DSC-3: Semester-III: Chemistry-3

Number of Theory Credits	Number of lecture hrs/semester	Number of practical Credits	Number of practical hrs/ sem
4	56	**2**	**56**
Content of Theory Course 3			**56Hrs**

Workload:4Hours/Week.

Course objectives:

1. Interrelationship among frequency, wavelength and wave number and importance of validation parameters of an instrumental method will be taught
2. Principle,instrumentationandapplicationsofspectrophotometry,nephelometry and turbidometry will be taught
3. Fundamentals of separation methods and principles of paper, thin layer and column chromatography will be taught
4. Principle, types and applications of solvent extraction will be taught
5. Principle and mechanism of ion-exchange, types of resins and domestic and industrial applications of ion-exchange chromatography will be taught
6. The concept of mechanism and its importance will be taught to the student
7. Concept and importance of intermediates inorganic chemistry will be taught taking proper examples
8. The various techniques for identification of reaction mechanism will be taught to the student taking proper examples
9. Concept of stereochemistry and its importance will be taught.
10. The various projection formulae and the techniques of designating the molecules into R, S, D, L will be taught taking proper examples
11. The theory and concept of Cis-,Trans-isomerism and its importance and the techniques to differentiate between them will be taught taking examples

Course Specific Outcomes

After the completion of this course, the student would be able to

1. Understand the importance of fundamental law and validation parameters in chemical analysis
2. Know how different analytes in different matrices (water and real samples) can be determined by spectrophotometric nephelometric and turbidometric methods.
3. Understand the requirement for chemical analysis by paper, thin layer and column chromatography.
4. Apply solvent extraction method for quantitative determination of metal ions in different samples
5. Utilize the ion-exchange chromatography for domestic and industrial applications
6. Explain mechanism for a given reaction.
7. Predict the probable mechanism for a reaction. explain the importance of reaction intermediates, its role and techniques of generating such intermediates
8. Explain the importance of Stereochemistry in predicting the structure and property of organic molecules.
9. Predict the configuration of an organic molecule and able to designate it.
10. Identify the chiral molecules and predict its actual configuration.

Syllabus

Unit-I Quantitative analysis-Instrumental methods 14hrs

Electromagneticspectrum,absorptionofelectromagneticradiationBeer'slaw,Beer-Lambert law derivation, deviations from Beer's law, limitations, construction of calibration graph (Plot of absorbance versus concentration), Evaluation Procedures-standard addition, Internal standard addition, validation parameters-detection limits, sensitivity, dynamic/linearity range, Instrumentation: single beam and double beam spectrophotometers, quantitative applications of colorimetry (determination of Fe, Mo, Cu, Ti and PO_4^{3-}) and numerical problems on application of Beer's law. **10hrs**

Nephelometry and Turbidometry: Introduction, principle, instrumentations of nephelometry and turbidometry; effects of concentration, particle size and wavelength on scattering; choice between nephelometry and turbidometry, applications of nephelometry and turbidimetry (determination of $S0_4^{2-}$and PO_4^{3-}) **4hrs**

Unit-II Structure and Bonding-I 14 hrs

Structure and Bonding-I

The ionic bond II: Structures of ionic solids, Radius ratio rules, Calculation of some limiting radius ratio values, Coordination number 3 (planar triangle), Coordination number 4 (tetrahedral and square planar), Coordination number6 (octahedral) close packing. **4hrs**

Classification of ionic structures:
Ionic compounds of the type AX (ZnS, NaCl, CsCI), Ionic compounds of the type AX_2 (Calcium fluoride (fluorite) and Rutile structure, Layer structures CdI_2, Cadmium iodide structure, Limitations of radius ratio concept, Kapustinskii equation, solvation energy and solubility of ionic solids, Numerical problems **5hrs**

