

Semester: I  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: Organic Chemistry I

Code: CEMACOR01T

Credit: 4

- Course coordinator: **Dr. Swastika Karmakar**
- Course Outcome
- CO1: To impart students a broad outline of the basic organic chemistry in general.
- CO2: The students will learn the Bonding of organic compounds in the light of valence bond and MO theories, Hybridization of organic compound and their Physical Properties, different types of organic reactions like ionic, radical and pericyclic etc., different types of reaction like: addition, elimination and substitution reactions, electrophiles and nucleophiles.
- CO3: They will also learn about reactive intermediates like carbocation (carbenium and carbonium ions), carbanions, carbon radicals, carbenes to explain different types of reaction.
- CO4: Student will know stereochemistry and various possible conformations of organic compounds, Concept of chirality and symmetry.
- CO5: Different types reactions are discussed here.

Course planne

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.10.2021
Aug				
Sep				
Oct	<i>Valence Bond Theory</i> : concept of hybridisation, shapes of molecules, resonance (including hyperconjugation); calculation of formal charges and double bond equivalent (DBE); orbital pictures of bonding ( $sp^3$ , $sp^2$ , $sp$ : C-C, C-N & C-O systems and <i>s-cis</i> and <i>s-trans</i> geometry for suitable cases).	PD	3hrs	
	<i>Electronic displacements</i> : inductive effect, field effect, mesomeric effect, resonance energy; bond polarization and bond polarizability; electromeric effect; steric effect, steric inhibition of resonance.	SM	5hrs	
	<i>MO theory</i> : qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about $\sigma$ , $\sigma^*$ , $\pi$ , $\pi^*$ , $n$ – MOs; basic idea about Frontier MOs (FMO); concept of HOMO, LUMO and SOMO; interpretation of chemical reactivity in terms of FMO interactions; sketch and energy levels of $\pi$ MOs of i) acyclic p orbital system (C=C, conjugated diene, triene, allyl and pentadienyl systems) ii) cyclic p orbital system (neutral systems: [4], [6]-annulenes; charged systems: 3-,4-,5-membered ring systems);	SK	7 hrs	
Nov	<i>Physical properties</i> : influence of hybridization on bond properties: bond dissociation energy (BDE) and bond energy; bond distances, bond angles; concept of bond angle strain (Baeyer's strain theory); melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces; polarity of molecules and dipole moments; relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heat of combustion and heat of formation.	PD	5 hrs	
	<i>Mechanistic classification</i> : ionic, radical and pericyclic (definition and example); reaction type: addition, elimination and substitution reactions	SM	5hrs	

	(definition and example); nature of bond cleavage and bond formation: homolytic and heterolytic bond fission.			
	Hückel's rules for aromaticity up to [10]-annulene (including mononuclear heterocyclic compounds up to 6-membered ring); concept of antiaromaticity and homoaromaticity; non-aromatic molecules; Frost diagram; elementary idea about $\alpha$ and $\beta$ ; measurement of delocalization energies in terms of $\beta$ for buta-1,3-diene, cyclobutadiene, hexa-1,3,5-triene and benzene.	SK	5 hrs	
Dec /Jan	<i>Mechanistic classification</i> : homogenic and heterogenic bond formation; curly arrow rules in representation of mechanistic steps; reagent type: electrophiles and nucleophiles (elementary idea); electrophilicity and nucleophilicity in terms of FMO approach.	SK	2 hrs	
	<i>Reactive intermediates</i> : carbocations (carbenium and carbonium ions), carbanions, carbon radicals, carbenes: generation and stability, structure using orbital picture and electrophilic/nucleophilic behavior of reactive intermediates (elementary idea).	PD	3hrs	
	<i>Relative and absolute configuration</i> : D/L and R/S descriptors; <i>erythro/threo</i> and <i>meso</i> nomenclature of compounds; <i>syn/anti</i> nomenclatures for aldols	SM	3hrs	
	<i>Bonding geometries of carbon compounds and representation of molecules</i> : tetrahedral nature of carbon and concept of asymmetry; Fischer, sawhorse, flying-wedge and Newman projection formulae and their inter translations.  <i>Concept of chirality and symmetry</i> : symmetry elements and point groups ( <i>C<sub>av</sub></i> , <i>C<sub>nh</sub></i> , <i>C<sub>nv</sub></i> , <i>C<sub>n</sub></i> , <i>D<sub>ah</sub></i> , <i>D<sub>nh</sub></i> , <i>D<sub>nd</sub></i> , <i>D<sub>n</sub></i> , <i>S<sub>n</sub></i> ( <i>C<sub>s</sub></i> , <i>C<sub>i</sub></i> ); molecular chirality and centre of chirality; asymmetric and dissymmetric molecules; enantiomers and diastereomers; concept of epimers; concept of stereogenicity, chirotopicity and pseudoasymmetry; chiral centres and number of stereoisomerism: systems involving 1/2/3-chiral centre(s) (AA, AB, ABA and ABC types).	SK	10 hrs	
	<i>E/Z</i> descriptors for C=C, conjugated diene, triene, C=N and N=N systems; combination of <i>R/S</i> - and <i>E/Z</i> - isomerisms.	PD	2hrs	
Dec	<i>Optical activity of chiral compounds</i> : optical rotation, specific rotation and molar rotation; racemic compounds, racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates); resolution of acids, bases and alcohols via diastereomeric salt formation; optical purity and enantiomeric excess; invertomerism of chiral trialkylamines.	SK	10 hrs	
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry*, Second edition, Oxford University Press, 2012.
2. Sykes, P., *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
3. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
4. Nasipuri, D. *Stereochemistry of Organic Compounds*, Wiley Eastern Limited.

1. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: I  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: Organic Chemistry I LabCode: CEMACOR01P

Credit: 2

- Course coordinator: **Dr. Suman Mandal**
- Course Outcome
- CO1: Based on solubility separation of different inorganic and organic liquid and solid compounds are discussed.
- CO2: Recrystallization of the separated compounds is to be done.
- CO3: Determination of boiling point of common organic liquid compounds is to be discussed.
- CO4: Student will learn how different solid and liquid organic compounds are identified.

#### Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul Aug Sep				Class starts from 01.10.2021
Oct	Separation, based upon solubility, by using common laboratory reagents like water (cold, hot), dil. HCl, dil. NaOH, dil. NaHCO <sub>3</sub> , etc., of components of a binary solid mixture; purification of any one of the separated components by crystallization and determination of its melting point. The composition of the mixture may be of the following types: Benzoic acid/ <i>p</i> -Toluidine; <i>p</i> -Nitrobenzoic acid/ <i>p</i> -Aminobenzoic acid; <i>p</i> -Nitrotoluene/ <i>p</i> -Anisidine; etc.	MS+SK	15hrs	
Nov	Determination of boiling point of common organic liquid compounds e.g., ethanol, cyclohexane, chloroform, ethyl methyl ketone, cyclohexanone, acetylacetone, anisole, crotonaldehyde, mesityl oxide, etc. [Boiling point of the chosen organic compounds should preferably be less than 160 °C]	BD+SM	15 hrs	
Dec	Identification of a Pure Organic Compound <i>Solid compounds</i> : oxalic acid, tartaric acid, citric acid, succinic acid, resorcinol, urea, glucose, cane sugar, benzoic acid and salicylic acid	SK+MS	15 hrs	
Dec /Jan	Identification of a Pure Organic Compound <i>Liquid Compounds</i> : formic acid, acetic acid, methyl alcohol, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene	BD+SM	15hrs	
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Bhattacharyya, R. C, *A Manual of Practical Chemistry*.
2. Vogel, A. I. *Elementary Practical Organic Chemistry*, Part 2: *Qualitative Organic Analysis*, CBS Publishers and Distributors.
3. Dutta, S, B. *Sc. Honours Practical Chemistry*, Bharati Book Stall.

2. Other resources :

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Semester: I  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: Physical Chemistry I

Code: CEMACOR02T

Credit: 4

- Course coordinator: **Dr. Bidyut Debnath**
- Course Outcome
- CO1: Following aspects of gas are discussed: Kinetic Theory of gases, Maxwell's distribution of speed and energy, Real gas and virial equation.
- CO2: Zeroth, first and second law of thermodynamics, laws of thermochemistry, different thermodynamic relations are discussed.
- CO3: In this course a detailed study of Chemical kinetics is to be discussed.
- CO4: Learners will learn about homogeneous catalysis in different processes.
- CO5: Students will know about the equipartition of energy.

Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.10.2021
Aug				
Sep				
Oct	Chemical Thermodynamics : Zeroth and 1st law of Thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; Concept of heat, work, internal energy and statement of first law; enthalpy, $H$ , relation between heat capacities, calculations of $q$ , $w$ , $U$ and $H$ for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions; Joule's experiment and its consequence	MS	5hrs	

	Kinetic Theory of gases: Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Rate of collision on wall and rate of effusion.	BD	5hrs	
	Chemical Thermodynamics: Thermochemistry: Standard states; Heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Laws of thermochemistry; bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equations and effect of pressure on enthalpy of reactions; Adiabatic flame temperature; explosion temperature	SM	5hrs	
Nov	Kinetic Theory of gases: Maxwell's distribution of speed and energy: Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions; Kinetic energy distribution in one, two and three dimensions, calculations of average, root mean square and most probable values in each case; Calculation of number of molecules having energy $\geq \epsilon$ , Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases	BD	7hrs	
	Kinetic Theory of gases: Real gas and virial equation: Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour, other equations of state (Berthelot, Dietrici); Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states; virial equation of state; van der Waals equation expressed in virial form and significance of second virial coefficient; Intermolecular forces (Debye, Keesom and London interactions; Lennard-Jones potential - elementary idea)	SM	8hrs	
Dec	Chemical Thermodynamics: Second Law: Need for a Second law; statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle; Physical concept of Entropy; Carnot engine and refrigerator; Kelvin – Planck and Clausius statements and equivalence of the two statements with entropic formulation.	BD	5hrs	
	Chemical Thermodynamics: Carnot's theorem; Values of $dQ/T$ and Clausius inequality; Entropy change of systems and surroundings for various processes and transformations; Entropy and unavailable work; Auxiliary state functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium.	MS	5hrs	
	Chemical Thermodynamics: Thermodynamic relations: Maxwell's relations; Gibbs- Helmholtz equation, Joule-Thomson experiment and its consequences; inversion temperature; Joule-Thomson coefficient for a van der Waals gas; General heat capacity relations.	SM	5hrs	
Dec /Jan	Chemical kinetics: Rate law, order and molecularity: Introduction of rate law, Extent of reaction; rate constants, order; Forms of rates of First, second and n-th order reactions; Pseudo first order reactions (example using acid catalyzed hydrolysis of methyl acetate); Determination of order of a reaction by half-life and differential method; Opposing reactions, parallel reactions and consecutive reactions (with explanation of kinetic and thermodynamic control of products; all steps first order) ; Rate equation for the fast reaction.	BD	5hrs	

	Chemical kinetics: Role of T and theories of reaction rate: Temperature dependence of rate constant; Arrhenius equation, energy of activation; Rate-determining step and steady-state approximation – explanation with suitable examples; Collision theory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment).	MS	5hrs	
	Chemical kinetics: Homogeneous catalysis: Homogeneous catalysis with reference to acid-base catalysis; Primary kinetic salt effect; Enzyme catalysis; Michaelis-Menten equation, LineweaverBurk plot, turn-over number. Autocatalysis; periodic reactions.	SM	5 hrs	
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Rakshit, P.C., *Physical Chemistry* Sarat Book House
2. Atkins, P. W. & Paula, J. de *Atkins' Physical Chemistry*, Oxford University Press
3. Glasstone, S. & Lewis, G.N. *Elements of Physical Chemistry*
4. Atkins, P. W. & Paula, J. de *Atkins' Physical Chemistry*, Oxford University Press

3. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: I  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: Physical Chemistry I LabCode: CEMACOR02P

Credit: 2

- Course coordinator: **Dr. Bidyut Debnath**
- Course Outcome
- CO1: Some experiments of pH, kinetics of acid-catalyzed hydrolysis, kinetics of decomposition of  $\text{H}_2\text{O}_2$ , heat of neutralization, heat of solution are to be performed.

#### Course planne

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul Aug Sep				Class starts from 01.10.2021
	Experiment 1: Determination of pH of unknown solution (buffer), by color matching method	MS+SK	12hrs	

Oct	Experiment 2: Determination of heat of neutralization of a strong acid by a strong base	BD+SM	4 hrs	
Nov	Experiment 2: Determination of heat of neutralization of a strong acid by a strong base	BD+SM	8 hrs	
	Experiment 3: Study of kinetics of acid-catalyzed hydrolysis of methyl acetate	MS+SK	12 hrs	
Dec	Experiment 4: Study of kinetics of decomposition of H <sub>2</sub> O <sub>2</sub>	BD+MS	12 hrs	
	Experiment 5: Determination of heat of solution of oxalic acid from solubility measurement	SM+SK	2 hrs	
Dec /Jan	Experiment 5: Determination of heat of solution of oxalic acid from solubility measurement	BD+SM	10hrs	
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Viswanathan, B., Raghavan, P.S. *Practical Physical Chemistry* Viva Books (2009)
2. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* 6th Ed., Pearson
3. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007)
4. Palit, S.R., De, S. K. *Practical Physical Chemistry* Science Book Agency
5. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta
6. Levitt, B. P. edited *Findlay's Practical Physical Chemistry* Longman Group Ltd.
7. Gurtu, J. N., Kapoor, R., *Advanced Experimental Chemistry* S. Chand & Co. Ltd

4. Other resources :

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Semester: II  
Department of Chemistry  
Basirhat College  
SESSION: 2021-22(JANU-JUNE 2022)

Lesson Plan for Course: INORGANIC CHEMISTRY-I    Code: CEMACOR03T    Credit: 4

- Course coordinator: **Dr. Bidyut Debnath**
- Course Outcome
- CO1: Fundamental ideas of atomic structure are discussed.
- CO2: Chemical periodicity in the light of screening effects, Slater's rules, atomic radii, ionic radii, covalent radii, lanthanide contraction. Ionization potential, electron affinity and electronegativity are to be accustomed with the students.
- CO3: Different laws and principles of acid & base reactions are discussed.

- CO4: Different aspects of Redox Reactions and precipitation reactions like balancing of reaction, Nernst equation, redox indicators, Redox potential diagram etc. are discussed.
- CO5: Solubility product and common ion effect and their applications in chemistry are discussed.

#### Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb	<u>Chemical periodicity</u> Modern IUPAC Periodic table, Effective nuclear charge, screening effects and penetration.	MS	4	Class started from 18.02.22
	<u>Acid-Base reactions</u> Acid-Base concept: Arrhenius concept, theory of solvent system (H <sub>2</sub> O, NH <sub>3</sub> , SO <sub>2</sub> and HF).			
	<u>Redox Reactions and precipitation reactions</u> Ion-electron method of balancing equation of redox reaction.	SM	2	
	<u>Extra nuclear Structure of atom</u> Bohr's theory, its limitations and atomic spectrum of hydrogen atom.	BD	2	
March	<u>Acid-Base reactions</u> Bronsted-Lowry's concept, relative strength of acids, Pauling's rules. Lux-Flood concept, Lewis concept, group characteristics of Lewis acids.	MS	4	
	<u>Redox Reactions and precipitation reactions</u> Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation). Influence of complex formation.	SM	4	
	<u>Extra nuclear Structure of atom</u> Sommerfeld's Theory. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance.	BD	8	
	<u>Chemical periodicity</u> Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction. Ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred-Rochow's scales) and factors influencing these properties, group electronegativities. Group trends and periodic trends in these properties in respect of s-, p- and d-block elements. Secondary periodicity, Relativistic Effect, Inert pair effect.			
	<u>Acid-Base reactions</u> Solvent levelling and differentiating effects. Thermodynamic acidity parameters, Drago-Wayland equation. Superacids, Gas phase acidity and proton affinity.	MS	6	
	<u>Redox Reactions and precipitation reactions</u> Precipitation and change of pH on redox potentials; formal potential. Feasibility of a redox titration.	SM	4	
	<u>Extra nuclear Structure of atom</u> Schrödinger's wave equation, significance of $\psi$ and $\psi^2$ . Quantum numbers and their significance. Radial and angular wave functions for hydrogen atom.	BD	8	
	<u>Redox Reactions and precipitation reactions</u> Redox potential at the equivalence point, redox indicators.			

Apr	<u>Acid-Base reactions</u> HSAB principle. Acid-base equilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer. Acidbase neutralisation curves; indicator,	MS	4	
	<u>Redox Reactions and precipitation reactions</u> Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications. Disproportionation and comproportionation reactions. Solubility product principle.	SM	4	
	<u>Extra nuclear Structure of atom</u> Radial and angular distribution curves. Shapes of <i>s</i> , <i>p</i> , <i>d</i> and <i>f</i> orbitals. Pauli's Exclusion Principle, Hund's rules and multiplicity, Exchange energy. Ground state Term symbols of atoms and ions for atomic number upto 30.	BD	4	
	<u>Redox Reactions and precipitation reactions</u> Common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides.	SM	4	
May	<u>Acid-Base reactions</u> choice of indicators.	MS	1	
	<u>Extra nuclear Structure of atom</u> Aufbau principle and its limitations.	BD	1	
	Assessment: End-term Test	Total: 60 Hrs		

#### Resources :

##### Books:

1. Lee, J. D. *Concise Inorganic Chemistry*, 5<sup>th</sup> Ed., Wiley India Pvt. Ltd., 2008.
2. Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970.
3. Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
4. Atkin, P. *Shriver & Atkins' Inorganic Chemistry*, 5<sup>th</sup> Ed., Oxford University Press (2010).
5. Cotton, F.A., Wilkinson, G. and Gaus, P.L., *Basic Inorganic Chemistry* 3<sup>rd</sup> Ed.; Wiley India.
6. Sharpe, A.G., *Inorganic Chemistry*, 4<sup>th</sup> Indian Reprint (Pearson Education) 2005.
7. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity* 4<sup>th</sup> Ed., Harper Collins 1993, Pearson, 2006.
8. Atkins, P.W. & Paula, J. *Physical Chemistry*, Oxford Press, 2006.
9. Mingos, D.M.P., *Essential trends in inorganic chemistry*. Oxford University Press (1998).
10. Winter, M. J., The Orbitron, <http://winter.group.shef.ac.uk/orbitron/> (2002). An illustrated gallery of atomic and molecular orbitals.
11. Burgess, J., *Ions in solution: basic principles of chemical interactions*. Ellis Horwood (1999).

##### 5. Other resources :

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- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
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- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: II  
Department of Chemistry  
Basirhat College  
SESSION: 2021-22( JANU-JUNE 2022)

Lesson Plan for Course: INORGANIC CHEMISTRY-I Code: CEMACOR03P

Credit: 2

- Course coordinator: **Dr. Monojit Sarkar**
- Course Outcome
- CO1:: They will learn how simple acid base titrations are to be done.
- CO2: Student will gather knowledge about different oxidation reduction titrations which helps them to estimate ions in a solution.

Course planner

Sl	Course Topic	Teacher	Class -hrs	Remarks
Jan	A) Estimation of carbonate and hydroxide present together in mixture	MS	2	Classes started from 18.02.22
	C) Estimation of free alkali present in different soaps/detergents	BD	2	
Feb	A) Estimation of carbonate and hydroxide present together in mixture. B) Estimation of carbonate and bicarbonate present together in a mixture.	MS	8	
	C) Estimation of free alkali present in different soaps/detergents. D) Estimation of Fe(II) using standardized $\text{KMnO}_4$ solution	BD	8	
March	Estimation of oxalic acid and sodium oxalate in a given mixture.	MS	8	
	Estimation of Fe(II) and Fe(III) in a given mixture using $\text{K}_2\text{Cr}_2\text{O}_7$ solution	BD	8	
April	Estimation of Fe(III) and Mn(II) in a mixture using standardized $\text{KMnO}_4$ solution.	MS	2	
	Estimation of Fe(III) and Mn(II) in a mixture using standardized $\text{KMnO}_4$ solution.	BD	2	
	Estimation of Fe(III) and Cu(II) in a mixture using $\text{K}_2\text{Cr}_2\text{O}_7$ .	MS	8	
	Estimation of Fe(III) and Cr(III) in a mixture using $\text{K}_2\text{Cr}_2\text{O}_7$ .	BD	8	
May	Repeat as per the need of the student.	MS	2	
	Repeat as per the need of the student.	BD	2	
	Assessment: End-term Test		Total: 60 Hrs	

Resources :

Books:

1. Bhattacharyya, R. C, *A Manual of Practical Chemistry*.
2. Vogel, A. I. *Elementary Practical Organic Chemistry*, Part 2: *Qualitative Organic Analysis*, CBS Publishers and Distributors.
3. Dutta, S, B. *Sc. Honours Practical Chemistry*, Bharati Book Stall.

6. Other resources :

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Semester: II  
Department of Chemistry  
Basirhat College  
SESSION: 2021-22( JANU-JULY 2022)

Lesson Plan for Course: ORGANIC CHEMISTRY-II Code: CEMACOR04T

Credit: 4

- Course coordinator: **Dr. Bidyut Debnath**
- CO1: Students will get a clear conception on “Chirality arising out of stereoaxis”.
- CO2: The students will learn about “Prostereoisomerism” and related topics.
- CO3: They will know elaborately about “Conformation” and related aspects of organic molecules.
- CO4: Reaction thermodynamics will be explained with various examples.
- CO5: Elaborative discussion will be made on organic acids and bases, tautomerism and reaction kinetics.
- CO6: Free-radical substitution reaction will be stated with some examples.
- CO7: Nucleophilic substitution reactions will be discussed thoroughly.
- CO8: Students will know about the elimination reactions namely E1, E2, E1cB and Ei (pyrolytic syn eliminations).

Course planne

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb	<u>Substitution and Elimination Reactions</u> <i>Free-radical substitution reaction:</i> halogenation of alkanes, mechanism (with evidence) and stereochemical features; reactivity-selectivity principle in the light of Hammond's postulate.	SK	6	Class started from 18.02.22
	<u>Stereochemistry II</u> Chirality arising out of stereoaxis: stereoisomerism of substituted cumulenes with even and odd number of double bonds; chiral axis in allenes, spiro compounds, alkylidenecycloalkanes and biphenyls; related configurational descriptors ( $R_a/S_a$ and P/M); atropisomerism; racemisation of chiral biphenyls; buttressing effect.			
	<u>General Treatment of Reaction Mechanism II</u> <i>Reaction thermodynamics:</i> free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change via BDE, intermolecular & intramolecular reactions.	PD	4	
March	<u>Substitution and Elimination Reactions</u> <i>Elimination reactions:</i> E1, E2, E1cB and Ei (pyrolytic syn eliminations).	SK	8	
	<u>Stereochemistry II</u> Concept of prostereoisomerism: prostereogenic centre; concept of (pro) <sup>n</sup> -chirality: topicity of ligands and faces (elementary idea); pro-R/pro-S, pro-E/pro-Z and Re/Si descriptors; pro-r and pro-s descriptors of ligands on propseudoasymmetric centre. Conformation: conformational nomenclature: eclipsed, staggered, gauche, syn and anti; dihedral angle, torsion angle.			
	<u>General Treatment of Reaction Mechanism II</u> <i>Concept of organic acids and bases:</i> effect of structure, substituent and solvent on acidity and basicity; proton sponge;	PD	4	

	gas-phase acidity and basicity; comparison between nucleophilicity and basicity; HSAB principle; application of thermodynamic principles in acid-base equilibria.		
April	<u>Substitution and Elimination Reactions</u> Formation of alkenes and alkynes; mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann) and stereoselectivity; comparison between substitution and elimination; importance of Bredt's rule relating to the formation of C=C.	PD	4
	<u>Stereochemistry II</u> Klyne-Prelog terminology; P/M descriptors; energy barrier of rotation, concept of torsional and steric strains; relative stability of conformers on the basis of steric effect, dipole-dipole interaction and H-bonding; butane gauche interaction; conformational analysis of ethane, propane, n-butane, 2methylbutane and 2,3-dimethylbutane; haloalkane, 1,2-dihaloalkanes and 1,2-diols (up to four carbons); 1,2- halohydrin; conformation of conjugated systems (s-cis and s-trans).	SK	8
	<u>General Treatment of Reaction Mechanism II</u> <i>Tautomerism</i> : prototropy (keto-enol, nitro - aci-nitro, nitroso-oximino, diazo-amino and enamine-imine systems); valence tautomerism and ring-chain tautomerism.	PD	4
May	<u>General Treatment of Reaction Mechanism II</u> Composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3dicarbonyl systems, phenols and related systems), factors affecting keto-enol tautomerism; application of thermodynamic principles in tautomer equilibria.	SK PD	2 2
	<u>General Treatment of Reaction Mechanism II</u> <i>Reaction kinetics</i> : rate constant and free energy of activation; concept of order and molecularity; free energy profiles for one-step, two-step and three-step reactions.	PD	4
	<u>Substitution and Elimination Reactions</u> <i>Nucleophilic substitution reactions</i> : substitution at $sp^3$ centre: mechanisms (with evidence), relative rates & stereochemical features: $S_N1$ , $S_N2$ , $S_N2'$ , $S_N1'$ (allylic rearrangement) and $S_Ni$ ; effects of solvent, substrate structure, leaving group and nucleophiles (including ambident nucleophiles, cyanide & nitrite); substitutions involving NGP.	SK	8
	<u>General Treatment of Reaction Mechanism II</u> Catalyzed reactions: electrophilic and nucleophilic catalysis; kinetic control and thermodynamic control of reactions; isotope effect: primary and secondary kinetic isotopic effect ( $k_H/k_D$ ); principle of microscopic reversibility; Hammond's postulate.	PD	4
	<u>Substitution and Elimination Reactions</u> Role of crown ethers and phase transfer catalysts; [systems: alkyl halides, allyl halides, benzyl halides, alcohols, ethers, epoxides].	SK	2
	Assessment: End-term Test	Total: 60 Hrs	

Resources :

Books:

1. Clayden, J., Greeves, N., Warren, S. *Organic Chemistry*, Second edition, Oxford University Press 2012.
2. Sykes, P., *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
3. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
4. Carey, F. A. & Giuliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
5. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
6. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
7. Nasipuri, D. *Stereochemistry of Organic Compounds*, Wiley Eastern Limited.
8. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Finar, I. L. *Organic Chemistry (Volume 1)* Pearson Education.
10. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
11. James, J., Peach, J. M. *Stereochemistry at a Glance*, Blackwell Publishing, 2003.
12. Robinson, M. J. T., *Stereochemistry*, Oxford Chemistry Primer, Oxford University Press, 2005.
13. Maskill, H., *Mechanisms of Organic Reactions*, Oxford Chemistry Primer, Oxford University Press.

7. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: II  
Department of Chemistry  
Basirhat College  
SESSION: 2021-22( JAN-JULY 2022)

Lesson Plan for Course: Organic Chemistry I Lab Code: CEMACOR04P

Credit: 2

- Course coordinator: **Dr. Swastik Karmakart**
- Course Outcome
- CO1: They will learn about the preparation of some common organic reaction product.
- CO2: Student will learn how to purify the crude product and to make crystal from water/alcohol.
- CO3: Student will learn to determine the melting point of the purified product.

Course planner

The following reactions are to be performed, noting the yield of the crude product. Crystallization of the crude product and melting point are also to be detected by the student.				
Sl	Course Topic	Teacher	Class -hrs	Remarks
Feb	Nitration of aromatic compounds.	SK+SM	2	Class started from
	Nitration of aromatic compounds.	SK+MS	2	
Mar	Condensation reactions, Hydrolysis of amides/imides/esters	SK+SM	8	
	Acetylation of phenols/aromatic amines, Benzoylation of	SK+MS	8	

ch	phenols/aromaticamines			18.02.2
April	Side chain oxidation of aromatic compounds, Diazo coupling reactions of aromaticamines	SK+SM	8	3
	Bromination of anilides using green approach (Bromate-Bromide method)	SK+MS	8	
May	Redox reaction including solid-phase method	SK+SM	2	
	Redox reaction including solid-phase method	SK+MS	2	
	Green multi-component-coupling reaction	SK+SM	8	
	Selective reduction of <i>m</i> -dinitrobenzene to <i>m</i> -nitroaniline.	SK+MS	8	
	Repeat as per the need of the student.	SK+SM	2	
	Repeat as per the need of the student.	SK+MS	2	
	Assessment: End-term Test		Total:60 Hrs	

Resources:

Books:

1. Vogel, A. I. *Elementary Practical Organic Chemistry*, Part 1: *Small scale Preparations*, CBS Publishers and Distributors.
2. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N. University of Calcutta, 2003.
3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009).
4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed. Pearson (2012).
5. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press (2000).
6. *Practical Workbook Chemistry (Honours)*, UGBS, Chemistry, University of Calcutta, 2015.

Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: III  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: PHYSICAL CHEMISTRY-II Code: CEMACOR05T

Credit: 4

- Course coordinator: **Dr. Bidyut Debnath**
- Course Outcome
- CO1: Transport properties of liquid like viscosity, conductance and transport number are discussed in detail. Application of conductance measurement, conductometric titrations is also discussed.
- CO2: Different thermodynamic properties like partial properties and chemical potential, thermodynamic conditions for equilibrium, nernst's distribution law, thermodynamic properties of ideal substances- pure and mixtures etc. are discussed.

- CO3: Some fundamentals of Quantum Mechanics like black body radiation, wave function, concepts of operators, particle in a box, simple harmonic oscillations are discussed.
- CO4: They will about numerical knowledge.
- CO5: Here different derivations have been discussed.

### Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.09.2021
Aug				
Sep	Transport processes: Fick's law: Flux, force, phenomenological coefficients & their inter-relationship (general form), different examples of transport properties. Transport processes: Viscosity: General features of fluid flow (streamline flow and turbulent flow); Newton's equation, viscosity coefficient; Poiseuille's equation; principle of determination of viscosity coefficient of liquids by falling sphere method; Temperature variation of viscosity of liquids and comparison with that of gases	BD	7 hrs	
	Transport processes: Conductance and transport number: Ion conductance; Conductance and measurement of conductance, cell constant, specific conductance, equivalent conductance and molar conductance; Variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's law of independent migration of ions; Equivalent and molar conductance at infinite dilution and their determination for strong and weak 16 electrolytes; Debye –Huckel theory of Ion atmosphere (qualitative)- asymmetric effect, relaxation effect and electrophoretic effect; Ostwald's dilution law; Ionic mobility; Application of conductance measurement (determination of solubility product and ionic product of water); Conductometric titrations	MS	5 hrs	
	Transport processes: Transport number, Principles of Hittorf's and Moving-boundary method; Wien effect, Debye-Falkenhagen effect, Walden's rule	SM	3 hrs	
Oct	Applications of Thermodynamics – I: Partial properties and Chemical potential: Chemical potential and activity, partial molar quantities, relation between Chemical potential and Gibbs' free energy and other thermodynamic state functions; variation of Chemical potential ( $\mu$ ) with temperature and pressure; Gibbs-Duhem equation; fugacity and fugacity coefficient; Variation of thermodynamic functions for systems with variable composition; Equations of states for these systems, Change in G, S, H and V during mixing for binary solutions.	BD	7hrs	
	Applications of Thermodynamics – I: Chemical Equilibrium: Thermodynamic conditions for equilibrium, degree of advancement; van't Hoff's reaction isotherm (deduction from chemical potential); Variation of free energy with degree of advancement; Equilibrium constant and standard Gibbs' free energy change.	SM	4hrs	
	Applications of Thermodynamics – I: Definitions of KP, KC and KX; van't Hoff's reaction isobar and isochore from different standard states; Shifting of equilibrium due to change in external parameters e.g. temperature and pressure; variation of equilibrium constant with addition to inert gas; Le Chatelier's principle and its derivation.	MS	4 hrs	

Nov	Nernst's distribution law; Application- (finding out $K_{eq}$ using Nernst dist law for $KI+I_2 = KI_3$ and dimerization of benzene) Foundation of Quantum Mechanics: Beginning of Quantum Mechanics: Black-body radiation and Planck's theory of radiation; Light as particles: photoelectric and Compton effects; electrons as waves; Wave-particle duality: de Broglie hypothesis, Uncertainty relations (without proof)	BD	5hrs	
	Chemical potential and other properties of ideal substances- pure and mixtures: a) Pure ideal gas-its Chemical potential and other thermodynamic functions and their changes during a change of Thermodynamic parameters of mixing; Chemical potential of an ideal gas in an ideal gas mixture; Concept of standard states and choice of standard states of ideal gases. Foundation of Quantum Mechanics: Wave function: Schrödinger time-independent equation; nature of the equation, acceptability conditions imposed on the wave functions and probability interpretations of wave function; Orthogonal and normal functions; Schmidt's orthogonalization	MS	7hrs	
	b) Condensed Phase – Chemical potential of pure solid and pure liquids, Ideal solution – Definition, Raoult's law; Mixing properties of ideal solutions, chemical potential of a component in an ideal solution; Choice of standard states of solids and liquids. Foundation of Quantum Mechanics: Concept of Operators: Elementary concepts of operators, eigenfunctions and eigenvalues; Linear operators; Commutation of operators, commutator and uncertainty relation; Expectation value; Hermitian operator; Postulates of Quantum Mechanics; General structure of Schrodinger equation (S.E.) and time dependency; Stationary state	SM	6hrs	
Dec	Foundation of Quantum Mechanics: Particle in a box: Setting up of S.E. for one-dimensional well and its solution; Comparison with free particle eigenfunctions and eigenvalues. Properties of PB wave functions (normalisation, orthogonality, probability distribution);	BD	4hrs	
	Foundation of Quantum Mechanics: Expectation values of $x$ , $x^2$ , $p_x$ and $p_x^2$ and their significance in relation to the uncertainty principle; Extension of the problem to two and three dimensions and the concept of degenerate energy levels; Accidental degeneracy	MS	4hrs	
Jan	Foundation of Quantum Mechanics: Simple Harmonic Oscillator: setting up of the Schrodinger stationary equation, energy expression (without derivation), expression of wave function for $n = 0$ and $n = 1$ (without derivation) and their characteristic features.	SM	4hrs	
Jan	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Atkins, P. W. & Paula, J. de *Atkins', Physical Chemistry*, Oxford University Press
2. Castellan, G. W. *Physical Chemistry*, Narosa
3. McQuarrie, D. A. & Simons, J. D. *Physical Chemistry: A Molecular Approach*, Viva Press
4. Levine, I. N. *Physical Chemistry*, Tata McGraw-Hill
5. Rakshit, P.C., *Physical Chemistry*, Sarat Book House
6. Moore, W. J. *Physical Chemistry*, Orient Longman
7. Mortimer, R. G. *Physical Chemistry*, Elsevier
8. Denbigh, K. *The Principles of Chemical Equilibrium* Cambridge University Press
9. Engel, T. & Reid, P. *Physical Chemistry*, Pearson
10. Levine, I. N. *Quantum Chemistry*, PHI
11. Atkins, P. W. *Molecular Quantum Mechanics*, Oxford

12. Zemansky, M. W. & Dittman, R.H. *Heat and Thermodynamics*, Tata-McGraw-Hill
13. Rastogi, R. P. & Misra, R.R. *An Introduction to Chemical Thermodynamics*, Vikas
14. Klotz, I.M., Rosenberg, R. M. *Chemical Thermodynamics: Basic Concepts and Methods* Wiley
15. Glasstone, S. *An Introduction to Electrochemistry*, East-West Press

8. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: III  
Department of Chemistry

Lesson Plan for Course: PHYSICAL CHEMISTRY-II LabCode: CEMACOR05P

Credit: 2

- Course coordinator: Dr. Monojit sarkar
- Course Outcome
- CO1: Study of viscosity, partition coefficient, conductometric titration, verification of ostwald,s dilution law etc. are to be done.
- CO2: students will learn about various types of titrations.

Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.09.20 21
Aug				
Sep	Experiment 1: Study of viscosity of unknown liquid (glycerol, sugar) with respect to water	MS+SK	10hrs	
	Experiment 2: Determination of partition coefficient for the distribution of I <sub>2</sub> between water and CCl <sub>4</sub>	MS+SK	5hrs	
Oct	Experiment 2: Determination of partition coefficient for the distribution of I <sub>2</sub> between water and CCl <sub>4</sub>	BD+SM	5hrs	
	Experiment 3: Determination of K <sub>eq</sub> for KI + I <sub>2</sub> = KI <sub>3</sub> , using partition coefficient between water and CCl <sub>4</sub>	BD+SM	10hrs	
Nov	Experiment 4: Conductometric titration of an acid (strong, weak/ monobasic, dibasic) against base strong	BD+MS	10hrs	
	Experiment 5: Study of saponification reaction conductometrically	SM+SK	10hrs	
Dec	Experiment 6: Verification of Ostwald's dilution law and determination of K <sub>a</sub> of weak acid	BD+MS	10hrs	
Jan	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Viswanathan, B., Raghavan, P.S. *Practical Physical Chemistry* Viva Books (2009)
2. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* 6th Ed., Pearson
3. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007)
4. Palit, S.R., De, S. K. *Practical Physical Chemistry* Science Book Agency
5. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta
6. Levitt, B. P. edited *Findlay's Practical Physical Chemistry* Longman Group Ltd.
7. Gurtu, J. N., Kapoor, R., *Advanced Experimental Chemistry* S. Chand & Co. Ltd.

9. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: III  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: Inorganic chemistry-II. Code: CEMACOR06T

Credit: 4

- Course coordinator: dr. Suman Mandal
- Course Outcome
- CO1: General characteristics of ions and ionic bonds and covalent bonds are discussed in general.
- CO2: Lattice energy Concept is revealed.
- CO3: In the second part molecular orbital concepts of bonding, qualitative idea of valence bond and band theories, different weak chemical forces in molecules are discussed.
- CO4: H-bonding concept is discussed.
- CO5: Theories of radioactivity and uses of radioactive elements are discussed.

Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.09.2021
Aug				
Sep	Chemical Bonding-I: <i>Ionic bond</i> : General characteristics, types of ions, size effects, radius ratio rule and its application and limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy.	BD	6hrs	
	Chemical Bonding-I: Madelung constant, Born-Haber cycle and its application, Solvation energy. Defects in solids (elementary idea). Solubility energetics of dissolution process	MS	6hrs	
	Chemical Bonding-I: <i>Covalent bond</i> : Polarizing power and polarizability, ionic potential, Fajan's rules.	SM	3 hrs	
Oct	Chemical Bonding-I: Lewis structures, formal charge. Valence Bond Theory. The hydrogen molecule (Heitler-London approach), directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent's rule, Dipole moments.	SM	5hrs	
	Chemical Bonding-I: VSEPR theory, shapes of 19 molecules and ions containing lone pairs and bond pairs (examples from main groups)	BD	4hrs	

	chemistry) and multiple bonding ( $\zeta$ and $\pi$ bond approach).			
	Chemical Bonding-II: Molecular orbital concept of bonding (The approximations of the theory, Linear combination of atomic orbitals (LCAO)) (elementary pictorial approach): sigma and pi bonds and delta interaction, multiple bonding. Orbital designations: <i>gerade</i> , <i>ungerade</i> , HOMO, LUMO. Orbital mixing.	MS	6hrs	
Nov	Chemical Bonding-II: MO diagrams of H <sub>2</sub> , Li <sub>2</sub> , Be <sub>2</sub> , B <sub>2</sub> , C <sub>2</sub> , N <sub>2</sub> , O <sub>2</sub> , F <sub>2</sub> , and their ions wherever possible; Heteronuclear molecular orbitals: CO, NO, NO <sup>+</sup> , CN <sup>-</sup> , HF, BeH <sub>2</sub> , CO <sub>2</sub> and H <sub>2</sub> O. Bond properties: bond orders, bond lengths.	BD	4hrs	
	Chemical Bonding-II: <i>Metallic Bond</i> : Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.	MS	4hrs	
	Chemical Bonding-II: <i>Weak Chemical Forces</i> : van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Intermolecular forces: Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), receptor-guest interactions, Halogen bonds. Effects of chemical force, melting and boiling points.	SM	10hrs	
Dec	Radioactivity: Nuclear stability and nuclear binding energy. Nuclear forces: meson exchange theory. Nuclear models (elementary idea):. Nuclear energy and power generation.	BD	4hrs	
	Radioactivity: Concept of nuclear quantum number, magic numbers. Nuclear Reactions: Artificial radioactivity, transmutation of elements, fission, fusion and spallation.	MS	4hrs	
	Radioactivity: . Separation and uses of isotopes. Radio chemical methods: principles of determination of age of rocks and minerals, radio carbon dating, hazards of radiation and safety measures.	SM	4hrs	
Jan	Assessment: End-term Test		Total: 60Hrs	

Resources :

#### Books:

1. Lee, J. D. *Concise Inorganic Chemistry*, 5th Ed., Wiley India Pvt. Ltd., 2008.
2. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson, 2006.
3. Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970.
4. Porterfield, H. W., *Inorganic Chemistry*, Second Edition, Academic Press, 2005.
5. Purecell, K.F. and Kotz, J.C., *An Introduction to Inorganic Chemistry*, Saunders: Philadelphia, 1980.
6. Cotton, F.A., Wilkinson, G., & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.*; Wiley India.
7. Gillespie, R. J. and Hargittai, I., *The VSEPR Model of Molecular Geometry*, Prentice Hall (1992).
8. Albright, T., *Orbital interactions in chemistry*, John Wiley and Sons (2005).
9. Mingos, D.M.P., *Essential trends in inorganic chemistry*. Oxford University Press (1998).
10. Miessler, G. L., Fischer, P. J., Tarr, D. A., *Inorganic Chemistry*, Pearson, 5th Edition.
11. Kaplan, I., *Nuclear Physics*, Addison-Wesley Publishing Company Inc. London, 1964.
12. Friedlander, G., Kennedy, J. W., Macias, E. S. And Miller, J. M., *Nuclear and Radiochemistry*, Wiley, 1981.

#### 10. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: III  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: INORGANIC CHEMISTRY-II LAB. Code: CEMACOR06P

Credit: 2

- Course coordinator: **Dr. Suman Mandal**
- Course Outcome
- CO1: Iodometric titrations for estimations of metal ions, vitamin C and available chlorine in bleaching powder are to be done. Estimation of metals in brass, steel and cement are also to be done.
- CO2: Students will the fundamental ideas about metal estimations.

Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.09.2021
Aug				
Sep	Iodimetric Titrations: Estimation of Cu(II)	MS+SK	8hrs	
	Iodimetric Titrations: Estimation of Vitamin C	MS+SK	8hrs	
Oct	Iodimetric Titrations: Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically	BD+SM	10hrs	
	Iodimetric Titrations: Estimation of available chlorine in bleaching powder	BD+SM	8hrs	
Nov	Estimation of metal content: Estimation of Cu in brass.	BD+MS	8hrs	
	Estimation of metal content: Estimation of Cr and Mn in Steel.	SM+SK	8hrs	
Dec	Estimation of metal content: Estimation of Fe in cement.	BD+MS	10hrs	
Jan	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.

11. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: III  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: ORGANIC CHEMISTRY-III Code: CEMACOR07T

Credit: 4

- Course coordinator: **Dr. Swastik Karmakar**
- Course Outcome
- CO1: Students will learn about addition reaction to alkenes and alkynes.
- CO2: Electrophilic aromatic substitution and nucleophilic aromatic substitution will be discussed elaborately.
- 
- CO3: They will know clearly about various reactions of carbonyl compounds and will get elementary ideas of green chemistry including various green syntheses. Some specific mechanisms *BAC2*, *AAC2*, *AAC1*, *AAL1* will be discussed with evidence in connection to hydrolysis of esters.
- CO4: Elaborative discussion will be made on organometallic reagents which includes Grignard reagent, Organolithiums, Gilman cuprates etc.
- CO5: They will learn briefly about Grignard reagent.

Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.09.20 21
Aug				
Sep	<b>Chemistry of alkenes and alkynes</b> : <i>Addition to C=C</i> : mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity.	SK	3hrs	
	<b>Chemistry of alkenes and alkynes</b> : reactions: hydrogenation, halogenations, iodolactonisation, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, epoxidation, <i>syn</i> and <i>anti</i> -hydroxylation, ozonolysis.	BD	3 hrs	
	<b>Chemistry of alkenes and alkynes</b> : Addition of singlet and triplet carbenes; electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; Birch reduction of benzenoid aromatics; interconversion of <i>E</i> - and <i>Z</i> - alkenes; contra-thermodynamic isomerization of internal alkenes.	MS	3 hrs	
	<b>Chemistry of alkenes and alkynes</b> : <i>Addition to C≡C (in comparison to C=C)</i> : mechanism, reactivity, regioselectivity (Markownikoff and anti-Markownikoff addition) and stereoselectivity;	PD	3hrs	
	<b>Chemistry of alkenes and alkynes</b> : Reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; interconversion of terminal and non-terminal alkynes.	SM	3 hrs	
Oct	<b>Aromatic Substitution: Electrophilic aromatic substitution</b> : mechanisms and evidences in favour of it; orientation and reactivity;	MS	3hrs	

	<b>Aromatic Substitution:</b> reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reaction; one-carbon electrophiles (reactions: chloromethylation, Gatterman-Koch, Gatterman, Houben-Hoesch, Vilsmeier-Haack, Reimer-Tiemann, Kolbe-Schmidt); <i>Ips</i> o substitution.	SK	4hrs	
	<b>Aromatic Substitution:</b> <i>Nucleophilic aromatic substitution:</i> addition-elimination mechanism and evidences in favour of it; $S_N1$ mechanism; cine substitution (benzyne mechanism), structure of benzyne.	MS	3hrs	
	<b>Carbonyl and Related Compounds:</b> <i>Addition to C=O:</i> structure, reactivity and preparation of carbonyl compounds; mechanism (with evidence), reactivity, equilibrium and kinetic control; Burgi-Dunitz trajectory in nucleophilic additions;	SM	3 hrs	
	<b>Carbonyl and Related Compounds:</b> Formation of hydrates, cyanohydrins and bisulphite adduct; nucleophilic addition-elimination reactions with alcohols, thiols and nitrogen- based nucleophiles; reactions: benzoin condensation, Cannizzaro and Tischenko reactions, reactions with ylides: Wittig and Corey-Chaykovsky reaction; Rupe rearrangement, oxidations and reductions: Clemmensen, Wolff-Kishner, $LiAlH_4$ , $NaBH_4$ , MPV, Oppenauer, Bouveault-Blanc, acyloin condensation; oxidation of alcohols with PDC and PCC; periodic acid and lead tetraacetate oxidation of 1,2-diols.	PD	3 hrs	
Oct	<b>Carbonyl and Related Compounds:</b> <i>Exploitation of acidity of <math>\alpha</math>-H of C=O:</i> formation of enols and enolates; kinetic and thermodynamic enolates.	SK	3hrs	
Nov	<b>Carbonyl and Related Compounds:</b> Reactions (mechanism with evidence): halogenation of carbonyl compounds under acidic and basic conditions, Hell-Volhard-Zelinsky (H. V. Z.) reaction, nitrosation, $SeO_2$ (Riley) oxidation; condensations (mechanism with evidence).	SK	4hrs	
	<b>Carbonyl and Related Compounds:</b> Aldol, Tollens", Knoevenagel, Claisen-Schmidt, Claisen ester including Dieckmann, Stobbe; Mannich reaction, Perkin reaction, Favorskii rearrangement; alkylation of active methylene compounds.	MS	3hrs	
	<b>Carbonyl and Related Compounds:</b> Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate; specific enol equivalents (lithium enolates, enamines, aza-enolates and silylenol ethers) in connection with alkylation, acylation and aldol type reaction.	BD	3 hrs	
	<i>Elementary ideas of Green Chemistry:</i> Twelve (12) principles of green chemistry; planning of green synthesis; common organic reactions and their counterparts: reactions: 22 Aldol, Friedel-Crafts, Michael, Knoevenagel, Cannizzaro, benzoin condensation and Dieckmann condensation.	SM	3hrs	
	<i>Nucleophilic addition to <math>\alpha,\beta</math>-unsaturated carbonyl system:</i> general principle and mechanism (with evidence); direct and conjugate addition, addition of enolates (Michael reaction), Stetter reaction, Robinson annulation.	PD	4hrs	
Dec	<i>Substitution at <math>sp^2</math> carbon (C=O system):</i> mechanism (with evidence): $B_{AC}2$ , $A_{AC}2$ , $A_{AC}1$ , $A_{AL}1$ (in connection to acid and ester); acid derivatives: amides, anhydrides & acyl halides (formation and hydrolysis including comparison).	BD	4hrs	

	<b>Organometallics:</b> Grignard reagent; Organolithiums; Gilman cuprates: preparation and reactions (mechanism with evidence); addition of Grignard and organolithium to carbonyl compounds; substitution on -COX; directed orthometalation of arenes using organolithiums, conjugate addition by Gilman cuprates; Corey-House synthesis; abnormal behavior of Grignard reagents; comparison of reactivity among Grignard,	SK	3hrs	
Jan	<b>Organometallics:</b> Organolithiums and organocopper reagents; Reformatsky reaction; Blaise reaction; concept of <i>umpolung</i> and base-nucleophile dichotomy in case of organometallic reagents.	SM	2hrs	
Jan	Assessment: End-term Test		Total: 60 Hrs	

Resources :

Books:

1. Clayden, J., Greeves, N., Warren, S. *Organic Chemistry*, Second edition, Oxford University Press 2012.
2. Sykes, P., *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
3. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
4. Carey, F. A., Giuliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
5. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
6. Norman, R.O. C., Coxon, J. M. *Principles of Organic Synthesis*, Third Edition, Nelson Thornes, 2003.
7. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. *Organic Chemistry (Volume I)*, Pearson Education.
9. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
10. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
11. Jenkins, P. R., *Organometallic Reagents in Synthesis*, Oxford Chemistry Primer, Oxford University Press.
12. Ward, R. S., *Bifunctional Compounds*, Oxford Chemistry Primer, Oxford University Press.
13. Ahluwalia, V. K. *Strategies for Green Organic Synthesis*, ANE Books Pvt. Ltd.

12. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: III

Department of Chemistry

Basirhat College

Lesson Plan for Course: ORGANIC CHEMISTRY-III LAB. Code: CEMACOR07P

Credit: 2

- Course coordinator: **Mr. Prasanta Das**
- Course Outcome
- CO1: Qualitative Analysis of Single Solid Organic Compounds like elemental detection, solubility and classification, functional group, melting points and derivative preparations are to be done.
- CO2: Students will learn about organic sample separation.

Course planner

Sl	Course Topic	Teacher	Class	Remarks
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			-hrs	
Jul				Class starts from 01.09.2021
Aug				
Sep	Detection of special elements (N, S, Cl, Br) by Lassaigne's test. Detection of the following functional groups: aromatic amino (-NH <sub>2</sub> ), aromatic nitro (-NO <sub>2</sub> )	BD+SM	8hrs	
	Solubility and classification (solvents: H <sub>2</sub> O, 5% HCl, 5% NaOH and 5% NaHCO <sub>3</sub> ) Detection of the following functional groups: amido (-CONH <sub>2</sub> , including imide), phenolic -OH	MS+SK	8hrs	
Oct	Detection of the following functional groups: carboxylic acid (-COOH), carbonyl (-CHO and >C=O) Melting point of the given compound .	BD+SM	6hrs	
	Preparation, purification and melting point determination of a crystalline derivative of the given compound . Identification of the compound through literature survey.	MS+SK	10hrs	
Nov	Identification of <b>known (at least six)</b> organic compounds. through qualitative chemical tests for all the special elements and the functional groups with relevant derivatisation	BD+MS	10hrs	
	Identification of <b>unknown (at least six)</b> organic compounds. through qualitative chemical tests for all the special elements and the functional groups with relevant derivatisation	SM+SK	6hrs	
Dec	Identification of <b>unknown (at least six)</b> organic compounds. through qualitative chemical tests for all the special elements and the functional groups with relevant derivatisation	BD+MS	12hrs	
Jan	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Vogel, A. I. *Elementary Practical Organic Chemistry*, Part 2: *Qualitative Organic Analysis*, CBS Publishers and Distributors.
2. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N. University of Calcutta, 2003.
3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009).
4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed., Pearson (2012).
5. Clarke, H. T., *A Handbook of Organic Analysis (Qualitative and Quantitative)*, Fourth Edition, CBS Publishers and Distributors (2007).
6. *Practical Workbook Chemistry (Honours)*, UGBS, Chemistry, University of Calcutta, 2015.

13. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: IV  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: PHYSICAL CHEMISTRY-III Code: CEMACOR08T

Credit: 4

- Course coordinator: **Dr. Monojit Sarkar**
- Course Outcome
- CO1: This course helps in understanding about dilute solution behavior and colligative properties and their applications for measurements different properties.
- CO2: How to study phase rule and phase diagram for different component systems are discussed. This study helps in chemical engineering.
- CO3: Chemical potential of an ion in solution, activity and activity coefficients of ions for electrolytes using Debye-Huckel limiting law are discussed.
- CO4: Here the formations of different chemical and electrochemical cells and their behavior are discussed elaborately.
- CO5: Detailed study of quantum mechanics for rigid rotator model of rotation of diatomic molecule and Schrödinger equation are discussed.

Course planer

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb	<b>Application of Thermodynamics – II</b> Colligative properties: Vapour pressure of solution; Ideal solutions, ideally diluted solutions and colligative properties; Raoult's law; Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) Osmotic pressure] and amount of solute.	MS	4hrs	Class starts from 18.02.2022
	<b>Electrical Properties of molecules</b> Ionic equilibria: Chemical potential of an ion in solution; Activity and activity coefficients of ions in solution; Debye-Huckel limiting law-brief qualitative description of the postulates involved, qualitative idea of the model, the equation (without derivation) for ion-ion atmosphere interaction potential.	BD	4hrs	
	<b>Application of Thermodynamics – II</b> Applications in calculating molar masses of normal, dissociated and associated solutes in solution; Abnormal colligative properties Phase rule: Definitions of phase, component and degrees of freedom; Phase rule and its derivations; Definition of phase diagram; Phase diagram for water, CO <sub>2</sub> , Sulphur First order phase transition and Clapeyron equation; Clausius-Clapeyron equation - derivation and use; Liquid vapour equilibrium for two component systems; Phenolwater system	MS	8hrs	

	Three component systems, water-chloroform-acetic acid system, triangular plots			
	<b>Electrical Properties of molecules</b> Estimation of activity coefficient for electrolytes using Debye-Huckel limiting law; Derivation of mean ionic activity coefficient from the expression of ion-atmosphere interaction potential; Applications of the equation and its limitations Electromotive Force: Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry; Chemical cells, reversible and irreversible cells with examples; Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb <sub>2</sub> O <sub>3</sub> electrodes	BD	8hrs	
Mar	<b>Quantum Chemistry</b> Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component; Properties of angular momentum operators; Eigenfunctions of $L_z$ and $L^2$ ; Rigid rotator model of rotation of diatomic molecule and Schrödinger equation; Transformation to spherical polar coordinates; Separation of variables; Spherical harmonics; Discussion of solution	SM	8hrs	
	<b>Application of Thermodynamics – II</b> Binary solutions: Ideal solution at fixed temperature and pressure; Principle of fractional distillation; Duhem-Margules equation; Henry's law; Konowaloff's rule; Positive and negative deviations from ideal behavior; Azeotropic solution; Liquidliquid phase diagram using phenol- water system; Solid-liquid phase diagram; Eutectic mixture	MS	8hrs	
	<b>Electrical Properties of molecules</b> Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers; Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation) Dipole moment and polarizability: Polarizability of atoms and molecules, dielectric constant and polarisation, molar polarisation for polar and non-polar molecules; Clausius-Mosotti equation and Debye equation (both without derivation) and their application; Determination of dipole moments	BD	8 hrs	
Apr	<b>Quantum Chemistry</b> Qualitative treatment of hydrogen atom and hydrogen-like ions: Setting up of S.E. in spherical polar coordinates, radial part, quantization of energy (only final energy expression); Plots of polar	SM	8hrs	

	parts and radial distributions; Wave –function of one electron atoms; Average and most probable distances of electron from nucleus; Setting up of Schrödinger equation for many-electron atoms (He, Li) LCAO and HF-SCF: Born-Oppenheimer approximation; LCAO-MO treatment of H <sub>2</sub> <sup>+</sup> ;			
May	<b>Quantum Chemistry</b> Bonding and antibonding orbitals; Qualitative extension to H <sub>2</sub> ; Comparison of LCAOMO and VB treatments of H <sub>2</sub> and their limitations; Covalent bonding, valence bond and molecular orbital approaches, Hartree-Fock method development, SCF and configuration interaction (only basics)	SM	4hrs	
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Castellan, G. W. *Physical Chemistry*, Narosa
2. Atkins, P. W. & Paula, J. de *Atkins', Physical Chemistry*, Oxford University Press
3. McQuarrie, D. A. & Simons, J. D. *Physical Chemistry: A Molecular Approach*, Viva Press
4. Levine, I. N. *Physical Chemistry*, Tata McGraw-Hill
5. Moore, W. J. *Physical Chemistry*, Orient Longman
6. Mortimer, R. G. *Physical Chemistry*, Elsevier
7. Engel, T. & Reid, P. *Physical Chemistry*, Pearson
8. Levine, I. N. *Quantum Chemistry*, PHI
9. Atkins, P. W. *Molecular Quantum Mechanics*, Oxford
10. Engel, T. & Reid, P. *Physical Chemistry*, Pearson
11. Maron, S.H., Prutton, C. F., *Principles of Physical Chemistry*, McMillan
12. Klotz, I.M., Rosenberg, R. M. *Chemical Thermodynamics: Basic Concepts and Methods* Wiley
13. Rastogi, R. P. & Misra, R.R. *An Introduction to Chemical Thermodynamics*, Vikas
14. Glasstone, S. *An Introduction to Electrochemistry*, East-West Press

14. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: IV  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: PHYSICAL CHEMISTRY-III Lab, Code: CEMACOR08P,

Credit: 2

- Course coordinator: **Dr. Suman Mandal**
- Course Outcome

CO1: Some experiments with potentiometer, phase diagram, determination of solubility of sparingly soluble salt in water, effect of ionic strength on rate and pH-metric titrations are to be done.

