# VidyasagarUniversity

## CurriculumforB.Sc.HonoursinChemistry[ChoiceBasedCreditSystem]

**Semester-I**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sl.No.** | **Nameofthe Subject** | **Nature** | **Code** | **TeachingScheme inhourperweek** | **Credit** | **Marks** |
| **L** | **T** | **P** |
| **C1** | **C1T:**OrganicChemistry-I | CoreCourse-1 |  | 4 | 0 | 0 | 6 | 75 |
| **C1P:** Organic Chemistry-ILab | CoreCourse1 [Practical] |  | 0 | 0 | 4 |
| **C2** | **C2T:**Physical Chemistry-I | CoreCourse-2 |  | 4 | 0 | 0 | 6 | 75 |
| **C2P:**Physical Chemistry-ILab | CoreCourse-2 [Practical] |  | 0 | 0 | 4 |
| **GE-1** | GE-1 | GE |  |  |  |  | 4/5 | 75 |
| GE-1 | GE |  |  |  |  | 2/1 |
| **AECC** | English | AECC |  |  |  |  | 2 | 50 |
|  |  |  |  | **TotalCredits=20** |  |

**L=Lecture,T=Tutorial,P=Practical**

**AECC-AbilityEnhancementCompulsoryCourse**:English/ModernIndianLanguage.

**Interdisciplinary/GenericElective(GE)fromother Department**

[**Fourpapersaretobetakenandeachpaperwillbeof6credits**]:

[Papersaretobetakenfromanyofthefollowingdiscipline(**GE-1fromMathematics**)]:**Mathematics/ Physics /Computer Sc/Statistics/Geology/Electronics/ zoology/Botany/Microbiology /Physiology**

**/Biotechnology/Nutrition**

**Semester-1CoreCourse**

**CC-1:ORGANICCHEMISTRY-I Credits06**

**(Credits:Theory-04,Practicals-02)**

## C1T1:ORGANICCHEMISTRY-I Credits04

**Theory:60Lectures**

**BasicsofOrganicChemistry**

**BondingandPhysicalProperties:(AP) (25Lectures)**

*Valence Bond Theory:* concept of hybridisation, shapes of molecules, resonance (including hyperconjugation); 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).

*Electronic displacements:* inductive effect, field effect, mesomeric effect, resonance energy; bond polarization and bond polarizability; electromeric effect; steric effect, steric inhibition of resonance.

*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 levelsof *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 mononuclearheterocyclic 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.

*Physical properties:* influence of hybridization on bond properties: bond dissociation energy (BDE) andbondenergy;bonddistances,bondangles;conceptofbondanglestrain(Baeyer’sstraintheory); 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 offormation.

**GeneralTreatmentofReactionMechanismI:(NKH) (10Lectures)**

*Mechanisticclassification:*ionic,radicalandpericyclic(definitionandexample);

reaction type: addition, elimination and substitution reactions (definition and example); nature of bondcleavageandbondformation:homolyticandheterolyticbondfission,homogenicand

heterogenic bond formation; curly arrow rules in representation of mechanistic steps; reagent type: electrophiles and nucleophiles (elementary idea); electrophilicity and nucleophilicity in terms ofFMO approach.

*Reactive intermediates:* 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).

**Stereochemistry I:(NKH) (25Lectures)**

*Bonding geometries of carbon compounds and representation of molecules:* tetrahedral nature of carbon and concept of asymmetry; Fischer, sawhorse, flying-wedge and Newman projection formulae and their inter translations.

*Conceptofchirality and symmetry:* symmetry elements and point groups (*C**v*, *Cnh*, *Cnv*, *Cn*, *D**h*, *Dnh*, *Dnd*, *Dn*, *Sn*(*Cs*, *Ci*); 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).

*Relative and absolute configuration:* D/L and *R/S* descriptors; *erythro/threo* and *meso* nomenclature of compounds; *syn/anti* nomenclatures for aldols; *E*/*Z* descriptors for C=C, conjugated diene, triene, C=N and N=N systems; combination of*R/S*- and *E/ Z-* isomerisms.

*Optical activity of chiral compounds:* 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.