Covalent bond II: The Lewis theory, octet rule, exceptions to the octet rule, Sidgwick-Powell theory. Review of Valence shell electron pair repulsion (VSEPR) theory, Effect of lone pairs, electronegativity, isoelectronic principle, Examples using VSEPR theory: $BF_3$and BF_4^-, NH_3 and NH_4^+, CIF_3, SF_4, $I_3^-$and I_3^+, SF_6 and IF_7. Limitations of VSEPR. **5hrs**

Unit III Mechanism of Organic Reactions II 14hrs

Carbon-carbon pi bonds: Formation of alkenes and alkynes by elimination reaction. Mechanism of E1, E2, E1cB reaction. Saytzeff and Hofmann eliminations. Addition of HBr to propene, Free radical addition of HBr to propene. Addition of halogens to alkenes-carbocation and halonium ion mechanism. Stereo-specificity of halogen addition. Ozonolysis mechanism - ozonolysis of propene. Diel –Alder reaction and Mechanism of Allylic and benzylic bromination and mechanism in propene, 1-butene, 1-toluene and ethylbenzene. **7 hrs**

Nucleophilic substitution at saturated carbon: Mechanism of SN_1 and SN_2 reactions with suitable examples. Energy profile diagrams, Stereochemistry and factors effecting SN_1 and SN_2 reactions.

Aromatic Electrophilic substitution reactions**:** Mechanisms, σ and π complexes, Halogenation, Nitration, Sulphonation, Friedel Crafts alkylation and acylation with their mechanism. Activating and deactivating groups. Orientation influence, Ortho-para ratio. Aromatic nucleophilic substitution reaction: SN_{Ar} and Benzyne mechanism with suitable examples. **7 hrs**

UNIT IV Thermodynamics and surface chemistry 14hrs

First Law of Thermodynamics

Thermodynamic Processes, Reversible and Irreversible Processes, Nature of Heat and Work, Internal Energy, First Law of Thermodynamics, Enthalpy of a System, Work done in isothermal and adiabatic expansion of an ideal gas, Numerical problems, Joule -Thomson Expansion, Relation between Joule-Thomson coefficient and other thermodynamic parameters

Second law of Thermodynamics

Concept of entropy, thermodynamic scale of temperature, Statements of the Second Law of Thermodynamics, molecular interpretation of entropy, Calculation of entropy change for reversible and irreversible processes. Free Energy Functions: Gibbs and Helmholtz energy, Variation of S, G, A with T, V and P, Numerical problems, Free energy change and spontaneity, Gibbs-Helmholtz equation

Third Law of Thermodynamics

Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. **9Hrs**

Surface Chemistry

Adsorption

Types of adsorption isotherms. Freundlich adsorption isotherm (only equation), its limitations. Langmuir adsorption isotherm (derivation to be done) and BET equation (derivation not included).

Catalysis

Types of Catalysis and theories with examples (intermediate compound theory and adsorption theory), Michaelis-Menten equation-derivation. Heterogeneous catalysis: surface reactions, unimolecular, bimolecular surface reactions. Autocatalysis with examples. Applications: Design process to removal of toxic compounds from industrial wastewater and treatment of portable water requirements. **5Hrs**

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York (2005).
2. Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).
3. Quantitative Analysis, R.A. Dayand A.L.Underwood, 6thedition, PHI Learning Pvt Ltd. New Delhi (2009).
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd.(2007).
5. Organic Reaction Mechanism by V.K.Ahluwalia and R.K.Parashar (Narosa Publishers)
6. Organic Chemistry by S.M.Mukherji, S.P.Sinha and R.K.Kapoor (Narosa Publishers)
7. Morrison R.N and Boyd R.N, Organic Chemistry, Darling Kindersley (India) Pvt. Ltd. (Pearson Education)
8. Finar I.L, Organic Chemistry (VolumeI); Finar I.L (VolumeII) Stereochemistry and the Chemistry of Natural Products.,Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
9. Kalsi P.S.Stereochemistry, conformation and Mechanism, Newage International
10. Eliel E.Landwilen S.H,Stereochemistry of OrganicCompounds,Wiley,(London).