CO2: Triple point of can be determined in phase diagram experiment.

### Course planer

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb	Experiment 1: Determination of solubility of sparingly soluble salt in water, in electrolyte with common ions and in neutral electrolyte (using common indicator)	MS+BD	10hrs	Class starts from 18.02.2022
	Experiment 2: Potentiometric titration of Mohr's salt solution against standard $K_2Cr_2O_7$ solution	MS+BD	10hrs	
Mar	Experiment 3: Determination of $K_{sp}$ for AgCl by potentiometric titration of $AgNO_3$ solution against standard KCl solution	BD+MS	10hrs	
	Experiment 4: Effect of ionic strength on the rate of Persulphate – Iodide reaction	BD+MS	10hrs	
Apr	Experiment 6: pH-metric titration of acid (mono- and di-basic) against strong base	BD+MS	10 hrs	
May	Experiment 5: Study of phenol-water phase diagram	BD+MS	10hrs	
Jun				
	Assessment: End-term Test		Total: 60Hrs	

### Resources:

#### Books:

1. Viswanathan, B., Raghavan, P.S. *Practical Physical Chemistry* Viva Books (2009)
2. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* 6th Ed., Pearson
3. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007)
4. Palit, S.R., De, S. K. *Practical Physical Chemistry* Science Book Agency
5. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta
6. Levitt, B. P. edited *Findlay's Practical Physical Chemistry* Longman Group Ltd.
7. Gurtu, J. N., Kapoor, R., *Advanced Experimental Chemistry* S. Chand & Co. Ltd.

#### 15. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: IV  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: INORGANIC CHEMISTRY-III      Code: CEMACOR09T

Credit: 4

- Course coordinator: **Dr. Suman Mandal**
- Course Outcome
- CO1: General Principles of Metallurgy is discussed.
- CO2: Chemistry of *s* and *p* Block Elements, noble gases are to be known.
- CO3: Types of inorganic polymers, synthesis, properties and comparison with organic polymers are given here.
- CO4: A brief idea of coordination chemistry is discussed.
- CO5: IUPAC nomenclatures of inorganic samples have been discussed.

Course planer

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb	<b>General Principles of Metallurgy</b> Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy.	SM	4 hrs	Class starts from 18.02.2022
	<b>General Principles of Metallurgy</b> Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.	SM	2hrs	
	<b>Chemistry of <i>s</i> and <i>p</i> Block Elements</b> Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Beryllium hydrides and halides.	SM	8hrs	
Mar	<b>Chemistry of <i>s</i> and <i>p</i> Block Elements</b> Boric acid and borates, boron nitrides, borohydrides (diborane) and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine. Peroxo acids of sulphur, sulphur-nitrogen compounds, interhalogen compounds, polyhalide ions, pseudohalogens, fluorocarbons and basic properties of halogens.	SM	8hrs	
	<b>Inorganic Polymers:</b> Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes.	BD	4hrs	
	<b>Coordination Chemistry-I</b> Coordinate bonding: double and complex salts. Werner's theory of coordination complexes,	MS	6 hrs	
Apr	<b>Noble Gases:</b> Occurrence and uses, rationalization of inertness of noble gases, peculiar behaviour of liquid helium, Clathrates; preparation and properties of XeF <sub>2</sub> , XeF <sub>4</sub> and XeF <sub>6</sub> ; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF <sub>2</sub> and XeF <sub>4</sub> ).	BD	6 hrs	

	<b>Coordination Chemistry-I</b> Classification of ligands, Ambidentate ligands, chelates, Coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers),	MS	10 hrs	
May	<b>Noble Gases:</b> Xenon-oxygen compounds. Molecular shapes of noble gas compounds (VSEPR theory).	BD	4hrs	
	<b>Coordination Chemistry-I</b> Isomerism in coordination compounds, constitutional and stereo isomerism, Geometrical and optical isomerism in square planar and octahedral complexes.	MS	8 hrs	
Jun				
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 4<sup>th</sup> Ed.*, Harper Collins 1993, Pearson, 2006.
2. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.
3. Cotton, F.A., Wilkinson, G., Murrillo, C. A., Bochmann, M., *Advanced Inorganic Chemistry 6<sup>th</sup> Ed.* 1999., Wiley.
4. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* 4<sup>th</sup> Ed., Pearson, 2010.
5. Purecell, K.F. and Kotz, J.C., *An Introduction to Inorganic Chemistry*, Saunders: Philadelphia, 1980.
6. Mingos, D.M.P., *Essential trends in inorganic chemistry*. Oxford University Press (1998).

16. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: IV  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: INORGANIC CHEMISTRY-III Lab, Code: CEMACOR09P,

Credit: 2

- Course coordinator: **Dr. Bidyut Debnath**
- Course Outcome
- CO1: Complexometric titration of few metal ions in solution and preparation of few inorganic complex compounds are to be performed.
- CO2: Hardness of water can be determined by this course.

Course planer

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb	<b>Complexometric titration</b> 1. Zn(II) 2. Zn(II) in a Zn(II) and Cu(II) mixture.	SM+BD	10hrs	Class starts from 18.02.2022
	<b>Complexometric titration</b> 3. Ca(II) and Mg(II) in a mixture. 4. Hardness of water.	SM+MS	14hrs	
Mar	<b>Inorganic preparations</b> 1. $[\text{Cu}(\text{CH}_3\text{CN})_4]\text{PF}_6/\text{ClO}_4$ 2. <i>Cis</i> and <i>trans</i> $\text{K}[\text{Cr}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2]$ 3. Tetraamminecarbonatocobalt (III) ion	SM+BD	18hrs	
Apr	4. Potassium tris(oxalato)ferrate(III) 5. Tris-(ethylenediamine) nickel(II) chloride.	SM+MS	12 hrs	
May	6. $[\text{Mn}(\text{acac})_3]$ and $\text{Fe}(\text{acac})_3$ (acac= acetylacetonate)	SM+BD	6 hrs	
Jun				
	Assessment: End-term Test		Total: 60Hrs	

Resources:

Books:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.
2. *Inorganic Synthesis*, Vol. 1-10.
3. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta

17. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: IV  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: ORGANIC CHEMISTRY-III Code: CEMACOR10T

Credit: 4

- Course coordinator: **Mr. Prasanta Das**
- Course Outcome
- CO1: Preparations and reactions of amines, nitro compounds, alkylnitrile and isonitrile, diazonium salts and their related compounds are to be studied.
- CO2: Different organic rearrangement reactions should be known with mechanism.
- CO3: Students will learn about organic spectroscopy.
- CO4: Some special reactions have been discussed.
- CO5: Mainly N-compounds and its reactions have been discussed.

#### Course planer

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb	<b>Nitrogen compounds</b> <i>Amines: Aliphatic &amp; Aromatic:</i> preparation, separation (Hinsberg's method) and identification of primary, secondary and tertiary amines; reaction (with mechanism): Eschweiler-Clarke methylation, diazo coupling reaction, Mannich reaction; formation and reactions of phenylenediamines, diazomethane and diazoacetic ester.	PD	4 hrs	Class starts from 18.02.2022
	<b>The Logic of Organic Synthesis</b> <i>Retrosynthetic analysis:</i> disconnections; synthons, donor and acceptor synthons; natural reactivity and <i>umpolung</i> ; latent polarity in bifunctional compounds: consonant and dissonant polarity; illogical electrophiles and nucleophiles; synthetic equivalents; functional group interconversion and addition (FGI and FGA); C-C disconnections and synthesis: one-group and two-group (1,2- to 1,5-dioxygenated compounds)	SK	4 hrs	
Mar	<b>Nitrogen compounds</b> <i>Nitro compounds (aliphatic and aromatic):</i> preparation and reaction (with mechanism): reduction under different conditions; Nef carbonyl synthesis, Henry reaction and conjugate addition of nitroalkane anion. <i>Alkylnitrile and isonitrile:</i> preparation and reaction (with mechanism): Thorpe nitrile condensation, von Richter reaction. <i>Diazonium salts and their related compounds:</i> reactions (with mechanism) involving replacement of diazo group; reactions: Gomberg, Meerwein, Japp-Klingermann.	PD	8hrs	

	<b>The Logic of Organic Synthesis</b> Reconnection (1,6-dicarbonyl); protection-deprotection strategy (alcohol, amine, carbonyl, acid). <i>Strategy of ring synthesis:</i> thermodynamic and kinetic factors; synthesis of large rings, application of high dilution technique. <i>Asymmetric synthesis:</i> stereoselective and stereospecific reactions; diastereoselectivity and enantioselectivity (only definition); enantioselectivity: kinetically controlled MPV reduction; diastereoselectivity: addition of nucleophiles to C=O adjacent to a stereogenic centre: Felkin-Anh and Zimmermann-Traxler models.	SK	10hrs	
Apr	<b>Rearrangements</b> <i>Mechanism with evidence and stereochemical features for the following</i> <i>Rearrangement to electron-deficient carbon:</i> Wagner-Meerwein rearrangement, pinacol rearrangement, dienone-phenol; Wolff rearrangement in Arndt-Eistert synthesis, benzilbenzilic acid rearrangement, Demjanov rearrangement, Tiffeneau-Demjanov rearrangement.	PD	6 hrs	
	<b>Organic Spectroscopy</b> <b>(20 Lectures) Marks: 20</b> <i>UV Spectroscopy:</i> introduction; types of electronic transitions, end absorption; transition dipole moment and allowed/forbidden transitions; chromophores and auxochromes; Bathochromic and Hypsochromic shifts; intensity of absorptions (Hyper/Hypochromic effects); application of Woodward's Rules for calculation of $\lambda_{\max}$ for the following systems: conjugated diene, $\alpha,\beta$ -unsaturated aldehydes and ketones (alicyclic, homoannular and heteroannular); extended conjugated systems (dienes, aldehydes and ketones); relative positions of $\lambda_{\max}$ considering conjugative effect, steric effect, solvent effect, effect of pH; effective chromophore concentration: keto-enol systems; benzenoid transitions.	SK	8hrs	
May	<b>Rearrangements</b> <i>Rearrangement to electron-deficient nitrogen:</i> rearrangements: Hofmann, Curtius, Lossen, Schmidt and Beckmann. <i>Rearrangement to electron-deficient oxygen:</i> Baeyer-Villiger oxidation, cumene hydroperoxide-phenol rearrangement and Dakin reaction. <i>Aromatic rearrangements: Migration from oxygen to ring carbon:</i> Fries rearrangement and Claisen rearrangement. <i>Migration from nitrogen to ring carbon:</i> Hofmann-Martius rearrangement, FischerHepp rearrangement, N-azo to C-azo rearrangement, Bamberger rearrangement, Orton rearrangement and benzidine rearrangement.	PD	6 hrs	
	<b>Organic Spectroscopy</b> <i>IR Spectroscopy:</i> introduction; modes of molecular vibrations (fundamental and nonfundamental); IR active molecules; application of Hooke's law, force constant; <i>fingerprint region</i> and its significance; effect of deuteration; overtone bands; vibrational coupling in IR; characteristic and diagnostic stretching frequencies of	SK	8 hrs	

	C-H, N-H, O-H, C-O, C-N, C-X, C=C (including skeletal vibrations of aromatic compounds), C=O, C=N, N=O, C≡C, C≡N; characteristic/diagnostic bending vibrations are included; factors affecting stretching frequencies: effect of conjugation, electronic effects, mass effect, bond multiplicity, ring-size, solvent effect, H-bonding on IR absorptions; application in functional group analysis. <i>NMR Spectroscopy</i> : introduction;nuclear spin;NMR active molecules;basic principles of Proton Magnetic Resonance; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of <i>first-order</i> multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR ;			
June	<b>Rearrangements</b> <i>Rearrangement reactions by green approach</i> : Fries rearrangement, Claisen rearrangement, Beckmann rearrangement, Baeyer-Villiger oxidation.	PD	2 hrs	
	<b>Organic Spectroscopy</b> elementary idea about <i>non-first-order</i> splitting; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds (both aliphatic and benzenoid-aromatic); rapid proton exchange; interpretation of NMR spectra of simple compounds. Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules.	SK	4 hrs	
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
3. Norman, R.O. C., Coxon, J. M. *Principles of Organic Synthesis*, Third Edition, Nelson Thornes, 2003.
4. Clayden, J., Greeves, N., Warren, S., *Organic Chemistry*, Second edition, Oxford University Press 2012.
5. Silverstein, R. M., Bassler, G. C., Morrill, T. C. *Spectrometric Identification of Organic Compounds*, John Wiley and Sons, INC, Fifth edition.
6. Kemp, W. *Organic Spectroscopy*, Palgrave.
7. Pavia, D. L. *et al. Introduction to Spectroscopy*, 5th Ed. Cengage Learning India Ed. (2015).
8. Dyer, J. *Application of Absorption Spectroscopy of Organic Compounds*, PHI Private Limited
9. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
10. Harwood, L. M., *Polar Rearrangements*, Oxford Chemistry Primer, Oxford University Press.
11. Bailey, Morgan, *Organonitrogen Chemistry*, Oxford Chemistry Primer, Oxford University Press.
12. Ahluwalia, V. K. *Strategies for Green Organic Synthesis*, ANE Books Pvt. Ltd. 13. Warren, S. *Organic Synthesis the Disconnection Approach*, John Wiley and Sons.
14. Warren, S., *Designing Organic Synthesis*, Wiley India, 2009.
15. Carruthers, W. *Modern methods of Organic Synthesis*, Cambridge University Press.

16. Willis, C. A., Wills, M., *Organic Synthesis*, Oxford Chemistry Primer, Oxford University Press.

18. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: IV  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: ORGANIC CHEMISTRY-III Lab, Code: CEMACOR10P,

Credit: 2

- Course coordinator: **Mr. Prasanta Das**
- Course Outcome
- CO1: Students will learn various estimations regarding bio molecules.
- CO2: Estimation of saponification value and separation of fats and oils have been discussed.

Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb	<b>Quantitative Estimations:</b> 1. Estimation of glycine by Sørensen's formol method 2. Estimation of glucose by titration using Fehling's solution	SK+PD	10hrs	Class starts from 18.02.2022
	3. Estimation of sucrose by titration using Fehling's solution 4. Estimation of vitamin-C (reduced)	SK+PD	14hrs	
Mar	5. Estimation of aromatic amine (aniline) by bromination (Bromate-Bromide) method 6. Estimation of phenol by bromination (Bromate-Bromide) method 7. Estimation of formaldehyde (Formalin)	SK+PD	18hrs	
Apr	8. Estimation of acetic acid in commercial vinegar 9. Estimation of urea (hypobromite method)	SK+PD	12 hrs	
May	10. Estimation of saponification value of oil/fat/ester	SK+PD	6 hrs	
Jun				
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Arthur, I. V. *Quantitative Organic Analysis*, Pearson

2. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta

19. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: V  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: INORGANIC CHEMISTRY-IV Code: CEMACOR11T

Credit: 4

- Course coordinator: **Dr. Suman Mandal**
- Course Outcome
- CO1: Crystal Field Theory of coordination compounds and its related aspects like magnetic moments, d-d transition, Orgel diagram etc, are discussed in detail.
- CO2: CFSE can be calculated.
- CO3: Students can differentiate between CFT and VBT concepts.
- CO4: General comparison of 3d, 4d and 5d elements in term of electronic configuration, oxidation states, redox properties are elucidated.
- CO5: General properties of Lanthanoids and Actinoids are discussed.

Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.09.2021
Aug				
Sep	VB description and its limitations. Elementary Crystal Field Theory: splitting of dn configurations in octahedral, square planar and tetrahedral fields, crystal field stabilization energy (CFSE) in weak and strong fields; pairing energy. Spectrochemical series. Jahn-Teller distortion. Octahedral site stabilization energy (OSSE).	SM	10hrs	
	<b>Transition Elements: (1)</b> General comparison of 3d, 4d and 5d elements in term of electronic configuration, oxidation states, redox properties, coordination chemistry.	BD	6hrs	
Oct	Metalligand bonding (MO concept, elementary idea), sigma- and pi-bonding in octahedral complexes (qualitative pictorial approach) and their effects on the oxidation states of transitional metals (examples). Magnetism and Colour: Orbital and spin magnetic moments, spin only moments of dn ions and their correlation with effective magnetic moments, including orbital contribution.	SM	8hrs	

	<b>Transition Elements: (2)</b> General comparison of 3d, 4d and 5d elements in term of electronic configuration, oxidation states, redox properties, coordination chemistry.	BD	4hrs	
Oct	Quenching of magnetic moment: super exchange and antiferromagnetic interactions (elementary idea with examples only); d-d transitions; L-S coupling; qualitative Orgel diagrams for 3d1 to 3d9 ions.	SM	8 hrs	
Nov	<b>Lanthanoids and Actinoids: (1)</b> General Comparison on Electronic configuration, oxidation states, colour, spectral and magnetic properties; lanthanide contraction, separation of lanthanides (ion-exchange method only).	MS	6hrs	
	Selection rules for electronic spectral transitions; spectrochemical series of ligands; charge transfer spectra (elementary idea).	SM	8hrs	
	<b>Lanthanoids and Actinoids:</b> General Comparison on Electronic configuration, oxidation states, colour, spectral and magnetic properties; lanthanide contraction, separation of lanthanides (ion-exchange method only).	MS	6hrs	
Dec	Question Answer & Problem solve	SM+BD	4hrs	
Jan	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
2. Greenwood, N.N. & Earnshaw A. Chemistry of the Elements, Butterworth Heinemann. 1997.
3. Cotton, F.A., Wilkinson, G., Murrillo, C. A., Bochmann, M., Advanced Inorganic Chemistry 6th Ed. 1999., Wiley.
4. Atkin, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).
5. Purecell, K.F. and Kotz, J.C., An Introduction to Inorganic Chemistry, Saunders: Philadelphia, 1980.
6. Sinha, S. P., Ed., Lanthanide and Actinide Research (Journal, Vol. 1, 1986).
7. Wulfsberg, G., Principles of Descriptive Inorganic Chemistry, Brooks/Cole: Monterey, CA, 1987.

20. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)

- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: V  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: INORGANIC CHEMISTRY-IV Code: CEMACOR11P

Credit: 2

- Course coordinator: **Dr. Suman Mandal**
- Course Outcome
- CO1: Learners will be accustomed with chromatography for separation of metal ions from solution mixture.
- CO2: Gravimetry is another tool for quantitative estimation and student will learn it.
- CO3: Use of Spectrophotometry, learners also can estimate chloride ions in solution. Other uses of it are also discussed here.

### Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.09.2021
Aug				
Sep	Principles involved in chromatographic separations. Paper chromatographic separation of following metalions: 1. Ni (II) and Co (II) 2. Fe (III) and Al(III)	SM +SK	12hrs	
Oct	<b>Gravimetry</b>  1. Estimation of Ni(II) using Dimethylglyoxime(DMG).  2. Estimation of copper asCuSCN.  3. Estimation of Al(III) by precipitating with oxine and weighing as Al(oxine) <sub>3</sub> (aluminium oxinate).	SM  SM	12hrs  12 hrs	
Nov		SM	12 hrs	
Dec		SM	12hrs	
Jan	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

### **Reference Books**

1.Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson,2009.

21. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: V  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: ORGANIC CHEMISTRY-V Code: CEMACOR12T

Credit: 4

- Course coordinator: **Dr. Swastik Karmakar**
- Course Outcome
- 
- CO1: Synthetic methods of Polynuclear hydrocarbons and their derivatives and there reactions are discussed.
- CO2: Synthesis of 5- and 6-membered Heterocyclic compounds and there reactivity are discussed.
- CO3: Stereochemistry of cyclic compounds, substitution reactions, elimination reactions are discussed.
- CO4: Mechanism, stereochemistry, regioselectivity of Pericyclic reactions are discussed.
- CO5: Chemistry of carbohydrates are discussed here. Different reactions of aldose, ketose and different properties are also discussd.
- CO6: Synthesis of Biomolecules likeAmino acids, peptides, nucleic acids and there properties are discussed.

Course planner

	Course Topic	Teacher	Class-hrs	Remarks
				Class starts from 01.09.2021
	<i>Polynuclear hydrocarbons and their derivatives:</i> synthetic methods include Haworth, Bardhan-Sengupta, Bogert-Cook and other useful syntheses (with mechanistic details); fixation of double bonds and Fries rule; reactions (with mechanism) of naphthalene, anthracene, phenanthrene and their derivatives.	SK	5hrs	
	<i>Alicyclic compounds:</i> concept of I-strain; conformational analysis: cyclohexane, mono and disubstituted cyclohexane; symmetry properties and optical activity; topomerisation; ring-size and ease of cyclisation; conformation & reactivity in cyclohexane system: consideration of steric and stereoelectronic requirements; elimination (E2, E1).	PD	5hrs	
	<i>Heterocyclic compounds:</i> 5- and 6-membered rings with one heteroatom; reactivity, orientation and important reactions (with mechanism) of furan, pyrrole, thiophene and pyridine; synthesis (including retrosynthetic approach and mechanistic details): pyrrole: Knorr synthesis, Paal-Knorr synthesis, Hantzsch synthesis.	SK	5hrs	

	Nucleophilic substitution (SN1, SN2, SNi, NGP), merged substitution-elimination; rearrangements; oxidation of cyclohexanol, esterification, saponification, lactonisation, epoxidation, pyrolytic syn elimination and fragmentation reactions.	PD	5hrs	
	Furan: Paal-Knorr synthesis, Feist-Benary synthesis and its variation; thiophenes: Paal-Knorr synthesis, Hinsberg synthesis; pyridine: Hantzsch synthesis; benzo-fused 5- and 6-membered rings with one heteroatom: reactivity, orientation and important reactions (with mechanistic details) of indole, quinoline and isoquinoline; synthesis (including retrosynthetic approach and mechanistic details):	SK	4 hrs	
	<i>Monosaccharides</i> : Aldoses up to 6 carbons; structure of D-glucose & D-fructose (configuration & conformation); ring structure of monosaccharides (furanose and pyranose forms): Haworth representations and non-planar conformations; anomeric effect (including stereoelectronic explanation); mutarotation; epimerization; reactions (mechanisms in relevant cases): Fischer glycosidation, osazone formation, bromine water oxidation, HNO <sub>3</sub> oxidation, selective oxidation of terminal –CH <sub>2</sub> OH of aldoses, reduction to alditols, Lobry de Bruyn-van Ekenstein rearrangement; stepping-up (Kiliani-Fischer method) and stepping-down (Ruff's & Wohl's methods) of aldoses.	PD	7 hrs	
	<i>Mechanism, stereochemistry, regioselectivity in case of Electrocyclic reactions</i> : FMO approach involving 4 $\pi$ - and 6 $\pi$ -electrons (thermal and photochemical) and corresponding cycloreversion reactions.	SK	4 hrs	
	<i>Monosaccharides</i> : Aldoses up to 6 carbons; structure of D-glucose & D-fructose (configuration & conformation); ring structure of monosaccharides (furanose and pyranose forms): Haworth representations and non-planar conformations; anomeric effect (including stereoelectronic explanation); mutarotation; epimerization; reactions (mechanisms in relevant cases): Fischer glycosidation, osazone formation, bromine water oxidation, HNO <sub>3</sub> oxidation, selective oxidation of terminal –CH <sub>2</sub> OH of aldoses, reduction to alditols, Lobry de Bruyn-van Ekenstein rearrangement; stepping-up (Kiliani-Fischer method) and stepping-down (Ruff's & Wohl's methods) of aldoses.	PD	7hrs	
	<i>Cycloaddition reactions</i> : FMO approach, Diels-Alder reaction, photochemical [2+2] cycloadditions. <i>Sigmatropic reactions</i> : FMO approach, sigmatropic shifts and their order; [1,3]- and [1,5]-H shifts and [3,3]-shifts with reference to Claisen and Cope rearrangements.	SK	4hrs	
	<i>Amino acids</i> : synthesis with mechanistic details: Strecker, Gabriel, acetamidomalonic ester, azlactone, Bücherer hydantoin synthesis, synthesis involving diketopiperazine; isoelectric point, zwitterions; electrophoresis, reaction (with mechanism): ninhydrin reaction, Dakin-West reaction; resolution of racemic amino acids. <i>Peptides</i> : peptide linkage and its geometry; syntheses (with mechanistic details) of peptides using N-protection & C-protection, solid-phase (Merrifield) synthesis; peptide sequence: C-terminal and N-terminal unit determination (Edman, Sanger & „dansyl“ methods); partial hydrolysis; specific cleavage of peptides: use of CNBr. <i>Nucleic acids</i> : pyrimidine and purine bases (only structure & nomenclature); nucleosides and nucleotides corresponding to DNA and RNA; mechanism for acid catalysed hydrolysis of nucleosides	PD	12 hrs	

	(both pyrimidine and purine types); comparison of alkaline hydrolysis of DNA and RNA; elementary idea of double helical structure of DNA (Watson-Crick model); complimentary base-pairing in DNA.			
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Clayden, J., Greeves, N., Warren, S. *Organic Chemistry*, Second edition, Oxford University Press 2012.
2. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London.
3. Nasipuri, D. *Stereochemistry of Organic Compounds*, Wiley Eastern Limited.
4. Fleming, I. *Molecular Orbitals and Organic Chemical reactions*, Reference/Student Edition, Wiley, 2009.
5. Fleming, I. *Pericyclic Reactions*, Oxford Chemistry Primer, Oxford University Press.
6. Gilchrist, T. L. & Storr, R. C. *Organic Reactions and Orbital symmetry*, Cambridge University Press.
7. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
10. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press.
11. James, J., Peach, J. M. *Stereochemistry at a Glance*, Blackwell Publishing, 2003.
12. Robinson, M. J. T., *Stereochemistry*, Oxford Chemistry Primer, Oxford University Press, 2005.
13. Davis, B. G., Fairbanks, A. J., *Carbohydrate Chemistry*, Oxford Chemistry Primer, Oxford University Press.
14. Joule, J. A. Mills, K. *Heterocyclic Chemistry*, Blackwell Science.
15. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds*, John Wiley & Sons (1976).
16. Gilchrist, T. L. *Heterocyclic Chemistry*, 3rd edition, Pearson.
17. Davies, D. T., *Heterocyclic Chemistry*, Oxford Chemistry Primer, Oxford University Press.

22. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: V  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: ORGANIC CHEMISTRY-V LAB Code: CEMACOR12P

Credit: 2

- Course coordinator: Mr. Prasanta Das
- Course Outcome
- CO1: Chromatographic Separations of amino acids and different pigments are discussed.
- CO2: Spectroscopic Analysis (IR, UV VISIBLE, NMR) of Organic Compounds are discussed.

Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.09.2021
Aug				
Sep	<b>A. Chromatographic Separations</b>  1. TLC separation of a mixture containing 2/3 aminoacids 2. TLC separation of a mixture of dyes (fluorescein and methyleneblue) 3. Column chromatographic separation of leaf pigments from spinachleaves	PD+SK	24hrs	
Oct	4. Column chromatographic separation of mixture of dyes 5. Paper chromatographic separation of a mixture containing 2/3 aminoacids 6. Paper chromatographic separation of a mixture containing 2/3 sugars.	SK	12hrs	
		PD	12 hrs	
Nov		SK	6 hrs	
Dec	<b>B. Spectroscopic Analysis of Organic Compounds</b>  Repeat Practical & practice	PD	6hrs	
Jan	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

- a. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N. University of Calcutta, 2003.
- b. *Practical Workbook Chemistry (Honours)*, UGBS, Chemistry, University of Calcutta, 2015
- c. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic*

*Chemistry, 5th Ed., Pearson (2012).*

d. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education.

23. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: V  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: ADVANCED PHYSICAL CHEMISTRY Code: CEMADSE01T

Credit: 4

- Course coordinator: **Dr. Bidyut Debnath**
- Course Outcome
- CO1: This course deals with the Bravais Lattice and Laws of Crystallography.
- CO2: In this course the learner will learn the following: The distance between consecutive planes of crystals, Miller indices, Determination of crystal structure: Powder method; Structure of NaCl and KCl crystals etc.
- CO3: In this course Statistical Thermodynamics are discussed highlighting the following: Macrostates, microstates, Boltzmann distribution, Partition function etc.
- CO4: Specific heat of solid, 3rd law of thermodynamics, adiabatic demagnetization etc are discussed.
- CO5: Classification of polymers, nomenclature, Mechanism and kinetics of step growth and copolymerization, conducting polymers etc are discussed.

#### Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.09.2021
Aug				
Sep	Configuration: Macrostates, microstates and configuration; calculation of microstates with harmonic oscillator and tossing of coins; variation of W with E; equilibrium configuration .	MS	8hrs	
	Configuration: Macrostates, microstates and configuration; calculation of microstates with harmonic oscillator and tossing of coins; variation of W with E; equilibrium configuration Boltzmann distribution: Thermodynamic probability, entropy and probability, Boltzmann distribution formula (with derivation); Applications to barometric distribution; Concept of ensemble - canonical ensemble and grand canonical ensembles	BD	10hrs	
Oct	Crystal planes: Distance between consecutive planes [cubic, tetragonal and orthorhombic lattices]; Indexing of planes, Miller indices; calculation of dhkl; Relation between molar mass and unit cell dimension for cubic system; Laue's diffraction; Bragg's law (derivation) Determination of crystal structure: Powder method; Structure of NaCl and	MS	8hrs	

	KCl crystals			
	Partition function: molecular partition function and thermodynamic properties (U, H, S, CV, q, P); Partition function correlating – Chemical equilibrium and Maxwell's speed distribution; Gibbs' paradox; Ideal gas equation.	BD	8hrs	
Nov	Partition function: molecular partition function and thermodynamic properties (U, H, S, Cv, q, P); Partition function correlating – Chemical equilibrium and Maxwell's speed distribution; Gibbs' paradox; Ideal gas equation.	MS	6hrs	
	3rd law: Absolute entropy, Plank's law, Calculation of entropy, Nernst heat theorem Adiabatic demagnetization: Approach to zero Kelvin, adiabatic cooling, demagnetization, adiabatic demagnetization – involved curves.	SM	6hrs	
	Polymers: Classification of polymers, nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers; Criteria for synthetic polymer formation; Relationships between functionality, extent of reaction and degree of polymerization; Mechanism and kinetics of step growth and copolymerization; Conducting polymers Expectation value; Hermitian operator; Postulates of Quantum Mechanics; General structure of Schrodinger equation (S.E.) and time dependency; Stationary state.	BD	8hrs	
Dec	Question Answer & Problem solve	BD	2 hrs	
	Question Answer & Problem solve	MS	2hrs	
	Question Answer & Problem solve	SM	2hrs	
Jan	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Castellan, G. W. *Physical Chemistry*, Narosa
2. Levine, I. N. *Physical Chemistry*, Tata McGraw-Hill
3. Moore, W. J. *Physical Chemistry*, Orient Longman
4. Atkins, P. W. & Paula, J. de *Atkins', Physical Chemistry*, Oxford University Press
5. McQuarrie, D. A. & Simons, J. D. *Physical Chemistry: A Molecular Approach*, Viva Press
6. Engel, T. & Reid, P. *Physical Chemistry*, Pearson
7. Nash, L. K. *Elements of Statistical Thermodynamics*, Dover
8. Rastogi, R. P. & Misra, R.R. *An Introduction to Chemical Thermodynamics*, Vikas
9. Zemansky, M. W. & Dittman, R.H. *Heat and Thermodynamics*, Tata-McGraw-Hill
10. Billmeyer, F. W. *Textbook of Polymer Science*, John Wiley & Sons, Inc.
11. Seymour, R. B. & Carraher, C. E. *Polymer Chemistry: An Introduction*, Marcel Dekker, Inc.
12. Odian, G. *Principles of Polymerization*, Wiley
13. Billmeyer, F. W. *Textbook of Polymer Science*, Wiley Interscience, 1971.

24. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: V  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: ADVANCED PHYSICAL CHEMISTRY LAB Code: CEMADSE01P Credit: 2

- Course coordinator: **Dr. Bidyut Debnath**
- Course Outcome
- CO1: Computer programs based on numerical methods for Roots of equations, Numerical differentiation, Numerical integration, Matrix operations, Simple exercises using molecular visualization software are to be done.

#### Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.09.2021
Aug				
Sep	Computer programs based on numerical methods for  Programming 1: Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid)  Programming 2: Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations)	BD+MS	24hrs	
Oct	Programming 3: Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values  Programming 4: Matrix operations (Application of Gauss-Siedel method in colourimetry)	BD+MS	12hrs  12 hrs	
Nov	Programming 5: Simple exercises using molecular visualization software	BD	6 hrs	
Dec	Repeat Practical & Tutorial		6hrs	
Jan	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				Class starts from 01.09.20 21
Aug				
Sep	Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.	BD	5hrs	
	Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. <i>UV-Visible Spectrometry:</i> Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; <i>Basic principles of quantitative analysis:</i> estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. <i>Infrared Spectrometry:</i>	SK	8hrs	
	<i>Flame Atomic Absorption and Emission Spectrometry:</i> Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal.	PD	8hrs	
Oct	Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.	SK	5hrs	
	Techniques for the quantitative estimation of trace level of metal ions from water samples.	PD	4hrs	
	Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.	SM	5hrs	
Nov	Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.	MS	10hrs	
	Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. Chromatography: Classification, principle and efficiency of the technique.	BD	5hrs	

	Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.	SK	5hrs	
Dec	Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis.	SM	5hrs	
Jan	Assessment: End-term Test		Total: 60Hrs	

25. McQuarrie, D. A. *Mathematics for Physical Chemistry* University Science Books (2008)

26. Mortimer, R. *Mathematics for Physical Chemistry*. 3rd Ed. Elsevier(2005)

27. Yates, P. *Chemical Calculations*. 2nd Ed. CRC Press(2007)

28. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5

29. Noggle, J. H. *Physical Chemistry on a Microcomputer*. Little Brown & Co.(1985)

Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: V  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: ANALYTICAL METHODS IN CHEMISTRY Code: CEMADSE02T

Credit: 4

- Course coordinator: **Dr. Monojit Sarkar**
- Course Outcome
- CO1: Qualitative and quantitative aspects of analysis of sampling, evaluation of analytical data, errors, accuracy and precision, etc are discussed.
- CO2: Basics of Optical methods of analysis are discussed. Basic principles of instrumentation of UV-Visible Spectrometry, Infrared Spectrometry, Flame Atomic Absorption and Emission Spectrometry
- CO3: Techniques for the quantitative estimation of trace level of metal ions from water samples
- CO4: Theory of thermogravimetry (TG), basic principle of instrumentation and techniques for quantitative estimation of Ca and Mg from their mixture are discussed.
- CO5: Basic principle of pH metric, potentiometric and conductometric titrations and techniques used for the determination of equivalence points, pKa values are discussed.
- CO6: Different experiments of **Separation techniques like** Solvent extraction, Chromatography, IC, GLC, GPC, TLC and HPLC etc are discussed.
- CO7: Basic principles of Stereoisomeric separation and analysis are also to be done.

- Course planner

Resources :

Books:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.*, Pearson, 48 2009.
2. Willard, H.H. *et al.: Instrumental Methods of Analysis*, 7th Ed. Wardsworth 3. Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
7. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elsevier Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8. Ditts, R.V. *Analytical Chemistry; Methods of separation*, van Nostrand, 1974.

30. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: V  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: ANALYTICAL METHODS IN CHEMISTRY LAB Code: CEMADSE02P Credit: 2

- Course coordinator: **Dr. Suman Mandal**
- Course Outcome
- CO1: Learners will be accustomed with Separation and identification of the monosaccharides, Separate a mixture of Sudan yellow and Sudan Red, active ingredients of plants, flowers and juices by TLC.
- CO2: Solvent Extractions for separation of metal ions and Spectrophotometry for determination of BOD and COD and pKa values of indicator are to be done.

Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Jul				
Aug				Class starts

Sep	<b>I. Solvent Extractions:</b>  To separate a mixture of $\text{Ni}^{2+}$ & $\text{Fe}^{2+}$ by complexation with DMG and extracting the $\text{Ni}^{2+}$ - DMG complex in chloroform, and determine its concentration by spectrophotometry.  Analysis of soil:  (i) Determination of pH of soil.	SM+MS	24hrs	from 01.09.20 21
Oct	(ii) Estimation of calcium, magnesium, phosphate Ion exchange: Determination of exchange capacity of cation exchange resins and anion exchange resins.	MS	12hrs 12 hrs	
Nov	<b>II. Spectrophotometry</b>  1. Determination of pKa values of indicator using spectrophotometry. 2. Determination of chemical oxygen demand (COD). 3. Determination of Biological oxygen demand (BOD).  Tutorial class	PD+SM	6 hrs	
Dec			6hrs	
Jan			Total: 60Hrs	
Jan	Assessment: End-term Test			

Resources :

Books:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6<sup>th</sup> Ed.*, Pearson, 2009.
2. Willard, H.H. *et al.: Instrumental Methods of Analysis*, 7<sup>th</sup> Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6<sup>th</sup> Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C. *Exploring Chemical Analysis*, 9<sup>th</sup> Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
7. Mikes, O. & Chalmers, R.A. *Laboratory Handbook of Chromatographic & Allied Methods*, Elsevier Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation*. Van Nostrand, New York, 1974.

### 31. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: VI  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: INORGANIC CHEMISTRY-V Code: CEMACOR13T,

Credit: 4

- Course coordinator: **Dr. Suman Mandal**
- Course Outcome
- CO1: Bioinorganic Chemistry i.e., Basic chemical reactions in the biological systems and the role of metal ions in biological systems are discussed.
- CO2: Definition and classification of organometallic compounds on the basis of bond type, 18- electron rule, preparation, properties of inorganic organometallic compounds are discussed.
- CO3: Catalysis by Organometallic Compounds in industrial processes are discussed.
- CO4: Introduction to inorganic reaction mechanisms, theories of trans effect, Mechanism of nucleophilic substitution, Ligand field effects etc are discussed.
- CO5: Metal complex and their application in drug synthesis are discussed.

### Course planer

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb+ March	Elements of life: essential and beneficial elements, major, trace and ultratrace elements. Basic chemical reactions in the biological systems and the role of metal ions (specially Na <sup>+</sup> , K <sup>+</sup> , Mg <sup>2+</sup> , Ca <sup>2+</sup> , Fe <sup>3+/2+</sup> , Cu <sup>2+/+</sup> , and Zn <sup>2+</sup> ). Metal ion transport across biological membrane Na <sup>+</sup> / K <sup>+</sup> -ion pump. Dioxygen molecule in life. Dioxygen management proteins: Haemoglobin, Myoglobin, Hemocyanine and Hemerythrin. Electron transfer proteins: Cytochromes and Ferredoxins. Hydrylic enzymes: carbonate bicarbonate buffering system and carbonic anhydrase and carboxyanhydrase A.	SM	12hrs	Class starts from 18.02.20 22
April	Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. 18-electron and 16-electron rules (pictorial MO approach). Applications of 18-electron rule to metal carbonyls, nitrosyls, cyanides. General methods of preparation of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls. pi-acceptor behaviour of CO, synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: Preparation, structure, evidences of synergic effect. Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Reactions of organometallic complexes: substitution, oxidative addition, reductive elimination and insertion reactions.	SM	12hrs	
May	<b>Catalysis by Organometallic Compounds</b> Study of the following industrial processes 1. Alkene hydrogenation (Wilkinson's Catalyst) 2. Hydroformylation	SM	12hrs	

	3. Wacker Process 4. Synthetic gasoline (Fischer Tropsch reaction) 5. Ziegler-Natta catalysis for olefin polymerization.			
May+June	Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect and its application in complex synthesis, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.	SM	12hrs	
	Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect and its application in complex synthesis, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.	MS	12 hrs	
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.
2. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 4<sup>th</sup> Ed.*, Harper Collins 1993, Pearson, 2006.
3. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, ButterworthHeinemann, 1997.
4. Cotton, F.A., Wilkinson, G., Murrillo, C. A., Bochmann, M., *Advanced Inorganic Chemistry 6<sup>th</sup> Ed.* 1999., Wiley.
5. Bertini, I., Gray, H. B., Lippard, S.J., Valentine, J. S., Viva, 2007.
6. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
7. Purecell, K.F. and Kotz, J.C., *An Introduction to Inorganic Chemistry*, Saunders: Philadelphia, 1980.
8. Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
9. Collman, J. P. *et al. Principles and Applications of Organotransition Metal Chemistry*. Mill Valley, CA: University Science Books, 1987.
10. Crabtree, R. H. *The Organometallic Chemistry of the Transition Metals*. New York, NY: John Wiley, 2000.

32. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: VI  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: INORGANIC CHEMISTRY-V LAB      Code: CEMACOR13P      Credit: 2

- Course coordinator: **Dr. Suman Mandal**
- Course Outcome
- CO1: Students get total ideas about qualitative analysis of each and every inorganic sample.
- CO2: Qualitative semi microanalysis of mixtures containing radicals of inorganic salts is discussed.

Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb				Class starts from 18.02.2022
March	<b>Qualitative semimicro analysis of mixtures containing four radicals. Emphasis should be given to the understanding of the chemistry of different reactions and to assign the most probable composition.</b>  Cation Radicals: $\text{Na}^+$ , $\text{K}^+$ , $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Al}^{3+}$ , $\text{Cr}^{3+}$ , $\text{Mn}^{2+}/\text{Mn}^{4+}$ , $\text{Fe}^{3+}$ , $\text{Co}^{2+}/\text{Co}^{3+}$ , $\text{Ni}^{2+}$ , $\text{Cu}^{2+}$ , $\text{Zn}^{2+}$ , $\text{Pb}^{2+}$ , $\text{Cd}^{2+}$ , $\text{Bi}^{3+}$ , $\text{Sn}^{2+}/\text{Sn}^{4+}$ , $\text{As}^{3+}/\text{As}^{5+}$ , $\text{Sb}^{3+}/\text{Sb}^{5+}$ , $\text{NH}_4^+$ , $\text{Mg}^{2+}$ .	SM	24hrs	
April	Anion Radicals: $\text{F}^-$ , $\text{Cl}^-$ , $\text{Br}^-$ , $\text{BrO}_3^-$ , $\text{I}^-$ , $\text{IO}_3^-$ , $\text{SCN}^-$ , $\text{S}^{2-}$ , $\text{SO}_4^{2-}$ , $\text{NO}_3^-$ , $\text{NO}_2^-$ , $\text{PO}_4^{3-}$ , $\text{AsO}_4^{3-}$ , $\text{BO}_3^{3-}$ , $\text{CrO}_4^{2-}$ / $\text{CrO}_2^{2-}$ , $\text{Fe}(\text{CN})_6^{4-}$ , $\text{Fe}(\text{CN})_6^{3-}$ . Insoluble Materials: $\text{Al}_2\text{O}_3(\text{ig})$ , $\text{Fe}_2\text{O}_3(\text{ig})$ , $\text{Cr}_2\text{O}_3(\text{ig})$ , $\text{SnO}_2$ , $\text{SrSO}_4$ , $\text{BaSO}_4$ , $\text{CaF}_2$ , $\text{PbSO}_4$	MS+SM	12hrs 12 hrs	
May		SM	6 hrs	
			6hrs	
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books: 1. Svehla, G., *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.

