, high spin and low spin. Explain how CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy and use it to explain behaviour of organometallics

Unit 1: Coordination Chemistry

Brief discussion with examples of types of ligands, denticity and concept of chelate. IUPAC system of nomenclature of coordination compounds (mononuclear and binuclear) involving simple monodentate and bidentate ligands.

Unit-2 Bonding in Coordination compounds

Valence Bond Theory (VBT): Salient features of theory, concept of inner and outer orbital complexes of Cr, Fe, Co and Ni. Drawbacks of VBT.

Crystal Field Theory: Splitting of d orbitals in octahedral symmetry. Crystal field effects for weak and strong fields. Crystal field stabilization energy (CFSE), concept of pairing energy. Factors affecting the magnitude of Δ_o. Spectrochemical series. Splitting of d orbitals in tetrahedral symmetry. Comparison of CFSE for octahedral and tetrahedral fields, tetragonal distortion of octahedral geometry. Jahn-Teller distortion, square planar coordination.

Unit 3: Organometallic Compounds

Definition and classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structure and bonding of methyl lithium and Zeise's salt. Structure and physical properties of ferrocene.

Unit 4: Metal Carbonyls

18-electron rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. π-acceptor behaviour of carbon monoxide (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

References:

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1. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins Inorganic Chemistry, W. H. Freeman and Company.

2. Miessler, G. L.; Fischer P.J.; Tarr, D.A. (2014), Inorganic Chemistry, Pearson.

3. Huheey, J.E.; Keiter, E.A., Keiter; R.L., Medhi, O.K. (2009), Inorganic Chemistry-Principles of Structure and Reactivity, Pearson Education.

4. Pfennig, B. W. (2015), Principles of Inorganic Chemistry. John Wiley & Sons.

5. Cotton, F.A.; Wilkinson, G. (1999), Advanced Inorganic Chemistry Wiley-VCH.

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UCGE-04: STATISTICAL METHODS AND DATA ANALYSIS-II

Course Outcomes:

By the end of the course, the students will be able to:

- Understand key statistical tools such as confidence intervals and hypothesis testing for analytical data interpretation.
- Apply least square methods and evaluate figures of merit for data calibration and performance evaluation.
- Demonstrate proficiency in sampling techniques, sample handling, and laboratory data management.
- Analyse the role of standards, calibrations, and multivariate techniques in modern analytical methodologies.

Unit I: Statistical Foundations in Analytical Chemistry

Confidence interval, Testing of hypothesis, plotting of data, least square method.

Unit II: Analytical Performance Evaluation and Quality Control

Figures of merit: sensitivity, detection limit, linear dynamic range, control test, upper control limit and lower control limit, Validation, reporting analytical results and significant figures.

Unit III: Sampling Techniques and Sample Handling

Analytical samples, sample size, constituent sample, real samples, sample, sample handling, preparing laboratory samples, automated sample handling, lab on chip.

Unit IV: Laboratory Standards and Calibration Methods

General laboratory principles, recording laboratory data, standards, comparison of standards, internal standard, external standards calibration, least square method, and multivariant calibration.

References/Books:

1. Encyclopaedia of analytical chemistry: Applications, Theory, and Instrumentation, R A Meyor (Eds) Wiley and Sons (2000).

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UAEC-02: ENVIRONMENTAL SCIENCE AND SUSTAINABLE DEVELOPMENT-II

Course Outcomes:

After completing this course, students will be able to:

- Understand the causes and impacts of climate change on human health, biodiversity, and global economy.
- Analyse international environmental agreements and their relevance in addressing climate-related challenges.
- Assess the role of renewable energy sources in promoting sustainable development and environmental conservation.
- Evaluate the importance of environmental justice and movements in shaping national and global policies.

Unit I

Causes of Climate change, Global warming, Ozone layer depletion, and Acid rain; Impacts on human communities, biodiversity, global economy, and agriculture.

International agreements and programmes: Earth Summit, UNFCCC, Montreal and Kyoto protocols, Convention on Biological Diversity (CBD), Ramsar convention, The Chemical Weapons Convention (CWC), UNEP, CITES, etc.

Unit II

Sustainable Development Goals: India's National Action Plan on Climate Change and its major missions.

Human population growth: Impacts on environment, human health, and welfare; Carbon foot-print.

Unit III

Resettlement and rehabilitation of developmental project affected persons and communities; relevant case studies.

Environmental movements: Chipko movement, Appiko movement, Silent valley movement, Bishnois of Rajasthan, Narmada Bachao Andolan, etc.

Unit IV

Environmental justice: National Green Tribunal and its importance.

Renewable Energy Sources: Solar Energy, Wind Energy, Hydropower, Biomass and Bioenergy, Tidal and Wave Energy, Hydrogen and Fuel Cells, Geothermal Energy.

References/ Books:

Dr. Farbat Singh
Asstt. Registrar
Acad.

(Dr. Nisha Chandra) (Dr. Rakhee Chaudhary) (Dr. Anshu Bardia)

1. Divan, S. and Rosencranz, A. Environmental Law and Policy in India: Cases, Material & Statutes.
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. Environment.
3. Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environmental Science and Conservation.

(Dr. Nisha Gaur) (Dr. Rakhee Choudhary) (Dr. Anshu Pandey)

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UVAC-02: INDIAN KNOWLEDGE SYSTEM

Course Outcomes:

After successful completion of the course, a student will be able to:

- Understand the foundational concepts and scope of Indian Knowledge Systems (IKS).
- Examine the historical and cultural evolution of IKS from ancient to modern India.
- Explore the technological and scientific advancements of ancient India in fields such as aeronautics, metallurgy, and astronomy.
- Analyse archaeological and literary evidence supporting India's contributions to early science and engineering.

Unit I

Introduction to Indian Knowledge Systems (IKS): Definition, Concept and Scope of IKS, IKS-based approaches on Knowledge Paradigms, IKS in Ancient and Modern India, Genesis of the Land and Antiquity of Civilization, Traditional Knowledge System: Concept of Matter, Life and Universe.

Unit II

Scientific Thought and Technology in Ancient India: Sage Agastya's Model of Battery, Concept of Gravity and Velocity of Light, Vimāna: Aeronautics in Ancient Texts, Vedic Cosmology and Modern Concepts, Bhāratīya Kāla-gaṇanā (Indian Time Calculation).

Unit III

Astronomy and Cosmological Understanding: History and Culture of Astronomy, Sun, Earth, Moon, and Eclipses, Earth's Sphericity and Rotation, Archeoastronomy in Ancient India.

Unit IV

Material Sciences and Archaeological Insights: Laboratory Tools and Apparatus in Ancient India, Traditional Juices, Dyes, Paints, and Cements, Glass and Pottery Production, Metallurgy and Engineering in the Vedic & Post-Vedic Age Iron Pillar of Delhi, Rakhigarhi, Mehrgarh, Bet–Dwārkā Marine Technology and the Sindhu Valley Civilization.

References/Books:

1. The Knowledge System of Bhārata by Bhag Chand Chauhan.
2. Pride of India: A Glimpse of India's Scientific Heritage, edited by Pradeep Kohle
3. History of Science in India, Volume I and Volume VIII, edited by Sibaji Raha
4. India's Glorious Scientific Tradition by Suresh Soni.
5. Science and Technology in Ancient India by Debiprasad Chattopadhyaya.

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