

Maulana Azad National Urdu University

Course Code BCH201CCT4 **Semester**

Course title Conceptual Organic Chemistry 1

Scheme of Instruction

Scheme of Examination

Total Duration : 60 Hrs

Maximum Score : 70

Periods / Week : 4

Internal Evaluation : 30

Credits : 4

End Semester : 70

Instruction : Lecture

Examination hours : 3

Mode Hrs

Course Objectives: Stereochemistry of organic compounds and knowledge of different types of reactions in organic compounds with their mechanism.

Course Outcomes: Acquaintance with differentiation among addition, substitution and elimination organic reactions. Concepts of organic oxidation and reduction reactions and stereochemistry.

Unit	Course Content	Instruction Hours
1	<p>Stereochemistry</p> <p>Isomerism, Classification of isomerism, Structural and stereo isomerism, Geometrical and optical isomerism, requirements for a molecule to show geometrical isomerism, Cis- trans isomerism, E and Z notation along with CIP rules for geometrical isomers. Optical activity, specific and molar rotation, chirality, enantiomerism, diastereoisomerism, racemic mixtures and their resolution by salt formation method. Relative and absolute configuration, D & L nomenclature system for configuration of carbohydrates, R and S configuration (upto two chiral centres).</p>	15
2	<p>Addition Reactions</p> <p>Addition reactions in alkenes and alkynes, hydrogenation,</p>	

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	<p>addition of halogen Hydrohalogenation (Markovnikov, s and anti-Markovnikov, s addition) hydration, , Hydroboration- oxidation and Oxymercuration- demercuration. Ozonolysis, Reactivity of alkenes vs alkynes.</p> <p>Addition reactions in aldehydes and ketones (formaldehyde, acetaldehyde, benzaldehyde, acetone). Name reactions; aldol, cross aldol, Claisen, Knoevenagel, Cannizzaro, cross Cannizzaro. Reaction.</p>	15
3	<p>Substitution Reactions</p> <p>Types of substitution reactions, Electrophilic substitution reactions, General mechanism of electrophilic substitution reactions (nitration, halogenation, sulphonation, Friedal Crafts alkylation and acylation), directive influence of substituent's. Nucleophilic substitution reactions, alkyl, allyl and benzyl halides, substitution of halogen by some common nucleophiles. Mechanism of SN¹ and SN² reactions, free radical substitution reactions, halogenations of alkanes, allylic compounds and alkyl benzenes.</p>	15
4	<p>Elimination, Oxidation and Reduction Reactions</p> <p>Alkyl halides (dehydrogenation, Saytzeff, s rule), vicinal dihalides (dehalogenation), alcohols (Dehydration), Mechanism of E1 and E2 reactions (nature of substrate and base). Oxidation of alcohols with potassium permanganate, potassium dichromate, catalytic dehydrogenation and Oppenauer oxidation and oxidation of 1,2- diols with periodic acid and lead tetra acetate. Oxidation of aldehydes and ketones with potassium permanganate, sodium hypiodite (iodoform reaction) and Baeyer- villager oxidation.</p> <p>Reduction of aldehydes and ketones, Catalytic hydrogenation, reduction with sodium borohydride, lithium aluminium hydride, Clemmensen, and Wolff- kishner reduction. Reduction of carboxylic acids and their derivatives, lithium aluminium hydride, sodium- ethanol and Rosenmund reduction. Reduction</p>	15

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	of nitro compounds, Acidic, alkaline and neutral reducing agents, lithium aluminium hydride and electrolytic reduction.	
Examination and Evaluation Pattern :		
Text Books and References :		
1	I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.	
2	R. T. Morrison & R. N. Boyd: Organic Chemistry, Pearson Education.	
3	Arun Bahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand	
4	Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.	
5	Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994. 6. T. W. Graham Solomon's Organic Chemistry, John Wiley and Sons.	
6	P.S. Kalsi, Stereochemistry, Conformation and Mechanism, John Wiley and Sons. 8. D. Nasipuri, Stereochemistry of Organic Compounds, New Age International Publishers	

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Course Code	BSCH150CCT2	Semester
Course title	Conceptual Organic Chemistry	1
Scheme of Instruction		Scheme of Examination
Total Duration	: 60Hr	Maximum Score : 50
Periods /Week	: 4	Internal Evaluation : 15
Credits	: 2	End Semester : 35
Instruction Mode	: Lecture /Demonstration	Exam Duration : 3 Hrs

Course Objectives: Synthesis and qualitative analysis of organic compounds as well as the identification of inorganic elements.