PRACTICALS

Credit Points: 2 Teaching Hours: 4 hrs
Evaluation: Continuous InternalAssessment-25marks
Semester End Examination: 25marks

Course Objectives

1) To impart skills related to preparation of stock and working solutions and handling of instrumental methods
2) To know the principle of colorimetric analysis and construction of calibration plot
3) To understand the chemistry involved in colorimetric determination of metal ions and anions
4) To determine R_f values of different metal ions present in a mixture
5) To impart knowledge on the importance of functional groups inorganic compounds.
6) Techniques to identify the functional groups in a compound by performing physical and chemical tests
7) To record its melting point/boiling point.
8) To prepare suitable derivative for that compound and to characterize it.

Course Specific outcomes

After the completion of this course, the student would be able to

1) Understand the importance of instrumental methods for quantitative applications Apply colorimetric methods for accurate determination of metal ions and anions in water or real samples
2) Understand how functional groups in a compound is responsible for its characteristic property
3) Learn the importance of qualitative tests in identifying functional groups.
4) Learn how to prepare a derivative for particular functional groups and how to purify it.

Experiments list

PART-A

1) Colorimetric determination of copper using ammonia solution
2) Colorimetric determination of iron using thiocyanate solution
3) Determination of R_f values of two or three component systems by TLC /Paper Chromatography
4) Separation of different metal ions by paper chromatography/ Solvent extraction of iron using oxine solution **(demonstration)**

PART-B

Qualitative analysis of Organic compounds such as

1) Salicylic acid, p-Nitrobenzoic acid, Antranilicacid, p-Chloro benzoic acid
2) o-Cresol, p-Cresol, Resorcinol, o-Nitrophenol, p-nitophenol
3) o-Nitro aniline, p-Nitroaniline, p-Toluidine, p-Chloroaniline, p-Bromoaniline,
4) Ethyl Salicylate, Salicylaldehyde, Acetophenone, p-Dichlorobenzene, p-Nitrotoluene, Benzamideetc. (At least 6-8compounds to be analysed in a semester)

Examination

In the practical examination, a batch of maximum 15 (Fifteen) students may be made. Anyone experiment from Part-A or B can be given by selection done by the students based on lots. **Viva questions must be asked on any of the experiments prescribed in the practical syllabus.**

Part A: Distribution of marks

1. Accuracy: 12 Marks
2. Technique and presentation: 03 Marks
3. Graphs and Calculations: 05 Marks
4. Viva: 05 Marks

Total 25 Marks

Deduction of marks for accuracy: Error up to 5% - 12 marks, 6 - 10% 09 marks, 11-15% 6 marks, 16 or above 3 marks.

Part B: Distribution of Marks:

1. Preliminary tests and presentation - 03 marks,
2. Group test based on solubility: 02 marks
3. Distinguishing test and C.T: 10 marks (4+6)
4. Preparation of derivative: 03marks
5. Melting point of derivative: 02marks
6. Viva-Voce-5 marks

Total=25 marks.

References

1) Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.BarnesandM.J.K.Thomas,6thedition,ThirdIndian Reprint, Pearson Education Pvt. Ltd.(2007)
2) Vogels Text Book of Qualitative Chemical Analysis, ELBS

Semester-3: BSc/B Sc (Honors)

Title of the Course: Open Elective: Fuel Chemistry and Environmental Chemistry

Course	Credits	No. of Classes/ Week	Total No. of Lecture Hours	Duration of Exam in hrs	Internal Assessment Marks	Semester End Exam Marks	Total Marks
Theory	03	03	42	2	40	60	100

This course provides a broad introduction to the fundamental principles of Fuel chemistry, and Environmental Chemistry. The student will gain an understanding of basic and practical applications aspects of Fuels and environmental chemistry. This course is a valuable prerequisite for taking more technically challenging courses that will be required for career development.

Course Objectives

This course will deal with

1. Types of energy sources, concept of fuels, Petroleum and Environmental chemistry
2. Concept of different types of fuels and calorific values,
3. Basic principles of fuel sources, their preparation and applications.
4. Different types of lubricants and their applications
5. Concept of pollution, types of pollution and its prevention.