**ReferenceBooks**

1. Clayden,J.,Greeves,N.&Warren,S.*OrganicChemistry,*Secondedition,OxfordUniversityPress,2012.
2. Keeler,J.,Wothers,P.*ChemicalStructureandReactivity–AnIntegratedapproach*,OxfordUniversityPress.
3. Sykes,P.*AguidebooktoMechanisminOrganicChemistry,*PearsonEducation,2003.
4. Smith,J.G.*OrganicChemistry*,TataMcGraw-HillPublishingCompanyLimited.
5. Carey,F.A.,Guiliano,R.M.*OrganicChemistry*,Eighthedition,McGrawHillEducation,2012.
6. Eliel,E.L.&Wilen,S.H.*StereochemistryofOrganicCompounds*,Wiley:London,1994.
7. Nasipuri,D.*StereochemistryofOrganicCompounds,*WileyEasternLimited.
8. Morrison,R.N.&Boyd,R.N.*OrganicChemistry*,DorlingKindersley(India)Pvt.Ltd.(PearsonEducation).
9. Finar,I.L.*OrganicChemistry(Volume1)*,DorlingKindersley(India)Pvt.Ltd.(PearsonEducation)
10. Fleming,I.*MolecularOrbitalsandOrganicChemicalReactions*,Reference/StudentEdition,Wiley,2009.
11. James,J.,Peach,J.M.*StereochemistryataGlance*,BlackwellPublishing,2003.
12. Robinson,M.J.T.,*Stereochemistry*,OxfordChemistryPrimer,OxfordUniversityPress,2005.

**CC1P1-CHEMISTRYLAB-I:(AP) Credits02**

**(60Lectures)**

1. **Separation,** based upon solubility, by using common laboratory reagents like water (cold, hot), dil. HCl, dil. NaOH, dil. NaHCO3, *etc*.,ofcomponentsof a binary solidmixture; purificationof**any one** of the separated components by crystallization and determination ofits melting point. The composition of the mixture may be of the following types: Benzoic acid/*p*-Toluidine; *p*-Nitrobenzoic acid/*p*-Aminobenzoic acid; *p*-Nitrotolune/*p*-Anisidine; *etc*.
2. **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]
3. **IdentificationofaPureOrganic Compound**

*Solidcompounds*:oxalicacid,tartaricacid,citricacid,succinicacid,resorcinol,urea, glucose, cane sugar, benzoic acid and salicylic acid

*Liquid Compounds*: formic acid, acetic acid, methyl alcohol, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene

**ReferenceBooks**

1. Bhattacharyya,R.C,*AManualofPracticalChemistry.*
2. Vogel, A. I. *Elementary Practical Organic Chemistry,* Part 2: *Qualitative Organic Analysis,* CBS Publishers and Distributors.
3. Mann,F.G.&Saunders,B.C.*PracticalOrganicChemistry,*PearsonEducation(2009).
4. Furniss,B.S.,Hannaford,A.J.,Smith,P.W.G.,Tatchell,A.R.*PracticalOrganicChemistry,5thEd.,*Pearson (2012).
5. Dutta,S,*B.Sc.HonoursPracticalChemistry*,BharatiBookStall.

## CC-2:PHYSICALCHEMISTRY-I Credits06

**(Credits:Theory-04,Practicals-02)**

## C2T2:PHYSICALCHEMISTRY-I Credits04

**(Theory:60 Lectures)**

**KineticTheoryandGaseousstate:(SS) (20Lectures)**

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); Wall collision and rate of effusion

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 ≥ ε, Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity 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)

**ChemicalThermodynamics:(SKM) (25Lectures)**

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 andstatementoffirst law;enthalpy,*H*; relationbetweenheat capacities,calculationsof*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.

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

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; 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.

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

1. **Chemicalkinetics:(SS) (15Lectures)**

Rate law, order and molecularity: Introduction of rate law, Extent of reaction; rate constants, order; Forms of rates of First, second and nth 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, consecutive reactions and parallel reactions (with explanation of kinetic and thermodynamic control of products; all steps first order)

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)

Homogeneous catalysis: Homogeneous catalysis with reference to acid-base catalysis; Primarykinetic salt effect; Enzyme catalysis; Michaelis-Menten equation, Lineweaver-Burk plot, turn-over number

