# BANKURA SAMMILANI COLLEGE

## Department of Chemistry

## Teaching Module

## Subject: Chemistry (Core)

## UG, SEM I-VI Semester

## Faculty: Dr. Sabir Ahammed

**Core T1 - Organic Chemistry I**

| Core Topic | Modules | No. of Lectures |
|---|---|---|
| **General Treatment of Reaction Mechanism I** | Mechanistic classification: ionic, radical and pericyclic (definition and example) | 1 |
| | Reaction type: addition, elimination and substitution reactions (definition and example) | 1 |
| | Stereochemical representation of Newman and interconversions. | 1 |
| | Nature of bond cleavage and bond formation: homolytic and heterolytic bond fission, homogenic and heterogenic bond formation | 1 |
| | Curly arrow rules in representation of mechanistic steps | 1 |
| | Reagent type: electrophiles and nucleophiles (elementary idea) | 1 |
| | Electrophilicity and nucleophilicity in terms of FMO approach | 1 |
| | Reactive intermediates: carbocations (carbenium and carbonium ions) | 1 |
| | Reactive intermediates: carbanions: generation and stability, structure using orbital picture | 1 |
| | Reactive intermediates: carbon radicals: generation and stability, structure using orbital picture | 1 |
| | Reactive intermediates: carbenes: generation and stability, structure using orbital picture | 1 |
| | Electrophilic/nucleophilic behavior of reactive intermediates (elementary idea) | 1 |

**Core T4 - Organic Chemistry II**

| Core Topic | Modules | No. of Lectures |
|---|---|---|
| **Substitution and Elimination Reactions** | Free-radical substitution reaction: halogentaion of alkanes, mechanism (with evidence) and stereochemical features; reactivity-selectivity principle in the light of Hammond's postulate | 1 |
| | Nucleophilic substitution reactions: substitution at sp3 centre: mechanisms (with evidence), relative rates & stereochemical features | 1 |
| | SN1, SN2, SN2', SN1' (allylic rearrangement) and SNi | 1 |
| | effects of solvent, substrate structure, leaving group and nucleophiles (including ambident nucleophiles, cyanide & nitrite) | 1 |
| | Substitutions involving NGP | 1 |
| | Role of crown ethers and phase transfer catalysts; [systems: alkyl halides, allyl halides, benzyl halides, alcohols, ethers, epoxides] | 1 |
| | Elimination reactions: E1, E2, E1CB and Ei (pyrolytic syn eliminations) | 1 |
| | Formation of alkenes and alkynes; mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann) and stereoselectivity | 1 |
| | Comparison between substitution and elimination | 1 |
| | Importance of Bredt's rule relating to the formation of C=C | 1 |

**Core T7 - Organic Chemistry III**

| Core Topic | Modules | No. of Lectures |
|---|---|---|
| **Organometallics** | Grignard reagent: preparation and reactions (mechanism with evidence) | 1 |
| | Organolithiums: preparation and reactions (mechanism with evidence) | 1 |
| | Gilman cuprates: preparation and reactions (mechanism with evidence) | 1 |
| | Addition of Grignard and organolithium to carbonyl compounds | 1 |
| | Substitution on -COX; directed ortho metalation of arenes using organolithiums, conjugate addition by Gilman cuprates | 1 |
| | Corey-House synthesis, abnormal behavior of Grignard reagents | 1 |
| | Comparison of reactivity among Grignard, organolithiums and organocopper reagents | 1 |
| | Reformatsky reaction; Blaise reaction | 1 |
| | Concept of umpolung and base-nucleophile dichotomy in case of organometallic reagents | 1 |
| **Carbonyl and Related Compounds** | Nucleophilic addition to α,β-unsaturated carbonyl system: general principle and mechanism (with evidence) | 1 |
| | Direct and conjugate addition, addition of enolates (Michael reaction), Stetter reaction, Robinson annulation | 1 |
| | Substitution at sp2 carbon (C=O system): mechanism (with evidence): BAC2, AAC2, AAC1, AAL1 (in connection to acid and ester) | 1 |
| | Acid derivatives: amides, anhydrides & acyl halides (formation and hydrolysis including comparison) | 1 |
| **Green Chemistry** | Elementary ideas of Green Chemistry: Twelve (12) principles of green chemistry | 1 |
| | Planning of green synthesis | 1 |
| | common organic reactions and their counterparts: reactions: Aldol,Friedel-Crafts, Michael, Knoevenagel, Cannizzaro, benzoin condensation and Dieckmann condensation | 1 |

**Core T10 - Organic Chemistry IV**

| Core Topic | Modules | No. of Lectures |
|---|---|---|
| **Nitrogen compounds** | Amines: Aliphatic & Aromatic: preparation, separation (Hinsberg's method) and identification of primary, secondary and tertiary amines; reaction (with mechanism) | 1 |
| | Eschweiler–Clarke methylation, diazo coupling reaction, Mannich reaction | 1 |
| | Formation and reactions of phenylenediamines, diazomethane and diazoacetic ester | 1 |
| | Nitro compounds (aliphatic and aromatic): preparation and reaction (with mechanism): reduction under different conditions | 1 |
| | Nef carbonyl synthesis, Henry reaction and conjugate addition of nitroalkane anion | 1 |
| | Alkylnitrile and isonitrile: preparation and reaction (with mechanism): Thorpe nitrile condensation, von Richter reaction. | 1 |
| | Diazonium salts and their related compounds: reactions (with mechanism) involving replacement of diazo group; reactions: Gomberg, Meerwein, Japp-Klingermann. | 1 |
| **Rearrangements** | Rearrangement to electron-deficient carbon: Wagner-Meerwein rearrangement, pinacol rearrangement, dienone-phenol; Wolff rearrangement in Arndt-Eistert synthesis, benzilbenzilic acid rearrangement, Demjanov rearrangement, Tiffeneau–Demjanov rearrangement | 1 |
| | Rearrangement to electron-deficient nitrogen: rearrangements: Hofmann, Curtius, Lossen, Schmidt and Beckmann. | 1 |
| | Rearrangement to electron-deficient oxygen: Baeyer-Villiger oxidation, cumene hydroperoxide-phenol rearrangement and Dakin reaction. | 1 |
| | Aromatic rearrangements: Migration from oxygen to ring carbon: Fries rearrangement and Claisen rearrangement. | 1 |
| | Migration from nitrogen to ring carbon: Hofmann-Martius rearrangement, Fischer-Hepp rearrangement, N-azo to C-azo rearrangement, Bamberger rearrangement, Orton rearrangement and benzidine rearrangement | 1 |
| | Rearrangement reactions by green approach: Fries rearrangement, Claisen rearrangement, Beckmann rearrangement, Baeyer-Villiger oxidation. | 1 |