Course Outcomes: Understanding the utility of qualitative inorganic and organic analysis procedures.

Unit	Course Content	Instruction Hours
	List of Experiments: 1. Detection of elements (X, N, S) 2. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group 3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds) 4. Determination of optical activity by using polarimeter 5. To prepare p-bromo acetanilide 6. Nitration of nitrobenzene 7. Semicarbazone derivative of one the following compounds: acetone, ethyl methyl ketone, diethylketone, cyclohexanone, benzaldehyde. 8. Oxidation of benzaldehyde by using alkaline potassium permanganate.	60Hrs
Examination and Evaluation Pattern :		
Text Books and References :		

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1	Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)	
2	Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).	

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Course Code

BCH 201CCT 4

Semester

Course Title

Molecules of Life

2

Scheme of Instruction

Scheme of Examination

Total Duration : 60Hr

Maximum Score : 100

Periods /Week : 4

Internal Evaluation : 30

Credits : 4

End Semester : 70

Instruction Mode : Lecture

Exam Duration : 3 Hrs

Course Objectives: In –depth studies regarding classification, properties and uses of biomolecules.

Course Outcomes: Better understanding about the relationship between structures and chemical properties of biomolecules. Significance of biomolecules and their applications in daily human life

Unit	Course Content	Instruction Hours
1	<p>Carbohydrates:</p> <p>Introduction, Classification of carbohydrates, Reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structure. Epimers, anomers and muta rotation. Determination of configuration of glucose (Fischer proof). Cyclic structure of glucpse. Haworth projections. Cyclic structure of fructose. Chain lengthening and chain shortening of aldoses. Linkage between monosachharides, structure of disachharides (sucrose, maltose, lactose) and polysachhharides (starch and cellulose) excluding their structure elucidation.</p>	15
2	<p>Amino Acids, Peptides and Proteins:</p> <p>Introduction, Classification of amino acids, general properties of amino acids, Zwitterions structure and isoelectric point. Peptides, classification of peptides, Synthesis of simple peptides up to dipeptides, Merrifield solid phase peptide synthesis.</p> <p>Classification of proteins, Denaturation and renaturation of proteins, Overview of primary, secondary , tertiary and quaternary structure of proteins, determination of n- terminal</p>	15

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	amino acid by DNFB and Edman method.	
3	<p>Vitamins and Nucleic Acids:</p> <p>Classification of vitamins, Sources of vitamins, diseases caused by deficiency of vitamins, Detail study of structure of vitamin A and C. Components of Nucleic acids, Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), structure of polynucleotide's, Structure of DNA (Watson- crick model) and RNA and its type, Difference between DNA and RNA.</p>	15
4	<p>Lipids, Oil and Fats:</p> <p>Introduction to lipids, classification of lipids, Common fatty acids present in oils and fats, omega fatty acids, trans fats, hydrogenation, saponification value, Iodine number, Biological importance of triglycerides, phospholipids, glycolipids and steroids (cholesterol).</p>	15
Examination and Evaluation Pattern :		
Text Books and References :		
1	Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)	
2	Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).	
3	Arun Bahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand	
4	Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).	
5	Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman	
6	Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman.	

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Semester-3

Course Code **BCH 301CCT4**

Course Title **Chemical Bonding, Transition Metals & Coordination
Chemistry**

Scheme of Instruction

Scheme of Examination

Total Duration : 60Hr

Maximum Score : 100

Periods /Week : 4

Internal Evaluation : 30

Credits : 4

End Semester : 70

Instruction Mode : Lecture

Exam Duration : 3 Hrs

Course Objectives: Extended physico- chemical knowledge about chemical bonding, transition elements and coordination chemistry.