Autocatalysis;periodicreactions

### ReferenceBooks:

* 1. Atkins,P.W.&Paula,J.de*Atkins’PhysicalChemistry*,OxfordUniversityPress
	2. Castellan,G.W.*PhysicalChemistry*,Narosa
	3. McQuarrie,D.A.&Simons,J.D.*PhysicalChemistry:AMolecularApproach*,VivaPress
	4. Engel,T.&Reid,P.*PhysicalChemistry*,Pearson
	5. Levine,I.N.*PhysicalChemistry*,TataMcGraw-Hill
	6. Maron,S.&Prutton*Physical Chemistry*
	7. Ball,D.W.*PhysicalChemistry*,ThomsonPress
	8. Mortimer,R.G.*PhysicalChemistry*,Elsevier
	9. Laidler,K.J.*ChemicalKinetics*,Pearson
	10. Glasstone,S.&Lewis,G.N.*ElementsofPhysical Chemistry*
	11. Rakshit,P.C.,*PhysicalChemistry*SaratBookHouse
	12. Zemansky,M.W.&Dittman,R.H.*HeatandThermodynamics*,Tata-McGraw-Hill
	13. Rastogi,R.P.&Misra,R.R.*AnIntroductiontoChemicalThermodynamics*,Vikas
	14. Clauze&Rosenberg,*ChemicalThermodynamics*

## C2P2:CHEMISTRYLAB-II(SS+SKM) Credits04

**(60Lectures)**

Experiment1:DeterminationofpHofunknownsolution(buffer),bycolormatchingmethod

Experiment 2: Determinationof heat of neutralizationof a strongacidby a strongbase Experiment 3: Study of kinetics of acid-catalyzed hydrolysis of methyl acetate Experiment 4: Study of kinetics of decomposition of H2O2

Experiment5:Determinationofheatofsolutionofoxalicacidfromsolubilitymeasurement

**ReferenceBooks**

1. Viswanathan,B.,Raghavan,P.S.*PracticalPhysicalChemistry*VivaBooks(2009)
2. Mendham,J.,A.I.Vogel’sQuantitativeChemicalAnalysis6thEd.,Pearson
3. Harris,D.C.*QuantitativeChemicalAnalysis*.6thEd.,Freeman(2007)
4. Palit,S.R.,De,S.K.*PracticalPhysicalChemistry*ScienceBookAgency
5. *University Hand Book of Undergraduate Chemistry Experiments*, edited by Mukherjee, G. N., University of Calcutta
6. Levitt,B.P.edited*Findlay’sPracticalPhysicalChemistry*LongmanGroup Ltd.
7. Gurtu,J.N.,Kapoor,R.,*AdvancedExperimentalChemistry*S.Chand&Co.Ltd.

**GenericElective Syllabus**

### GE-1[Interdisciplinaryforotherdepartment]

**GE-1 : ATOMIC STRUCTURE, CHEMICAL PERIODICITY, ACIDS AND BASES, REDOX REACTIONS, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS. Credits06**

**GE1 T1: ATOMIC STRUCTURE, CHEMICAL PERIODICITY, ACIDS AND BASES, REDOX REACTIONS, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS. Credits04**

**Theory:60Lectures**

**SectionA:InorganicChemistry-I(30 Lectures)**

**Atomic Structure:(PB) (10Lectures)**

Bohr'stheoryforhydrogenatom(simplemathematicaltreatment),atomicspectraofhydrogen and Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many-electron atoms, *Aufbau* principle and its limitations.

**Chemical Periodicity:(SH) (05Lectures)**

Classificationofelementsonthebasisofelectronicconfiguration:generalcharacteristicsofs-, p-, d- and f-block elements. Positions of hydrogen and noble gases. Atomic and ionic radii,

ionizationpotential,electronaffinity,andelectronegativity;periodicandgroup-wisevariationof above properties in respect of s- and p- block elements.

**Acidsand bases:(SH) (10Lectures)**

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituentandsolvent,differentiatingandlevellingsolvents.Lewisacid-baseconcept,classificationof Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases ( HSAB concept), applications of HSAB process.

**Redoxreactions:(PB) (05Lectures)**

Balancingofequationsbyoxidationnumberandion-electronmethodoxidimetryand reductimetry.

***SectionB:OrganicChemistry-I*(30Lectures)**

**Fundamentals of Organic Chemistry:(AP) (5 Lectures)** *Electronicdisplacements*:inductiveeffect,resonanceandhyperconjugation;cleavageofbonds: homolytic and heterolytic; structure of organic molecules on the basis of VBT; nucleophiles electrophiles; reactive intermediates: carbocations, carbanions and free radicals.