**Core T12 - Organic Chemistry V**

| Core Topic | Modules | No. of Lectures |
|---|---|---|
| **Biomolecules** | Amino acids: synthesis with mechanistic details: Strecker, Gabriel, acetamido malonic ester, azlactone | 1 |
| | Amino acids: synthesis with mechanistic details: Bücherer hydantoin synthesis, synthesis involving diketopiperazine | 1 |
| | Isoelectric point, zwitterions; electrophoresis, reaction (with mechanism): ninhydrin reaction, Dakin-West reaction; resolution of racemic amino acids | 1 |
| | Peptides: peptide linkage and its geometry | 1 |
| | Syntheses (with mechanistic details) of peptides using N-protection & C-protection, solid-phase (Merrifield) synthesis | 1 |
| | peptide sequence: Cterminal and N-terminal unit determination (Edman, Sanger & 'dansyl' methods) | 1 |
| | Partial hydrolysis; specific cleavage of peptides: use of CNBr. | 1 |
| | Nucleic acids: pyrimidine and purine bases (only structure & nomenclature) | 1 |
| | Nucleosides and nucleotides corresponding to DNA and RNA | 1 |
| | Mechanism for acid catalysed hydrolysis of nucleosides (both pyrimidine and purine types) | 1 |
| | Comparison of alkaline hydrolysis of DNA and RNA | 1 |
| | Elementary idea of double helical structure of DNA (Watson-Crick model) | 1 |
| | Complimentary base–pairing in DNA | 1 |

# MODULE of the UG Syllabus Under CBCS and Semester System
# by DR. SAMARESH GHOSH

**Subject: UG Chemistry (Core)**

| Course | Course Title/ID | Course Type | Semester |
|---|---|---|---|
| SHCHE/101/C-1 | Organic Chemistry I/11411 | C-1 | I |

| Module | Course Description | Lectures |
|---|---|---|
| **1** | **Bonding and Physical Properties** | |
| 1.1 | Valence Bond Theory: Concept of hybridization, shapes of molecules, calculation of formal charges and double bond equivalent (DBE); orbital pictures of bonding (sp3, sp2, sp: C-C, C-N & C-O systems and s-cis and s-trans geometry for suitable cases) | 3 |
| 1.2 | Electronic displacements: inductive effect, field effect, mesomeric effect, resonance (including hyperconjugation); resonance energy; bond polarization and bond polarizability; electromeric effect; steric effect, steric inhibition of resonance. | 4 |
| 1.3 | Physical properties: 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. | 4 |
| 1.4 | MO theory: Qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ*, π, π *, 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 π 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); 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 α and β; measurement of delocalization energies in terms of β for buta-1,3-diene, cyclobutadiene, hexa-1,3,5-triene and benzene. | 5 |
| 1.5 | Assignment and discussion | 1 |
| **2** | **General Treatment of Reaction Mechanism I** | XXX |
| **3** | **Stereochemistry-I** | XXX |

Text Books

1. I. L. Finar, Organic Chemistry (Volume 1), Pearson Education.
2. T.W. Graham Solomons, C. B. Fryhle, Organic Chemistry, John Wiley & Sons, Inc.
3. N. Tewari, Organic Chemistry-A Modern Approach (Volume 1), McGraw Hill Education.

For Further Reading

*Contd*------

1. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, Second edition, Oxford University Press.
2. I. Fleming, Molecular Orbitals and Organic Chemical Reactions, Reference/Student Edition, Wiley.

# MODULE of the PG Syllabus under Semester System
# by DR. SAMARESH GHOSH

| Core Subject | Paper Code | Semester |
|---|---|---|
| **Organic Chemistry** | CHEM102C | I |

| Module | Course Description | Lectures |
|---|---|---|
| 1 | **Bonding in Organic Molecules** | XXX |
| 2 | **Stereochemistry and Conformational Analysis-I** | XXX |
| **3** | **NMR Spectroscopy** | |
| 3.1 | Principles, instrumentation and different techniques (CW and FT) of NMR spectroscopy. | 1 |
| 3.2 | Factors influencing chemical shift, spin-spin interactions, coupling constant (J); Jablonski diagram, spin-decoupling. First order and second order spectra, spin system notations. | 3 |
| 3.3 | Introduction to 13C: proton decoupled 13C spectra, NOE, cross polarization, peak integration, off resonance 13C. | 3 |
| 4 | **Mass Spectroscopy** | |
| 4.1 | Mass Spectroscopy Principles, instrumentation and applications of mass spectrometry-methods of generation of ions in EI, CI, FD and FAB, MALDI-TOF. | 2 |
| 4.2 | Detection of ions, ion analysis, ion abundance, molecular ion peak, metastable peak, isotope, ion-molecule interaction and analysis of fragmentation patterns. Calculation of MF from mass. | 3 |
| 4.3 | Applications of Mass, UV-VIS, IR and NMR spectroscopy to structural and mechanistic problems. | 2 |