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- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: VI  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: PHYSICAL CHEMISTRY- IV Code: CEMACOR14T,

Credit: 4

- Course coordinator: **Dr. Bidyut Debnath**
- Course Outcome
- CO1: Interaction of electromagnetic radiation with molecules are discussed.
- CO2: Rotation spectroscopy, Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules are discussed.
- CO3: Vibrational spectroscopy, Classical equation of vibration, Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines, Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, interpretation of PMR spectra of organic molecules, Electron Spin Resonance (ESR) spectroscopy: Its principle are discussed.
- CO4: Laws of photochemistry, photochemical Processes: potential energy curves, rate of photochemical processes: Photochemical equilibrium etc are discussed.
- CO5: Surface tension surface energy of liquid flow are discussed.
- CO6: Adsorption: Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm etc are discussed.
- CO7: Colloids, Coagulation and Schultz-Hardy rule, Zeta potential, Stability of colloids, micelle formation etc are discussed.

Course planer

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb+ March	Interaction of electromagnetic radiation with molecules; Transition between two states and time-dependent S.E.; Transition moment integral and selection rules; Various types of spectra Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies; Diatomic vibrating rotator, P, Q, R branches.	MS	12hrs	Class starts from 18.02.2022
	Lambert-Beer's law: Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients; Laws of photochemistry, 42 Stark-Einstein law of photochemical equivalence, quantum yield, actinometry, examples of low and high quantum yields Photochemical Processes: Potential energy curves (diatomic molecules), Frank-Condon principle and vibrational structure of electronic spectra; Bond dissociation and principle of determination of dissociation energy (ground state); Decay of excited states by radiative and non-radiative paths; Pre-dissociation; Fluorescence and phosphorescence, Jablonskii diagram.	BD	8 hrs	

April	Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.	MS	13hrs	
	Rate of Photochemical processes: Photochemical equilibrium and the differential rate of photochemical reactions, Photostationary state; HI decomposition, H <sub>2</sub> -Br <sub>2</sub> reaction, dimerisation of anthracene; photosensitised reactions, quenching; Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.	BD	7 hrs	
May	Surface tension and energy: Surface tension, surface energy, excess pressure, capillary rise and surface tension; Work of cohesion and adhesion, spreading of liquid over other surface; Vapour pressure over curved surface; Temperature dependence of surface tension.	SM	7hrs	
	Adsorption: Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs' adsorption isotherm and surface excess; Heterogenous catalysis (single reactant); Zero order and fractional order reactions.	MS	7 hrs	
	Colloids: Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids, Coagulation and Schultz-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Determination of Avogadro number by Perrin's method; Stability of colloids and zeta potential; Micelle formation.  <b>Tutorial</b>	BD	6 hrs	
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Castellan, G. W. Physical Chemistry, Narosa
2. Levine, I. N. Physical Chemistry, Tata McGraw-Hill
3. Atkins, P. W. & Paula, J. de Atkin's, Physical Chemistry, Oxford University Press
4. McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press
5. Mortimer, R. G. Physical Chemistry, Elsevier
6. Laidler, K. J. Chemical Kinetics, Pearson
7. Banwell, C. N. Fundamentals of Molecular Spectroscopy, Tata-McGraw-Hill
8. Barrow, G. M. Molecular Spectroscopy, McGraw-Hill
9. Hollas, J.M. Modern Spectroscopy, Wiley India
10. McHale, J. L. Molecular Spectroscopy, Pearson Education

11. Wayne, C. E. & Wayne, R. P. Photochemistry, OUP
12. Brown, J. M. Molecular Spectroscopy, OUP
13. Levine, I. N. Quantum Chemistry, PHI
14. Atkins, P. W. Molecular Quantum Mechanics, Oxford

33. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: VI  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: PHYSICAL CHEMISTRY- IV LAB    Code: CEMACOR14P    Credit: 2

- Course coordinator: **Dr. Monojit Sarkar**
- Course Outcome
- CO1: Lots of physical experiments will be learnt by the students.
- CO2: Students get ideas about the surfactants and its CMC measurement.
- CO3: Determination of surface tension of a liquid, CMC, verification of Beer and Lambert's Law, pH spectrophotometrically are to be done.

#### Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb				Class starts from 18.02.2022
March	Experiment 1: Determination of surface tension of a liquid using Stalagmometer  Experiment 2: Determination of CMC from surface tension measurements	BD	12hrs	
April	Experiment 3: Verification of Beer and Lambert's Law for $\text{KMnO}_4$ and $\text{K}_2\text{Cr}_2\text{O}_7$ solution  Experiment 4: Study of kinetics of $\text{K}_2\text{S}_2\text{O}_8 + \text{KI}$ reaction, spectrophotometrically	MS+BD	10hrs  10 hrs	
May	Experiment 5: Determination of pH of unknown buffer, spectrophotometrically	BD	10 hrs	
	Experiment 6: Spectrophotometric determination of CMC  Tutorial class		10hrs  8hrs	
	Assessment: End-term Test		Total: 60Hrs	

Resources :

1. Books: Viswanathan, B., Raghavan, P.S. *Practical Physical Chemistry* Viva Books(2009)
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson
3. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman(2007)
4. Palit, S.R., De, S. K. *Practical Physical Chemistry* Science Book Agency
5. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta
6. Levitt, B. P. edited *Findlay's Practical Physical Chemistry* Longman Group Ltd.
7. Gurtu, J. N., Kapoor, R., *Advanced Experimental Chemistry* S. Chand & Co. Ltd.

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- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: VI  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS  
CEMACORDSE03T,

Code:  
Credit: 4

- Course coordinator: **Dr. Monojit Sarkar**
- Course Outcome
- CO1: Recap of the spectroscopic methods covered in detail in the core chemistry syllabus.
- CO2: Interpretation of spectrum of UV-Visible/ Near IR, FTIR and related aspects of the instruments are discussed.
- CO3: Types of Chromatography and their use in separation techniques are discussed.
- CO4: Principle, Instrumentation and data analysis of Mass spectrometry, Atomic absorption, Atomic emission, and Atomic fluorescence, NMR spectroscopy to be done.
- CO5: Principle, Instrumentation and data analysis of Potentiometry & Voltammetry, X-ray analysis and electron spectroscopy are to be done.

Course planer

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb+ March	Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.	SK	4hrs	Class starts from 18.02.2022
	Interactions with molecules: absorption and scattering. Means of	SK	8 hrs	

	excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.			
	<i>Chromatography:</i> Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field).	PD	8 hrs	
April	<i>UV-Visible/ Near IR</i> – emission, absorption, fluorescence and photoacoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoacoustic, fluorescent tags).	SK	8hrs	
	Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.	PD	8 hrs	
May	Mass spectrometry (electrical discharges). Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).	SK	8hrs	
	Potentiometry & Voltammetry surface excess; Heterogenous catalysis (single reactant); Zero order and fractional order reactions.	PD	8 hrs	
	Radiochemical Methods, X-ray analysis and electron spectroscopy ( <b>surface analysis</b> ):	SK, PD	8 hrs	
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. D.A. Skoog, F.J. Holler & S. Crouch (ISBN 0-495-01201-7) *Principles of Instrumental Analysis*, Cengage Learning India Edition, 2007.
2. Willard, Merritt, Dean, Settle, *Instrumental Methods of Analysis*, 7th ed, IBH Book House, New Delhi.
3. Atkins, P.W & Paula, J.D. *Physical Chemistry*, 10<sup>th</sup> Ed., Oxford University Press (2014).
4. Kakkar, R. *Atomic and Molecular Spectroscopy: Concepts and Applications*. Cambridge University Press, 2015.
5. Castellan, G. W. *Physical Chemistry 4<sup>th</sup> Ed.*, Narosa (2004).
6. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy 4<sup>th</sup> Ed.*
7. Smith, B.C. *Infrared Spectral Interpretations: A Systematic Approach*. CRC Press, 1998.

8. Moore, W.J., *Physical Chemistry* Orient Blackswan, 1999.

34. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: VI  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

Code: CEMADSE03P

Credit: 2

- Course coordinator: **Dr. Swastik Karmakar**
- Course Outcome
- CO1: Safety Practices in the Chemistry Laboratory.
- CO2: Determination of a Mixture by UV/Vis spectra, Gas Chromatography, HPLC, Cyclic Voltammetry, NMR.
- CO3: Detection of illegal drugs or steroids in athletes, Detection of pollutants or illegal dumping, Fibre analysis etc.

#### Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb				Class starts from 18.02.2022
March	Safety Practices in the Chemistry Laboratory 2. Determination of the isoelectric pH of a protein. 3. Titration curve of an amino acid. 4. Determination of the void volume of a gel filtration column. 5. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.) 6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water) 7. IR Absorption Spectra (Study of Aldehydes and Ketones) 8. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption	SM	24hrs	
April	9. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride) 10. Separation of Carbohydrates	MS	12hrs 12 hrs	

May	HPLC	by	BD	6 hrs	
	11.	Determination of Caffeine in Beverages by HPLC			
	12.	Potentiometric Titration of a Chloride-Iodide Mixture	SK	6hrs	
	13.	Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple			
	14.	Nuclear Magnetic Resonance			
	15.	Use of fluorescence to do “presumptive tests” to identify blood or other body fluids.			
	16.	Use of “presumptive tests” for anthrax or cocaine			
	17.	Collection, preservation, and control of blood evidence being used for DNA testing			
	18.	Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome)			
	19.	Use of sequencing for the analysis of mitochondrial DNA			
	20.	Laboratory analysis to confirm anthrax or cocaine			
	21.	Detection in the field and confirmation in the laboratory of flammable accelerants or explosives			
	22.	Detection of illegal drugs or steroids in athletes			
	23.	Detection of pollutants or illegal dumping			
	24.	Fibre analysis			
	Assessment: End-term Test			Total: 60Hrs	

Resources :

1. Books: 1 Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7<sup>th</sup> Ed. Wadsworth Publishing Company Ltd.,

Belmont, California, USA, 1988

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: VI

Department of Chemistry  
Basirhat College

Lesson Plan for Course: **GREEN CHEMISTRY** Code: **CEMACORDSE04T**,

Credit: 4

- Course coordinator: Dr. Swastik Karmakar
- Course Outcome
- CO1: It about the go green for the chemistry.
- CO2: For the students this course is very much important as it is green chemistry so it tells about the chemicals that are environment friendly and less harmful for the human beings.
- CO3: This course deals with Principles of Green Chemistry and Designing a Chemical synthesis.
- CO4: Examples of Green Synthesis/ Reactions and some real world cases are to be studied.
- CO5: Students have to know about Future Trends in Green Chemistry.

Course planer

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb+ March	What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.	SM	4hrs	Class starts from 18.02.2022
	Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following: □ Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products , Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. Prevention/ minimization of hazardous/ toxic products reducing toxicity. risk = (function) hazard × exposure; waste or pollution prevention hierarchy.	SK	10 hrs	
	1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis) 2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions 54 in organic solvents Diels-Alder reaction and Decarboxylation reaction 3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction  (Ultrasonic alternative to Iodine) 4 Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO <sub>2</sub> for precision cleaning and dry cleaning of garments.	PD	8 hrs	

April	<p>Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluoruous biphasic solvent, PEG, solventless processes, immobilized</p> <p>□ solvents and how to compare greenness of solvents.</p> <ul style="list-style-type: none"> <li>▪ Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy. □</li> <li>▪ Selection of starting materials; avoidance of unnecessary derivatization – careful □ use of blocking/protecting groups. □</li> <li>▪ Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and</li> </ul> <p>5 Designing of Environmentally safe marine antifoulant.</p> <p>6 Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.</p> <p>7 An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.</p> <p>8 Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils</p> <p>9 Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting</p>	SK	8hrs	8 hrs
May	Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C <sub>2</sub> S <sub>3</sub> ); Green chemistry in sustainable development.	MS	10 hrs	
	<p>homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis. □</p> <p>□ Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD “What you don’t have cannot harm you”, greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization,</p> <p>□ simplification, substitution, moderation and limitation. □</p> <p>□ Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes. □</p>	SK	8 hrs	
May	Problem solve& Tutorial	SK, PD	4 hrs	
	Assessment: End-term Test		Total: 60Hrs	

Resources :

Books:

1. Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
2. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
3. Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
4. Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).

5. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2<sup>nd</sup> Edition, 2010.

35. Other resources :

\*Remarks will specify

- The nature of the class-topic (viz. Theoretical, Practical, and Tutorial).
- Methodology of teaching (whether using ICT, engaging students in group discussion, quiz etc. etc.)
- Different modes of assessment. (Please check UGC evaluation reforms).

Semester: VI  
Department of Chemistry  
Basirhat College

Lesson Plan for Course: GREEN CHEMISTRY LAB

Code: CEMADSE04P

Credit: 2

- Course coordinator: **Dr. Swastik Karmakar**
- Course Outcome
- CO1: Preparation and characterization of nanoparticles of gold using tea leaves.
- CO2: Using renewable resources like preparation of biodiesel, use of enzymes as catalysts instead of other hazardous catalyst, alternative green solvents extraction, use of alternative sources of energy like sunlight in chemical reactions etc are to be studied.

#### Course planner

Sl	Course Topic	Teacher	Class-hrs	Remarks
Feb				Class starts from 18.02.2022
March	<b>1. Safer starting materials</b> <ul style="list-style-type: none"> <li>• Preparation and characterization of nanoparticles of gold using tea leaves.</li> </ul>	SM	24hrs	
April	10. Using renewable resources 11. 12. Preparation of biodiesel from vegetable/waste cooking oil. 13.	SK	12hrs 12 hrs	
May	14. Avoiding waste 15. 16. Principle of atom economy 17.	SK	6 hrs	
	18. Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry. 19. Preparation of propene by two methods can be studied 20. Triethylamine ion + OH <sup>-</sup> → propene + trimethylpropene + water H <sub>2</sub> SO <sub>4</sub> /Δ 21. 1-propanol → propene + water	PD	6hrs	

	22. 23. Other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atomeconomy. 24. <b>25. Use of enzymes as catalysts</b> <b>26.</b> 27. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide. 28. <b>29. Alternative Green solvents</b> <b>30.</b> 31. Extraction of D-limonene from orange peel using liquid CO <sub>2</sub> prepared from dry ice. 32. 33. Mechanochemical solvent free synthesis of azomethines 34. <b>35. Alternative sources of energy</b> <b>36.</b> 37. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper(II). 38. Photoreduction of benzophenone to benzopinacol in the presence of sunlight. 39. 25. in athletes 26. Detection of pollutants or illegal dumping 27. Fibre analysis			
	Assessment: End-term Test		Total: 60Hrs	

Resources :

- Books: Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press(1998).
- Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC(2002).
- Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC(2002).
- Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore* CISBN978-93-81141-55-7(2013).

7. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society(2008).
8. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society(2008).
9. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2<sup>nd</sup>Edition,2010.
10. Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. *Introduction to OrganicLaboratory Techniques: A Microscale and Macro ScaleApproach*,

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11. W.B.Saunders,1995.

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