**Stereochemistry:(AP) (8Lectures)**

Differenttypesofisomerism;geometricalandopticalisomerism;conceptofchiralityandoptical activity (up to two carbon atoms); asymmetric carbon atom; elements of symmetry (plane and centre); interconversion of Fischer and Newman representations; enantiomerism and diastereomerism,*meso*compounds; *threo*and*erythro,* DandL,*cis*and*trans*nomenclature; CIP Rules: *R/S* (upto 2 chiral carbon atoms) and *E/Z* nomenclature.

**NucleophilicSubstitutionandEliminationReactions:(NKH) (5Lectures)**

*Nucleophilicsubstitutions*: SN1andSN2reactions;eliminations:E1andE2reactions(elementary mechanistic aspects); Saytzeff and Hofmann eliminations; elimination *vs* substitution.

**AliphaticHydrocarbons:(NKH) (12Lectures)**

Functionalgroupapproachforthefollowingreactions(preparations&reactions)tobestudied in context to their structures.

*Alkanes:*(upto5Carbons).*Preparation:*catalytichydrogenation,Wurtzreaction,Kolbe’s synthesis, from Grignard reagent. *Reactions:* mechanism for free radical substitution: halogenation.

*Alkenes:* (up to 5 Carbons). *Preparation:* elimination reactions: dehydration of alcohols and dehydrohalogenation of alkyl halides; *cis* alkenes (partial catalytic hydrogenation) and *trans* alkenes(Birchreduction).*Reactions:cis*-addition(alkalineKMnO4)and*trans*-addition(bromine) with mechanism, addition of HX [Markownikoff’s (with mechanism) and anti-Markownikoff’s addition], hydration, ozonolysis, oxymercuration-demercuration and hydroboration-oxidation reaction.

*Alkynes:*(upto5Carbons).*Preparation:*acetylenefromCaC2andconversionintohigheralkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides.

*Reactions:*formationofmetalacetylides,additionofbromineandalkalineKMnO4,ozonolysis and oxidation with hot alkaline KMnO4.

**ReferenceBooks:**

1. Lee,J.D.*ConciseInorganicChemistry*ELBS,1991.
2. Cotton,F.A.,Wilkinson,G.&Gaus,P.L.*BasicInorganicChemistry*,3rd ed.,Wiley.
3. Douglas,B.E.,McDaniel,D.H.&Alexander,J.J.*ConceptsandModelsinInorganicChemistry*,John Wiley & Sons.
4. Huheey,J.E.,Keiter,E.A.,Keiter,R.L.&Medhi,O.K.*InorganicChemistry:PrinciplesofStructure and Reactivity*, Pearson Education India, 2006.
5. Sethi,A.*ConceptualOrganicChemistry;*NewAgeInternationalPublisher.
6. Parmar,V.S.*ATextBookofOrganicChemistry*,S.Chand&Sons.
7. Madan,R.L.*OrganicChemistry*,S.Chand& Sons.
8. Wade,L.G.,Singh,M.S.,*OrganicChemistry.*
9. Finar,I.L.*OrganicChemistry*(*Volume1*),DorlingKindersley(India)Pvt.Ltd. (Pearson Education).
10. Morrison,R.T.&Boyd,R.N.*OrganicChemistry*,DorlingKindersley(India)Pvt.Ltd.(Pearson Education).
11. Eliel,E.L.&Wilen,S.H.*StereochemistryofOrganicCompounds*,Wiley:London, 1994.
12. SenGupta,Subrata.*BasicStereochemistryofOrganicmolecules.*
13. Kalsi,P.S.*StereochemistryConformationandMechanism*,Eighthedition,NewAge International, 2014.
14. Bahl,A.&Bahl,B.S.*AdvancedOrganicChemistry,*S.Chand,2010.

**GE1 P1:LAB: ATOMIC STRUCTURE, CHEMICAL PERIODICITY, ACIDS AND BASES, REDOX REACTIONS, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS**

**Credits02**

### 60Lectures

**SectionA:InorganicChemistry–LAB:(PB+SH) (30 Lectures)**

1. Estimationof sodiumcarbonateandsodiumhydrogencarbonatepresent in amixture.
2. Estimationof oxalicacid bytitratingit with KMnO4.
3. Estimation of waterofcrystallizationinMohr’ssalt bytitratingwithKMnO4.
4. EstimationofFe(II)ionsby titratingitwithK2Cr2O7usinginternalindicator.
5. Estimationof Cu(II)ionsiodometricallyusing Na2S2O3.