Reference Books


1. P.S. Kalsi, *Spectroscopy of Organic Compounds*, New Age International Publishers
2. W. Kemp, Organic Spectroscopy, Palgrave.
3. D. L. Pavia et al. *Introduction to Spectroscopy*, Cengage Learning India Ed.
4. J. Dyer, *Application of Absorption Spectroscopy of Organic Compounds*, PHI Private Ltd.
5. R. M. Silverstein, G. C. Bassler and T. C. Morrill, *Spectroscopic Identification of Organic Compounds*, John Wiley & Sons, Inc.

# MODULE of the PG Syllabus under Semester System
# by DR. SAMARESH GHOSH

| Core Subject | Paper Code | Semester |
|---|---|---|
| **Organic Chemistry** | CHEM202C | II |

| Module | Course Description | Lectures |
|---|---|---|
| **1** | **Heterocyclic Chemistry-I** | |
| 1.1 | Systematic nomenclature (Hantzch-Widman system) for monocycle and fused heterocycles. | 2 |
| 1.2 | General approach to heterocyclic synthesis-cyclisation and cycloaddition routes. Heterocycles in organic synthesis-masked functionalities, umpolung, Stork annulations reaction. Rearrangement and ring transformation involving 5- and 6-membered heterocycles with one heteroatom. | 4 |
| 1.3 | Assignment and Discussion | 1 |
| 2 | **Organic Name Reaction and Reagents** | XXX |
| 3 | **Pericyclic Reactions-I** | XXX |
| 4 | **Asymmetric Synthesis** | XXX |

Reference Books


1. J. Clayden, N. Greeves, S. Warren, *Organic Chemistry*, Oxford University Press .
2. J.A. Joule, K. Mills, *Heterocyclic Chemistry*, Blackwell Science.
3. T. L. Gilchrist, *Heterocyclic Chemistry*, Pearson Education.

# MODULE of the UG Syllabus Under CBCS and Semester System
# by DR. SAMARESH GHOSH

**Subject: UG Chemistry (Core)**

| Course | Course Title/ID | Course Type | Semester |
|---|---|---|---|
| SHCHE/202/C-4 | Organic Chemistry II/21412 | C-4 | II |

| Module | Course Description | Lectures |
|---|---|---|
| **1** | **Stereochemistry II** | XXX |
| **2** | **General Treatment of Reaction Mechanism II** | |
| 2.1 | Reaction thermodynamics: free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change via BDE, intermolecular & intramolecular reactions. | 3 |
| 2.2 | Concept of organic acids and bases: effect of structure, substituent and solvent on acidity and basicity; proton sponge; gas-phase acidity and basicity; comparison between nucleophlicity and basicity; HSAB principle; application of thermodynamic principles in acid base equilibria. | 4 |
| 2.3 | Tautomerism: prototropy (keto-enol, nitro - aci-nitro, nitroso-oximino, diazo-amino and enamine-imine systems); valence tautomerism and ring-chain tautomerism; composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3-dicarbonyl systems, phenols and related systems), factors affecting keto-enol tautomerism; application of thermodynamic principles in tautomeric equilibria. | 3 |
| 2.4 | Reaction kinetics: rate constant and free energy of activation; concept of order and molecularity; free energy profiles for one-step, two-step and three-step reactions; catalyzed reactions: electrophilic and nucleophilic catalysis; kinetic control and thermodynamic control of reactions; isotope effect: primary and secondary kinetic isotopiceffect ($k_H$ /$k_D$); principle of microscopic reversibility; Hammond's postulate. | 5 |
| 2.5 | Assignment and discussion | 1 |
| 3 | **Substitution and Elimination Reactions** | XXX |

Text Books


1. T.W. Graham Solomons, C. B. Fryhle, Organic Chemistry, John Wiley & Sons, Inc.
2. N. Tewari, Advanced Organic Reaction Mechanism, Books & Allied (P) Ltd.
3. M.S. Singh, Advanced Organic Chemistry-Reactions and Mechanisms, Pearson Education.


For Further Reading


1. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, Second edition, Oxford University Press.
2. G.M. Loudon, Organic Chemistry, Fourth edition, Oxford University Press.

# MODULE of the UG Syllabus Under CBCS and Semester System
# by DR. SAMARESH GHOSH

**Subject: UG Chemistry (Core)**

| Course | Course Title/ID | Course Type | Semester |
|---|---|---|---|
| SHCHE/303/C-7 | Organic Chemistry III/31413 | C-7 | III |