Course Outcomes: Better understanding about the formation of organic and inorganic compounds through chemical bonding. Conceptual knowledge of complex compounds and physical as well as chemical aspects of transition metals.

Unit	Course Content	Instruction Hours
1	Chemical Bonding Valence bond approach, Concept of resonance in various organic inorganic compounds, Hybridization and structure, equivalent and nonequivalent hybrid orbital's, Bent's rule and its applications, VSEPR model for predicting shapes of molecules and ions containing lone pairs sigma and pi bonds. LCAO method, symmetry and overlap for s-s , s-p and p-p combinations, MO treatment of homonuclear diatomic molecules of second period (B ₂ , C ₂ , N ₂ , O ₂ ,F ₂) and heteronuclear di-atomic molecules (CO, NO) and their ions. Van der Waals forces, Hydrogen bonding and its applications, effects of these forces on melting point boiling point and solubility.	15
2	Transition Elements (3d series)	

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	Definition of transition Elements, General electronic configuration of transition elements, Classification of transition elements , Physico-chemical properties of transition elements with reference to electronic configuration, variable oxidation state (first and second transition series), Ionisation energy, complex formation, magnetic properties, catalytic properties, alloys formation and interstitial compound formation, Preparation, properties and uses of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$. Structure of $\text{K}_2\text{Cr}_2\text{O}_7$ and K_2CrO_4 .	15
3	Coordination chemistry Double salt , Complex compounds, Difference between double salts and complex compounds, Types of complex compounds, Basic terminology of coordination chemistry (ligands, types of ligands, central metal ion, oxidation state, coordination number), Werners theory of complex compounds, IUPAC nomenclature of complex compounds (Mono nuclear complex), Factors affecting the stability of complex compounds, Isomerism in complex compounds, Applications of complex compounds in analytical chemistry, biological system and medicine. Bonding in complex compounds, Valence bond theory, EAN rule.	15
4	Crystal Field Theory Introduction, Crystal field effect, Crystal field splitting diagram for tetrahedral and octahedral complex. octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for O_h and T_d complexes, Tetragonal distortion of octahedral geometry	15
Examination and Evaluation Pattern :		
Text Books and References :		
1	James E. Huheey, "Inorganic Chemistry: Principles of structure and reactivity", Prentice Hall, IV Edition.	
2	D. S. Shriver and P.A. Atkins, "Inorganic Chemistry", Oxford University Press, IV Edition	
3	Alan G. Sharpe, "Inorganic Chemistry", University of Cambridge, III	

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	Edition.	
4	J. D. Lee, "A New Concise Inorganic Chemistry", ELBS IV Edition	
5	B. Douglas, D. H. McDaniel and J. J. Alexander, "Concepts and Models of Inorganic Chemistry", John Wiley and Sons, III Edition	
6	Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008.	

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Course Code **BSCH 350CCP- 2**

semester- 3

Course Title **Chemical Bonding, Transition Metals & Coordination
Chemistry**

Scheme of Instruction

Scheme of Examination

Total Duration : 60Hr

Maximum Score : 50

Periods /Week : 4

Internal Evaluation : 15

Credits : 2

End Semester : 35

Instruction Mode : Lecture /Demonstration

Exam Duration : 3 Hrs

Course Objectives: Preparation of standard solutions, standardization of secondary standards and the determination of desired constituent in a sample.

Course Outcomes: Abreast with different units of concentration of solution, standardization processs and application of redox reactions in chemical analysis.