### SectionB:OrganicChemistry-LAB:(NKH+AP) (30 Lectures)

*QualitativeAnalysisofSingleSolidOrganic Compound(s)*

ExperimentA:Detectionofspecialelements(N,Cl,andS)inorganiccompounds. Experiment B: Solubility and Classification (solvents: H2O, dil. HCl, dil. NaOH)

ExperimentC:Detectionoffunctionalgroups:Aromatic-NO2,Aromatic-NH2,-COOH, carbonyl (no distinction of –CHO and >C=O needed), -OH (phenolic) in solid organic compounds.

ExperimentsA-Cwithunknown (atleast 6)solidsamplescontainingnotmorethantwoof the above type of functional groups should be done.

**ReferenceBooks:**

1. *UniversityHandBookofUndergraduateChemistryExperiments*,editedbyMukherjee,G.N., University of Calcutta, 2003.
2. Das,S.C.,Chakraborty,S.B.,*PracticalChemistry.*
3. Mukherjee,K.S.*TextbookonPracticalChemistry*,NewOrientalBookAgency.
4. Ghosal,Mahapatra&Nad,*AnAdvancedcourseinpracticalChemistry,*NewCentralBookAgency.
5. Vogel,A.I.*ElementaryPracticalOrganicChemistry,*Part2:*QualitativeOrganicAnalysis,*CBS Publishers and Distributors.
6. Vogel,A.I.,Tatchell,A.R.,Furnis,B.S.,Hannaford,A.J.&Smith,P.W.G.,*TextbookofPractical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
7. Mann,F.G.&Saunders,B.C.*PracticalOrganicChemistry*Orient-Longman, 1960.

# VidyasagarUniversity

**CurriculumforB.Sc.HonoursinChemistry[ChoiceBasedCreditSystem]**

**Semester-II**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sl.****No.** | **Nameof the Subject** | **Nature** | **Code** | **Teaching Schemeinhour per week** | **Credit** | **Marks** |
| **L** | **T** | **P** |
| **C3** | **C3T:** InorganicChemistry-I | CoreCourse-3 |  | 4 | 0 | 0 | 6 | 75 |
| **C3P:**InorganicChemistry-I Lab | CoreCourse-3 [Practical] |  | 0 | 0 | 4 |
| **C4** | **C4T:**OrganicChemistry-II | CoreCourse-4 |  | 4 | 0 | 0 | 6 | 75 |
| **C4P:**Organic Chemistry-IILab | CoreCourse-4 [Practical] |  | 0 | 0 | 4 |
| **GE-2** | GE-2 | GE |  |  |  |  | 4/5 | 75 |
| GE-2 | GE |  |  |  |  | 2/1 |
| **AEC C-2** | EnvironmentalStudies | AECC |  |  |  |  | 4 | 100 |
|  |  |  |  | **TotalCredits=22** |  |

**L=Lecture,T=Tutorial,P=Practical**

**AECC-AbilityEnhancementCompulsoryCourse**:EnvironmentalStudies.

**Interdisciplinary/GenericElective(GE)fromotherDepartment**

### [Fourpapersaretobe takenandeachpaperwillbeof 6 credits]:

[Papersaretobetakenfromanyofthefollowingdiscipline(**GE-2fromMathematics**)]: **Mathematics/Physics /Computer Sc/Statistics/Geology/Electronics/ zoology/Botany**

### /Microbiology/Physiology/Biotechnology/Nutrition

**Semester-II CoreCourse**

**Core-3**

**CC-3:INORGANIC CHEMISTRY-I Credits06**

**(Credits:Theory-04,Practicals-02)**

**C3T:INORGANICCHEMISTRY-I Credits04**

**Theory:60Lectures**

**Extra nuclear Structure of atom:(PB) (18Lectures)**

Bohr’s theory, its limitations and atomic spectrum of hydrogen atom; Sommerfeld’s Theory. Wave mechanics: de Broglie equation, Heisenberg’s Uncertainty Principle and its significance, Schrödinger’s wave equation, significance of *ψ* and *ψ*2. Quantum numbers and their significance. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Pauli’s Exclusion Principle, Hund’s rules and multiplicity, Exchange energy, Aufbau principle and its limitations, Ground state Term symbols of atoms and ions for atomic number upto 30.