| Module | Course Description | No. of Lectures |
|---|---|---|
| **1** | **Chemistry of alkenes and alkynes** | XXX |
| **2** | **Aromatic Substitution** | XXX |
| **3** | **Carbonyl and Related Compounds** | |
| **3.1** | **Addition to C=O:** structure, reactivity and preparation of carbonyl compounds; mechanism (with evidence), reactivity, equilibrium and kinetic control; Burgi-Dunitz trajectory in nucleophilic additions; formation of hydrates, cyano hydrins 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, LiAlH4, NaBH4, MPV, Oppenauer, Bouveault-Blanc, acyloin condensation; oxidation of alcohols with PDC and PCC; periodic acid and leadtetraacetate oxidation of 1,2-diols. | 5 |
| 3.2 | **Exploitation of acidity of α-H of C=O:** formation of enols and enolates; kinetic and thermodynamic enolates; reactions (mechanism with evidence): halogenation of carbonyl compounds under acidic and basic conditions, Hell-Volhard-Zelinsky (H. V. Z.) reaction, nitrosation, SeO2 (Riley) oxidation; condensations (mechanism with evidence): Aldol, Tollens', Knoevenagel, Claisen-Schmidt, Claisen ester including Dieckmann, Stobbe; Mannich reaction, Perkin reaction, Favorskii rearrangement; alkylation of active methylene compounds; preparation and synthetic applications of diethyl malonate and ethyl acetoacetate; specific enol equivalents (lithium enolates, enamines, aza-enolates and silyl enol ethers) in connection with alkylation, acylation and aldol type reaction. | 4 |
| 3.3 | **Elementary ideas of Green Chemistry:** Twelve (12) principles of green chemistry; planning of green synthesis; common organic reactions and their counterparts: reactions: Aldol,Friedel- Crafts, Michael, Knoevenagel, Cannizzaro, benzoin condensation and Dieckmann condensation. | 3 |
| 3.4 | **Nucleophilic addition to α,β-unsaturated carbonyl system:** general principle and mechanism (with evidence); direct and conjugate addition, addition of enolates (Michael reaction), Stetter reaction, Robinson annulations. | 2 |
| 3.5 | **Substitution at sp2 carbon (C=O system):** mechanism (with evidence): BAC2, AAC2, AAC1, AAL1 (in connection to acid and ester); acid derivatives: amides, anhydrides & acyl halides (formation and hydrolysis including comparison). | 3 |
| 3.6 | Assignment and discussion | 1 |

| | | |
|---|---|---|
| 4 | **Organometallics** | XXX |

*Contd*------

Text Books

1. Finar, I. L. Organic Chemistry (Volume 1), Pearson Education.
2. T.W. Graham Solomons, C. B. Fryhle, Organic Chemistry, John Wiley & Sons, Inc.
3. N. Tewari, Advanced Organic Reaction Mechanism, Books & Allied (P) Ltd.
4. M.S. Singh, Advanced Organic Chemistry-Reactions & Mechanisms, Pearson Education.
5. S.K. Ghosh, Advanced General Organic Chemistry- A Modern Approach, New Central Book Agency (P) Ltd.

For Further Reading

1. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, Second edition, Oxford University Press.
2. G. M. Loudon, Organic Chemistry, Fourth edition, Oxford University Press.
3. T.M. Sorrell, Organic Chemistry, Viva Books (P) Ltd

# BANKURA SAMMILANI COLLEGE

## Department of Chemistry

### Teaching Module

**Subject: Chemistry (Core)**

**Semester-III**

**Course code: Core T5 - Physical Chemistry II**

**Unit: Transport Processes & Chemical Equilibrium  Faculty: Dr. Swapnadip Roy**

| No. of Lectures | Topic |
|---|---|
| Lecture 1 | Introductory class |
| Lecture 2 | Fick's law |
| Lecture 3 | Idea of Flux and force, |
| Lecture 4 | phenomenological coefficients & their inter-relationship (general form), different examples of transport properties |
| Lecture 5 | Basic idea of Viscosity |
| Lecture 6 | General features of fluid flow (streamline flow and turbulent flow) |
| Lecture 7 | Newton's equation, viscosity coefficient |
| Lecture 8 | Poiseuille's equation |
| Lecture 9 | Principle of determination of viscosity coefficient of liquids by falling sphere method |
| Lecture 10 | Temperature variation of viscosity of liquids and comparison with that of gases |
| Lecture 11 | Transport number |
| Lecture 12 | Principles of Hittorf's and Moving-boundary method |
| Lecture 13 | Wien effect, Debye-Falkenhagen effect |
| Lecture 14 | Walden's rule |
| Lecture 15 | Thermodynamic conditions for equilibrium |
| Lecture 16 | Degree of Advancement |
| Lecture 17 | Degree of Advancement |
| Lecture 18 | van't Hoff's reaction isotherm (deduction from chemical potential) |
| Lecture 19 | Variation of free energy with degree of advancement |
| Lecture 20 | Equilibrium constant and standard Gibbs free energy change |
| Lecture 21, 22 | Definitions of $K_P$, $K_C$ and $K_X$; van't Hoff's reaction isobar and isochore from different standard states |
| Lecture 23 | Shifting of equilibrium due to change in external parameters e.g. temperature and pressure |
| Lecture 24 | Variation of equilibrium constant with addition to inert gas |
| Lecture 25 | Le Chatelier's principle and its derivation |

# BANKURA SAMMILANI COLLEGE

## Department of Chemistry

Teaching Module

Subject: PG Chemistry

Semester-I

Course code: CHEM 103C - Physical Chemistry

Unit: Chemical Kinetics

Faculty: Dr. Swapnadip Roy

| No. of Lectures | Topic |
|---|---|
| Lecture 1 | Basic aspects of Chemical kinetics |
| Lecture 2 | Theories of reaction rates |
| Lecture 3 | Applications to uni-molecular reactions |
| Lecture 4 | Applications to bi-molecular reactions |
| Lecture 5 | Applications to termolecular reactions |
| Lecture 6 | Thermodynamic formulation of reaction rate |
| Lecture 7 | Reactions in solution phase |
| Lecture 8 | Cage Effect |
| Lecture 9 | Dielectric effect on ion-ion reaction |
| Lecture 10 | Electrostriction |
| Lecture 11 | Volume of activation |
| Lecture 12 | Effect of pressure on reaction rate |
| Lecture 13 | Classification of reactions on the basis of volume of activation |
| Lecture 14 | Curtin-Hammett principle |
| Lecture 15 | Linear free energy relationship |
| Lecture 16 | Hammett and Taft equation |
| Lecture 17 | Flow process and relaxation techniques |