Unit	Course Content	Instruction Hours
	<p>List of Experiments:</p> <ol style="list-style-type: none">1. Standardization of NaOH solution (standard solution of oxalic acid to be prepared)2. Determination of concentration of carbonate and bicarbonate present in a mixture.3. Standardization of KMnO₄ solution (standard solution of Mohr's salt to be prepared).4. Determination of concentration of Fe(II) in Mohr's salt and/or K₂Cr₂O₇ using diphenylamine/ N-phenylanthranilic acid as internal indicator (standard solution of K₂Cr₂O₇ and /or Mohr's salt to be prepared).5. Determination of concentration of Mg (II) & Zn (II) by titrimetric method using EDTA.6. Determination of iron content in ores / alloys using	60Hrs

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	appropriate redox titration. 7. Determination of concentration of total hardness of a given sample of water by complexometric titration 8. Preparation of complex compounds i) Tetraamminecarbonatocobalt (III) ion ii) Potassium tris(oxalate)ferrate(III), iii) Tetraamminecopper (II) sulphate,	
Examination and Evaluation Pattern :		
Text Books and References :		
1	Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009	
2	Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.	
3	Harris, D.C. & Freeman, W.H. & Co. Quantitative Chemical Analysis 7th Ed., New York	

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	rate constant, Rate law, Order of reaction, Differential and integrated form of rate expression up to second order reaction, Experimental methods of determination of rate laws, kinetics of complex reaction (integrated rate expression up to first order only), Molecularity of a reaction, Molecularity of a complex reaction. Temperature dependence of reaction rates, Arrhenius equation, Activation energy, Different methods of calculation of activation energy. Collision theory of reaction rate. Numerical problem based on activation energy.	15
4	<p>Surface Chemistry and Colloids</p> <p>Adsorption, Absorption, Types of adsorption, Difference between physical and chemical adsorption, Factors affecting adsorption, adsorption isotherms, Freundlich and Langmuir adsorption isotherms, Applications of adsorption.</p> <p>Difference between colloids and true solution. Classification of colloids on the basis of nature of dispersed phase and dispersion medium, on the basis of interaction between dispersed phase and dispersion medium, Methods of preparation of colloids by Chemical methods, Properties of colloids, Brownian movement, Tyndal effect, Electrophoresis, Gold number, Application of colloids, Emulsion, types of emulsion, Identification of emulsion, application of emulsion.</p>	15
Examination and Evaluation Pattern :		
Text Books and References :		
1	Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 9th Ed., Oxford University Press (2011)	
2	Ball, D. W. Physical Chemistry Thomson Press, India (2007).	
3	Alan G. Sharpe, "Inorganic Chemistry", University of Cambridge, III Edition.	
4	Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).	
5	Chang, R. Physical Chemistry for the Biosciences. University Science Books (2005)Edition	
6	Puri & Sharma	

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Course Code BCH 601DST 4

Semester

Course Title Bioinorganic & Environmental Chemistry

5

Scheme of Instruction

Scheme of Examination

Total Duration : 60Hr

Maximum Score : 100

Periods /Week : 4

Internal Evaluation : 30

Credits : 4

End Semester : 70

Instruction Mode : Lecture

Exam Duration : 3 Hrs

Course Objectives: Impact of inorganic metal ions and air pollutants on environment and human health. Remedial steps for pollution control.

Course Outcomes: Better understanding about the composition of atmosphere, hydrosphere and biosphere. Awareness about the impact of inorganic ions on environment and human health. Concept of green chemistry in pollution control.

Unit	Course Content	Instruction Hours
1	<p>Bio-Inorganic Chemistry</p> <p>A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na⁺, K⁺ and Mg²⁺ ions: Na/K pump; Role of Mg²⁺ ions in energy production and chlorophyll. Role of Ca²⁺ in blood clotting, stabilization of protein structures and structural role (bones).</p>	15
2	<p>Environment and its segments</p> <p>Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.</p> <p>Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution SO₂, CO₂, CO, NO_x, H₂S and other foul smelling gases. Methods of estimation of CO, NO_x, SO_x Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.</p>	15

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3	Water Pollution Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.	15
4	Energy & Environment Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management. Introduction to biocatalysis: Importance in “Green Chemistry” and Chemical Industry.	15
Examination and Evaluation Pattern :		
Text Books and References :		
1	E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.	
2	R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.	
3	S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.	
4	A.K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.	
5	A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).	
6	S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.	