### Chemical periodicity:(SH) (8Lectures)

Modern IUPAC Periodic table, Effective nuclear charge, screening effects and penetration, 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.

### Acid-Base reactions:(PB) (16Lectures)

Acid-Baseconcept:Arrheniusconcept, theory of solventsystem(in H2O, NH3, SO2and HF), Bronsted-Lowry’s concept, relative strength of acids, Pauling’s rules. Lux-Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects. Thermodynamic acidity parameters, Drago-Wayland equation. Superacids, Gas phase acidity and proton affinity; HSAB principle. Acid-base equilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer. Acid-base neutralisation curves; indicator, choice of indicators.

### Redox Reactions and precipitation reactions:(SH+PB) (18Lectures)

Ion-electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation). Influence of complex formation, precipitation and change of pH on redox potentials; formal potential. Feasibility of a redox titration, redox potential at the equivalence point, redox indicators. Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications. Disproportionation and comproportionation reactions (typical examples)

Solubilityproduct principle, common ion effect and their applicationstotheprecipitationand separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides.

### ReferenceBooks

1. Lee,J.D.*ConciseInorganicChemistry,*5thEd.*,*WileyIndiaPvt.Ltd.,2008.
2. Douglas,B.E.andMcDaniel,D.H.*Concepts&ModelsofInorganicChemistry*

Oxford,1970.

1. Day,M.C.andSelbin,J.*TheoreticalInorganicChemistry*,ACSPublications,1962.
2. Atkin, P. *Shriver & Atkins’ Inorganic Chemistry,* 5th Ed., Oxford University Press(2010).
3. Cotton,F.A.,Wilkinson,G.andGaus,P.L.,*BasicInorganicChemistry3rd Ed.;*Wiley India.
4. Sharpe,A.G.,*Inorganic Chemistry*,4thIndianReprint(PearsonEducation) 2005.
5. Huheey,J.E.;Keiter,E.A.&Keiter,R.L.*InorganicChemistry,Principlesof Structure and Reactivity 4th Ed.,* Harper Collins 1993, Pearson,2006.
6. Atkins,P.W.&Paula,J.*PhysicalChemistry*,OxfordPress,2006.
7. Mingos,D.M.P.,*Essentialtrendsininorganicchemistry*.OxfordUniversityPress (1998).
8. Winter,M.J.,TheOrbitron,<http://winter.group.shef.ac.uk/orbitron/>(2002).An illustrated gallery of atomic and molecular orbitals.
9. Burgess, J., *Ions in solution: basic principles of chemical interactions.* Ellis Horwood (1999).

**C3P:CHEMISTRY(LAB)(SH+PB) Credits02**

**60 Lectures**

**AcidandBaseTitrations:**

1. Estimationofcarbonate andhydroxidepresenttogetherinmixture
2. Estimationofcarbonate andbicarbonatepresenttogetherina mixture.
3. Estimationoffreealkalipresentindifferentsoaps/detergents.

### Oxidation-ReductionTitrimetric

1. EstimationofFe(II)usingstandardized KMnO4solution
2. Estimationofoxalicacidandsodiumoxalateinagiven mixture
3. EstimationofFe(II)andFe(III)inagivenmixtureusing K2Cr2O7solution.
4. EstimationofFe(III)andMn(II)inamixtureusingstandardizedKMnO4solution
5. EstimationofFe(III)andCu(II)inamixtureusingK2Cr2O7.
6. EstimationofFe(III)and Cr(III)inamixtureusingK2Cr2O7.

### ReferenceBooks

Mendham,J.,*A.I.Vogel’sQuantitativeChemicalAnalysis*6thEd.,Pearson,2009.

**Core-4**

**CC-4:ORGANICCHEMISTRY-II Credits06**

**(Credits:Theory-04,Practicals-02)**

**C4T ORGANICCHEMISTRY-II Credits02**

**Theory:60Lectures**

**StereochemistryII:(NKH) (20Lectures)**

*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.