# BANKURA SAMMILANI COLLEGE

## Department of Chemistry

### Teaching Module

### Subject: PG Chemistry

### Semester-III

### Course code: CHEM 303C - Physical Chemistry

**Unit: Surface Chemistry & Bio-physical Chemistry** **Faculty: Dr. Swapnadip Roy**

| No. of Lectures | Topic |
|---|---|
| Lecture 1 | General aspects of Surfacetension |
| Lecture 2 | Idea of curved surfaces |
| Lecture 3 | Young-Laplace and Kelvin equations |
| Lecture 4 | Adsorption on solids |
| Lecture 5 | Micelles reverse micelles |
| Lecture 6 | Microemulsion and its application |
| Lecture 7 | Thermodynamics of micellization |
| Lecture 8 | Application of micelles and microemulsion |
| Lecture 9 | Hydrophobic hydration |
| Lecture 10 | micelle formation |
| Lecture 11 | hydrophobic interaction |
| Lecture 12 | stabilization and denaturation of protein |
| Lecture 13 | Water structure alternation theory of denaturation of protein |
| Lecture 14 | protein–lipid interaction |
| Lecture 15 | Transport of ions and small molecules through membranes |
| Lecture 16 | Ion channels |

Core T1 - Organic Chemistry I

Teacher: Dr Pinaki Mandal

| Core Topic | Modules | No. of Lectures |
|---|---|---|
| Stereochemistry | Introduction; Concept of constitution, chirality, chiral centre,; stereochemical representation of Flying-wedge. | 1 |
| | Stereochemical representation of Fischer, Sawhorse, concept of configuration, conformation | 1 |
| | Stereochemical representation of Newman and interconversions. | 1 |
| | Molecular symmetry, symmetry operations plane, simple axes of symmetry. | 1 |
| | Symmetry operations: centre of symmetry and alternating axes; point groups (Cv, Cnh, Cnv, Cn, Dh, Dnh, Dnd, Dn, Sn, Cs, Ci); assymatric and dissymmetric molecules; enantiomers and diastereomers; concept of epimers | 1 |
| | Erythro/Threo, D/L, syn/anti nomenclatures for aldols . | 1 |
| | configurational nomenclature: R/S | 1 |
| | E/Z descriptors for C=C, conjugated diene, triene, C=N and N=N systems; combination of R/S- and 4. E/ Z- isomerisms: | 1 |
| | concept of stereogenicity, chirotopicity and pseudoasymmetry; chiralcentres and number of stereoisomerism: systems involving 1/2/3-chiral centre(s) (AA, AB, ABA and ABC types) | 1 |
| | Optical activity and optical isomerism, optical rotation: specific and molecular; optical purity, enantiomeric excess. | 1 |
| | racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates); | 1 |
| | Resolution of acids, bases and alcohols via diastereomeric salt formation; invertomerism of chiral trialkylamines | 1 |

Core T4 - Organic Chemistry II

Teacher: Dr Pinaki Mandal

| Core Topic | Modules | No. of Lectures |
|---|---|---|
| Stereochemistry | Conformational Analysis of Acyclic Molecules: energy barrier of rotation, concept of torsional and steric strains; conformational analysis of ethane, propane, n-butane, butane gauche interaction | 1 |
| | Relative stability of conformers on the basis of steric effect, dipole-dipole interaction and H-bonding; | 1 |
| | 2-methylbutane 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) | 1 |
| | Concept of prostereoisomerism: prostereogeniccentre; concept of (pro)n-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 propseudoasymmetriccentre. | 1 |
| | Chirality arising out of stereoaxis: stereoisomerism of substituted cumulenes with even and odd number of double bonds; chiral axis in allenes, spiro compounds, | 1 |
| | Alkylidenecycloalkanes and biphenyls; related configurational descriptors (Ra/Sa and P/M); atropisomerism; racemisation of chiral biphenyls; buttressing effect. | 1 |

Core T7 - Organic Chemistry III

Teacher: Dr Pinaki Mandal

| Core Topic | Modules | No. of Lectures |
|---|---|---|
| **Electrophilic and radical addition to C-C multiple bonds** | Addition to C=C: mechanism, reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity of reactions , Halogenation, hydrohalogenation, | 1 |
| | Hydration, hydrogenation, oxymercuration-demercuration | 1 |
| | Hydroboration-oxidation, contrathermodynamic isomerization of internal alkenes., epoxidation, syn and anti-hydroxylation | 1 |
| | ozonolysis, addition of singlet and triplet carbenes; electrophilic addition to diene (conjugated dienes and allene); | 1 |
| | Mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS | 1 |
| | Birch reduction of benzenoid aromatics; interconversion of E - and Z - alkenes; iodolactonisation | 1 |
| | Addition to C≡C (in comparison to C=C): mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations | 1 |
| | Addition to C≡C, hydrohalogenation, hydration, oxymercuration-demercuration | 1 |
| | Addition to C≡C hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity | 1 |
| **Aromatic electrophilic substitution** | Mechanism; halogenation, sulfonation | 1 |
| | Nitration, nitrosation Friedel-Crafts reactions | 1 |
| | Orientation and reactivity of Aromatic electrophilic substitution | 1 |
| | Haworth synthesis, Gatterman-Koch, Gatterman, Hoesch, | 1 |
| | Vilsmeier-Haack, Reimer-Tiemann, Kolbe-Schmidt, chloromethylation, Manasse | 1 |
| **Aromatic nucleophilic substitution** | $ArS_N1$ mechanism | 1 |
| | Addition-elimination mechanism, | 1 |
| | Elimination-addition (benzyne) mechanism; | 1 |
| | orientation and reactivity of aromatic nucleophilic substitution | 1 |