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Course Code BCH 502 DST 4

Semester

Course Title Analytical Methods in Chemistry

6

Scheme of Instruction

Scheme of Examination

Total Duration : 60Hr

Maximum Score : 100

Periods /Week : 4

Internal Evaluation : 30

Credits : 4

End Semester : 70

Instruction Mode : Lecture

Exam Duration : 3 Hrs

Course Objectives:

To kindle confidence in students for better understanding of basic concepts of classical and modern analytical methods of chemical analysis as well as to keep abreast with developments of recent techniques of analysis.

Outcomes : The knowledge of fundamental principles of each analytical method of analysis with possible applications will induce great confidence among students to utilize different analytical techniques in chemical analysis.

Unit	Course Content	Instruction Hours
1	Analytical Chemistry and Statistical Analysis of Analytical Data Introduction and importance of analytical chemistry. Role of instrumentation in chemical analysis. Collection, arrangement and analysis of analytical data. Types and sources of errors of analytical data, determinate and indeterminate errors, absolute and relative errors. Normal (or Gaussian error curve), accuracy and precision, statistical terms (mean, median, median deviation, standard deviation and variance). criteria of validity or rejection of result. Numerical problems.	15
2	UV- Visible spectrometry: Interaction of radiation with matter and types of electron transitions. Chromophores and	

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	<p>auxochrome groups. UV- Visible spectrometry : Validity of Beer- Lambert's law. Basic principles of instrumentation (choice of source, monochromator and detector) , Single and double beam instruments. Application in quantitative analysis, estimation of metal ions from aqueous solution, geometrical isomers, determination of composition of metal complexes using Job's method of continuous variation and mole ratio methods. Deviation from Beer,s law and photometric titrations.</p>	15
3	<p>IR and atomic Absorption / Emission Techniques: Infrared spectrometry; basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instruments, sampling techniques. Structural illustration through interpretation of data, effect of hydrogen bonding. Flame atomic absorption and emission spectrometry: principle and applications in quantitative estimation of trace level of metal ions from water samples. Sources of chemical interferences and their methods of removal.</p>	15
4	<p>Separation Techniques : Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non- aqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion – exchange mechanism. Bonded phases and reversed phase chromatography. Qualitative and quantitative aspects of chromatographic methods (IEC, GLC, GPC and HPLC / HPTLC). Chromatographic parameters(capacity factor, separation factor and resolution). Applications of chromatography techniques in metal ion separation, deionization of water and analysis of polymers, pharmaceutical products, bimoleculless and stereoisomer's.</p>	15

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Examination and Evaluation Pattern :

Text Books and References :

1	E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.	
2	R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.	
3	S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.	
4	A.K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.	
5	A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).	
6	S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.	

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CourseCode
BCH551DST
2

Semester

Course Title **Analytical Methods in Chemistry** **6**

Scheme of Instruction

Scheme of Examination

Total Duration : 60Hr

Maximum Score : 50

Periods /Week : 4

Internal Evaluation : 15

Credits : 2

End Semester : 35

Instruction Mode : Lecture /Demonstration

Exam Duration : 3 Hrs

Course Objectives: To use of volumetric methods of analysis for determination of analytes of different types in water samples.

Course Outcomes: The students will understand the various steps involved in volumetric analysis and gain knowledge of deciding proper method for estimation of desired constituents in specific sample.

Unit	Course Content	Instruction Hours
	1. Determination of dissolved oxygen in water. 2. Determination of Chemical Oxygen Demand (COD) 3. Determination of Biological Oxygen Demand (BOD) 4. Percentage of available chlorine in bleaching powder 5. Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO ₃ and potassium chromate) 6. Estimation of total alkalinity of water samples (CO ₃ ²⁻ , HCO ₃ ⁻) using double titration method 7. Measurement of dissolved CO ₂ . 8. Preparation of borax/ boric acid. Separation of mixtures by chromatography: Measure the R _f value in each case. (Combination of two ions to be given).	60
Examination and Evaluation Pattern :		
Text Books and References :		
1	E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.	
2	R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.	
3	S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.	
4	A.K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.	
5	A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).	
6	S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern	

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