Expected Course Outcomes

Upon completion of the course students will be able to

1. Understand the concept of fuels, and their classifications.
2. Learn the different types of fuels and their applications.
3. Know the different types of pollution and their prevention

UNIT-I: FUEL CHEMISTRY: 14hrs

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification).
Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications

UNIT-II 14 hrs

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

UNIT-III ENVIRONMENTAL CHEMISTRY 14 hrs

Energy and Environment: Sources of energy: coal, petrol and natural gas. Nuclear fusion/ fission, solar energy, hydrogen and geo-thermal energy. **3 hrs**
Air pollution: Major regions of atmosphere,

Air pollutants: types, sources, particle size and chemical nature. Control measures of air pollution. Photochemical smog: its constituents and photochemistry. Green house effect, global warming and ozone depletion. **4 hrs**
Water pollution, water quality standards: Water pollutants and their sources. Industrial effluents and their treatment (primary and secondary treatment). Sludge disposal. Water quality parameters for waste water, industrial water and domestic water.

Nuclear pollution: Disposal of nuclear waste, nuclear disaster and its management.**7hrs**

Reference:

1. Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
2. Jain, P.C. & Jain, M. Engineering Chemistry DhanpatRai& Sons, Delhi.
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).
4. Environmental Chemistry, A. K. De, 6th Edn. New Age International (P) Ltd.,(2008).
5. Environmental Chemistry-S. K. Banerji, (Prentice Hall India), 1993
6. Industrial Chemistry, B.K.Sharma, 9th Edn. Krishna Prakashan Media (P) Ltd. Meerut (1997-98)

SEMESTER III

OEC3-BOILER WATER MANAGEMENT

[Only For B. Sc. (Sugar Science & Technology) Students]

Credits – 3	Max. Marks: 100
Teaching Hours / week: 4 Hours	Marks: Theory = 60
Theory Examination duration :2 Hours	Internal assessment= 40

UNIT – I **14 hours**

General boiler mounting/accessories & working: General boiler types, Water tube boiler- General parts – furnace / combustion zone / feed water tank/feed pump/ steam drum /mud drum /super heater/level indicators/ economizer/air heater/ID fan/FD fan/SA fan/ etc, High pressure & low pressure boilers

UNIT – II **14 hours**

Water: Water properties & nature, Sources of water, Use of water & basic chemistry, water related tables, Impurities in water and their effects on boiler working – scale formation – boiler tubes &economiser / carry over / Silica deposition/Super heater & turbine deposits/ Corrosion

Water quality requirement & treatment: General standards for boiler water/boiler feed water for high pressure as well as low pressure boilers, Objectives of boiler water treatment, External & Internal treatment

UNIT – III 1**4 hours**

External water treatment - Clarification, Filtration, , Chlorination, Ion exchange, De-areation, Reverse Osmosis, Silica removal, Oil removal, deareation

Ion exchange methods: Softner, De-alkalisation, Demineralisation application & limitation, Resin

Membrane Technology: Ultra filtration, Nano Filtration, Reverse Osmosis, Electro-dialysis

UNIT - IV **14 hours**

Internal treatment: Organic polymers & their role in scale inhibition, Dispersants & sludge conditioners, various chemical dosing, corrosion due to low pH, prevention of corrosion in boiler. Use of oxygen scavengers

Boiler operations & water quality: Boiler blow down, Reasons for boiler failures, Boiler preventive maintenance, Tubes internal chemical cleaning, water tube boilers – fire side cleaning

REFERENCE BOOKS:

1. Practical boiler water treatment Handbook, N. Manivasakam, By Shakti Book Services, Coimbatore
2. Training manual for sugar mills. Mangal Singh; Somaiya publications Pvt.Ltd. Mumbai.
3. Efficient Management of sugar factories, Mangal Singh, Somaiya publication Pvt.Ltd. Bombay
4. System of Technical control for cane sugar factories in India; Varma, N.C. The Sugar Technologists Association of India N.Delhi.