*Core T12* - **Organic Chemistry V**

**Teacher: Dr Pinaki Mandal**

| Core Topic | Modules | No. of Lectures |
|---|---|---|
| **Carbohydrate chemistry** | Chemistry of monosaccharides and disaccharides including structures | 1 |
| | Conformations of monosaccharides and disaccharides | 1 |
| | Configurations: D-glucose, fructose, galactose, arabinose and sucrose | 1 |
| | Reactions of monosaccharides | 1 |
| | stepping-up reactions of monosaccharides | 1 |
| | stepping-down reactions of monosaccharides | 1 |
| | conversion of aldose to ketose and vice versa | 1 |
| | mutarotation | 1 |
| | epimerization | 1 |
| | anomeric effect, | 1 |
| | elementary idea about starch and cellulose | 1 |
| **Pericyclic reactions** | Pericyclic reactions FMO approach, definition, classification | 1 |
| | Construction of molecular orbitals of different *pi*-electrons system | 1 |
| | Electrocyclic reactions | 1 |
| | [2+2] Cycloaddition reactions | 1 |
| | [4+2] Cycloaddition reactions | 1 |
| | Alder ene reaction | 1 |
| | Sigmatropic reactions: [1,j] and [i,j] shifts | 1 |
| | Sigmatropic reactions: [1,3] and [1,5] shifts | 1 |
| | [3,3] sigmatropic shifts with reference to Cope rearrangements | 1 |
| | [3,3] sigmatropic shifts with reference to Claisen rearrangements | 1 |
| **Cyclic Stereochemistry** | Alicyclic compounds: concept of I-strain; conformational analysis: cyclohexane, mono anddisubstituted cyclohexane; symmetry properties and optical activity; topomerisation | 1 |
| | Conformation & reactivity in cyclohexane system: consideration ofsteric and stereoelectronic requirements | 1 |
| | Synthesis and reactions in cyclohexane systems: elimination (E2, E1) | 1 |
| | Synthesis and reactions in cyclohexane systems: nucleophilic substitution (SN1,SN2, SNi, NGP), merged substitution-elimination | 1 |
| | Rearrangements; oxidation of cyclohexanol,esterification, saponification, lactonisation, epoxidation, pyrolytic syn elimination | 1 |

BANKURA SAMMILANI COLLEGE

Teaching Module Subject: Chemistry (Core)

Semester-I Course code: Core T2 - Physical Chemistry I

Unit : Kinetic Theory and Gaseous state Teacher: Dr. Mrinmoy Shannigrahi

| No.of Lectures | Topic |
|---|---|
| Lecture 1 | Kinetic Theory of gases: Concept of pressure and temperature; |
| Lecture 2 | Collision of gas molecules, Collision diameter; Collision number and mean free path |
| Lecture 3 | Frequency of binary collisions (similar and different molecules); Wall collision and rate of effusion |
| Lecture 4 | Maxwell's distribution of speeds, Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions |
| Lecture 5 | calculations of average, root mean square and most probable values in each case |
| Lecture 6 | Kinetic energy distribution in one, two and three dimensions,Calculation of number of molecules having energy $\geq \varepsilon$ |
| Lecture 7 | Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases |
| Lecture 8 | Deviation of gases from ideal behavior; compressibility factor; |
| Lecture 9 | Boyle temperature; Andrew's and Amagat's plots; |
| Lecture 10 | van der Waals equation and its features; its derivation and application in explaining real gas behaviour, |
| Lecture 11 | Other equations of state (Berthelot, Dietrici); Existence of critical state, Critical constants in terms of van der Waals constants; |
| Lecture 12 | Law of corresponding states; virial equation of state; |
| Lecture 13 | van der Waals equation expressed in virial form and significance of second virial coefficient; |
| Lecture `13 | Intermolecular forces (Debye, Keesom and London interactions; Lennard-Jones potential - elementary idea) |

# BANKURA SAMMILANI COLLEGE

**Teaching Module** **Subject: Chemistry (Core)**

**Semester-I** **Course code: Core T2 - Physical Chemistry I**

**Unit : Chemical Thermodynamics** **Teacher: Dr. Mrinmoy Shannigrahi**

| No.of Lectures | Topic |
|---|---|
| Lecture 1 | Zeroth and 1st law of Thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics |
| Lecture 2 | Concept of heat, work, internal energy and statement of first law; enthalpy, H |
| Lecture 3 | 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; |
| Lecture 4 | Joule's experiment and its consequence |
| Lecture 5 | Thermochemistry: Standard states; Heats of reaction; |
| Lecture 6 | enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Laws of thermochemistry |
| Lecture 7 | bond energy, bond dissociation energy and resonance energy from thermochemical data |
| Lecture 8 | Kirchhoff's equations and effect of pressure on enthalpy of reactions; Adiabatic flame temperature; explosion temperature |
| Lecture 9 | Need for a Second law; statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle |
| Lecture 10 | Physical concept of Entropy; Carnot engine and refrigerator; Kelvin – Planck and Clausius statements and equivalence of the two statements with entropic formulation; Carnot's theorem; Values of dQ/T and Clausius inequality |
| Lecture 11 | Entropy change of systems and surroundings for various processes and transformations; Entropy and unavailable work; |
| Lecture 12 | Auxiliary state functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium |
| Lecture 13 | Thermodynamic relations: Maxwell's relations; Gibbs- Helmholtz equation, |
| Lecture `14 | Joule-Thomson experiment and its consequences; inversion temperature; Joule-Thomson coefficient for a van der Waals gas; General heat capacity relations |

# Department of Chemistry

## Module of the Syllabus

Session-2016-2017

| Subject | Course | Class | Paper | Teacher |
|---|---|---|---|---|
| Chemistry ( Major) | Physical Chemistry | Part-III | XI | Dr. M. Shannigrahi |

**( 20 lectures)**

| Core Chapter | Teaching Module | No. of Lectures |
|---|---|---|
| **Quantum Chemistry** *'It is safe to say that nobody understands quantum mechanics' - Richard Feynman.* | Black Body Radiation – birth of quantum mechanics | 1 |
| | Planck's Radiation Law- explanation of Black Body Radiation | 1 |
| | Photo-electric effect- Facts | 1 |
| | Photo-electric effect- Einstein's explanation | 1 |
| | Wilson-Sommerfeld quantization rule and its applications-I ( Bohr atom, Harmonic Oscillator ) | 1 |
| | Wilson-Sommerfeld quantization rule and its applications-II ( Rigid rotator, Particle in 1-D box ) | 1 |
| | Heisenberg's uncertainty principle | 1 |
| | Bohr's correspondance principle and its application to Bohr atom and Particle in 1-D box | 1 |
| | Elementary concept of operators, eigen function and eigen values | 1 |
| | Linear operators, commutation of operators | 1 |
| | Expectation values, Hermitian Operator and its properties | 1 |
| | Schrodinger's time independent equation, acceptability of wave function | 1 |
| | Probability, interpretation of wave functions | 1 |
| | Particle in 1-D box, setting up of Schrodinger's equation of 1-D box and its applications | 1 |
| | Application of 1-D box, degeneracy, comparison with free particle eigen function and eigen values | 1 |
| | Normalisation, Orthogonality and probability distribution of $\psi$ | 1 |
| | Expectation values of $x$, $x^2$, $p_x$, $p_x^2$ and their significance in relation to the uncertainty principle | 1 |
| | Extension of the problem to 2-d and 3-d and the problem of degeneracy | 1 |
| | Stationary Schrodinger equation for the H-atom in polar coordinates, Separation of Radial and Angular parts | 1 |
| | Solution of $\varphi$ part and emergence of magnetic q. no., Hydrogenic wave function upto n= 2 | 1 |
| | Real wave function, concept of orbitals and shapes of *s* & *p* orbitals | 1 |

| Core Chapter | Teaching Module | No. of Lectures |
|---|---|---|
| Photochemistry & Spectroscopy | Primary photophysical processes, potential energy diagram | 1 |
| | Franck-Condon principle | 1 |
| | vibrational structure of electronic spectra | 1 |
| | bond dissociation, decay of excited state by radiative and nonradiative paths, | 1 |
| | fluorescence and phosphorescence | 1 |
| | Jablonsky diagram, laws of photochemistry | 1 |
| | quantum yield, photochemical equilibrium | 1 |
| | photosensitized reactions, kinetics of HI decomposition | 1 |
| | Alkali metal spectra, multiplicity of spectral lines | 1 |
| | idea of spin quantum number, physical idea of spin-orbit coupling | 1 |
| | Rotational spectroscopy of diatomic molecules, rigid rotator model | 1 |
| | characteristic features (spacing and intensity), applications | 1 |
| | Vibrational spectroscopy of diatomic molecules, Simple Harmonic Oscillator (SHO) model; | 1 |
| | Vibration rotation spectra, applications | 1 |
| | Raman effect, characteristic feature and condition of Raman activity with illustrations, | 1 |
| | rotational and vibrational Raman spectra | 1 |
| | rule of mutual exclusion with examples | 1 |
| | NMR spectra, nuclear spin | 1 |
| | Larmour precision, chemical shift | 1 |
| | spin-spin interaction | 1 |

**( 20 lectures)**

**(8 lectures)**

| Core Chapter | Teaching Module | No. of Lectures |
|---|---|---|
| Statistical thermodynamics and the third law | Thermodynamic probability, entropy and probability | 1 |
| | Boltzmann distribution formula (with derivation), application to barometric distribution | 1 |
| | partition function and thermodynamic properties (U, H & P) | 1 |
| | Einstein's theory of heat capacity of solids and its limitations | 1 |
| | Nernst heat theorem and its implications | 1 |
| | approach to zero Kelvin | 1 |
| | Planck's formulation of third law | 1 |
| | absolute entropies | 1 |

| Core Chapter | Teaching Module | No. of Lectures |
|---|---|---|
| Symmetry and group | Introduction | 1 |
| | symmetry elements and operations with illustrations | 1 |
| | symmetry elements and physical properties | 1 |
| | group and symmetry group | 1 |
| | group multiplication table | 1 |
| | point group | 1 |
| | determination of molecular point groups- I | 1 |
| | determination of molecular point groups- II | 1 |
| | | **(8 lectures)** |

SHANTANU HAZRA

# MODULE OF CHEMISTRY (HONS) PAPER I

## INORGANIC CHEMISTRY

| CORE TOPIC | MODULE | LECTURE(S) |
|---|---|---|
| Atomic structure and periodic properties | Bohr's model | 1 |
| | Sommerfeld's extension | 1 |
| | de Broglie's wave particle duality; Heisenberg's uncertainty principle and Schrödinger's equation (qualitative) | 1 |
| | Significance of $\psi$ and $\psi^2$; radial density, angular probability | 1 |
| | Characteristics of s-/p-/d-orbital | 1 |
| | Aufbau principle, Pauli's exclusion/antisymmetry principle (statement and implication) | 1 |
| | Hund's rules, Slater's rules, quantum defect | 1 |
| | Mendeleev-Seaborg's periodic table: basis and possible extension | 1 |
| | Periodic properties | 1 |
| | Atomic radius, ionic radius, covalent radius, van der Waals radius | 1 |
| | Ionization energy | 1 |
| | Electron affinity | 1 |
| | Electronegativity and its different scales, orbital/group electronegativity | 1 |
| | Ionic potential, diagonal relationship, work function; aperiodicity | 1 |
| Bonding and structure | Different bonds: ionic, covalent, dative, retrodative, hydrogen, metallic | 1 |
| | $\sigma$-/$\pi$-/$\mu$-/$\delta$-, banana (3c-2e) | 1 |
| | Different weak forces | 1 |
| | Varied hybrid (sp, ds, $sp^2$, $sp^3$, $d^3s$, $dsp^2$, $sp^3d$, $d^2sp^3$, $d^3sp^3$ etc) orbitals | 1 |
| | Hypervalence, resonance, bond polarity, dipole moment | 1 |
| | Fajan's rules | 1 |
| | VB, LCAO, MO (qualitative idea on homo-/heteronuclear di-/tri-/polyatomic molecules such as $AX_2$ to $AX_6$) | 1 |
| | symmetry, energy and overlap | 1 |
| | HOMO-LUMO, VB-MO comparison; | 1 |
| | bond multiplicity, bond strength and related implications | 1 |
| | Prediction of structures and shapes of molecules: Helferich rules | 1 |
| | VSEPR theory | 1 |
| | Steric number, Bent's rule | 1 |
| | Non-rigid molecules, Berry pseudorotation | 1 |
| Acid-base and donor-acceptor | Different concepts | 1 |
| | Pauling's rules, solvent acidity/basicity, Drago-Wayland equation | 1 |
| | Donor/acceptor number, Gutmann's rules, | 1 |
| | Hammett acidity function | 1 |
| | Super acid, solid acid, surface acidity, factors affecting acidity/basicity, | 1 |
| | HSAB principle | 1 |
| | Symbiosis, HOMO-LUMO and acid-base interaction | 1 |
| | Basis, measurement and anisotropicity of hardness/softness, pictorial diagram of frontier orbitals | 1 |

| CORE TOPIC | MODULE | LECTURE(S) |
|---|---|---|
| Redox system | Complementary/non-complementary redox reactions | 1 |
| | Standard/formal electrode potentials | 1 |
| | Influence of pH, complex formation and precipitation reaction on formal potential | 1 |
| | Latimer/Forst/Pourbaix diagram | 1 |
| | Electrochemical series and its implication towards metal extraction principle | 1 |
| | Basis of redox titration, redox indicator, disproportionation, comproportionation | 1 |
| Coordination chemistry I | Tassaert's observation, Jorgensen's proposition | 1 |
| | Werner's theory | 1 |
| | Lewis dot structure | 1 |
| | Classification and binding modes of ligands: classical, non-classical ($\pi$-complexing), $\sigma$-/($\sigma + \pi$)-donor, $\sigma$-donor + $\pi$-acceptor, bridging (EO/EE) and bridging loop | 1 |
| | Chelator (*cis/trans*) and chelate effect | 1 |
| | Congregator, innermetallic, ambidentate, sequestering, flexidentate, | 1 |
| | Innocent, non-innocent, tripod, macrocycle,pod and, coronand, crown ether | 1 |
| | Cryptand, metalloorganic, organometallic, cyclometallated, Schiff-base, metalloligand and duplex behaviour | 1 |
| | Synthesis of compounds of different nuclearities | 1 |
| | Internal parameters: metal and ligand. External parameters: temperature, pressure, solvent, reagent, counter ion, aerobic/anaerobic | 1 |
| | Stabilization of different oxidation states | 1 |
| | Choice of starting materials, self assembly | 1 |
| | Types of isomerism | 1 |
| | Statistical numbering system, enumeration of isomers; factors effecting isomer population | 1 |
| | Interplay of steric and electronic factors, isomorphism and doping, structural equilibria | 1 |
| | Resolution of optical isomers | 1 |
| | IUPAC nomenclature I | 1 |
| | IUPAC nomenclature II | 1 |

# BANKURA SAMMILANI COLLEGE

## Department of Chemistry

### Teaching Module

**Subject: Chemistry (Core)**

**Semester-I**

**Course code: Core T2 - Physical Chemistry I**

**Unit: Chemical Kinetics** **Faculty: Dr. Swapnadip Roy**

| No. of Lectures | Topic |
|---|---|
| Lecture 1 | Introductory class with basic chemistry |
| Lecture 2 | Rate law, order and molecularity |
| Lecture 3 | Introduction of rate law |
| Lecture 4 | Extent of reaction; rate constants, order of a reaction |
| Lecture 5 | Forms of rates of First, second and nth order reactions |
| Lecture 6 | Pseudo first order reactions (example using acid catalyzed hydrolysis of methyl acetate) |
| Lecture 7 | Determination of order of a reaction by half-life and differential method |
| Lecture 8 | Opposing reactions, consecutive reactions and parallel reactions (with explanation of kinetic and thermodynamic control of products; all steps first order) |
| Lecture 9 | Role of Temperature and theories of reaction rate |
| Lecture 10 | Temperature dependence of rate constant |
| Lecture 11 | Arrhenius equation, energy of activation |
| Lecture 12 | Rate-determining step and steady-state approximation – explanation with suitable examples; |
| Lecture 13 | Collision theory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment) |
| Lecture `13 | Homogeneous catalysis: Homogeneous catalysis with reference to acid-base catalysis |
| Lecture 14 | Primary kinetic salt effect; Enzyme catalysis |
| Lecture 15 | Michaelis-Menten equation, Lineweaver-Burk plot, turn-over number |
| Lecture 16 | Autocatalysis; periodic reactions |