*Concept of prostereoisomerism*: prostereogenic centre; concept of (*pro*)n-*chirality*: topicityof 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; Klyne-Prelog terminology; *P/M* descriptors; energy barrier of rotation, concept of torsional and stericstrains; relativestabilityofconformers on thebasis of steric effect, dipole-dipole interaction and H-bonding; *butane gauche* interaction; conformational analysis of ethane, propane, *n*-butane, 2-methylbutane and 2,3- dimethylbutane; haloalkane, 1,2-dihaloalkanes and1,2-diols (up to four carbons); 1,2- halohydrin; conformation of conjugated systems (*s-cis* and *s-trans*).

### GeneralTreatmentofReactionMechanismII:(AP) (22Lectures)

*Reaction thermodynamics:* free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change via BDE, intermolecular & intramolecular reactions.

*Conceptoforganicacids andbases:*effectofstructure,substituentandsolventonacidityand basicity; proton sponge; gas-phase acidity and basicity; comparison between nucleophlicity and basicity; HSAB principle; application of thermodynamic principles in acid-base equilibria.

*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.

*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 isotopic effect (*k*H/*k*D); principleof microscopic reversibility; Hammond’s postulate.

### SubstitutionandEliminationReactions:(AP) (18Lectures)

*Free-radical substitution reaction:* halogentaion of alkanes, mechanism (with evidence) and stereochemical features;reactivity-selectivity principle in the light of Hammond’s postulate. *Nucleophilic substitution reactions:* substitution at sp3 centre: mechanisms (with evidence), relativerates&stereochemicalfeatures:SN1,SN2,SN2',SN1'(allylicrearrangement)and SNi;effectsofsolvent,substratestructure,leavinggroupand nucleophiles(including ambident nucleophiles, cyanide & nitrite); substitutions involving NGP; role of crown ethers and phase transfer catalysts; [systems: alkyl halides, allyl halides, benzyl halides, alcohols,ethers, epoxides].

*Elimination reactions****:*** E1, E2, E1cB and Ei (pyrolytic *syn* eliminations); formation ofalkenes 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.

### ReferenceBooks

* 1. Clayden,J.,Greeves,N.,Warren,S.*OrganicChemistry,*Secondedition,Oxford UniversityPress 2012.
	2. Sykes,P.*AguidebooktoMechanisminOrganicChemistry,*PearsonEducation, 2003.
	3. Smith,J.G.*OrganicChemistry*,TataMcGraw-HillPublishingCompany Limited.
	4. Carey,F.A.&Guiliano,R.M.*Organic Chemistry*,Eighthedition, McGrawHill Education, 2012.
	5. Loudon,G.M.*OrganicChemistry*,Fourth edition,OxfordUniversityPress,2008.
	6. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
	7. Nasipuri,D.*StereochemistryofOrganicCompounds,*WileyEasternLimited.
	8. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
	9. Finar,I.L.*OrganicChemistry(Volume1)*PearsonEducation.
	10. GrahamSolomons,T.W.,Fryhle,C.B.*OrganicChemistry,*JohnWiley &Sons, Inc.
	11. James,J.,Peach,J.M.*Stereochemistryata Glance*,BlackwellPublishing,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.

### C4P:CHEMISTRY(LAB) Credits02

**(60Lectures)Organic Prparations**

(AP+NKH)

1. Thefollowingreactionsaretobeperformed, notingtheyieldofthecrude product:
	1. Nitrationofaromaticcompounds
	2. Condensation reactions
	3. Hydrolysisof amides/imides/esters
	4. Acetylationofphenols/aromatic amines
	5. Benzoylationofphenols/aromaticamines
	6. Sidechainoxidationofaromaticcompounds
	7. Diazocouplingreactions ofaromatic amines
	8. Brominationofanilides usinggreenapproach (Bromate-Bromidemethod)
	9. Redoxreactionincludingsolid-phase method
	10. Green‘multi-component-coupling’reaction
	11. Selectivereductionof*m*-dinitrobenzeneto*m*-nitroaniline

### Studentsmustalsocalculatepercentageyield,baseduponisolatedyield(crude)and theoretical yield.

1. Purificationofthecrudeproductistobemadebycrystallisationfromwater/alcohol, crystallization after charcoal treatment, or sublimation, whichever is applicable.
2. Meltingpointofthepurifiedproduct istobenoted.

### ReferenceBooks

* 1. Vogel,A.I.*ElementaryPracticalOrganicChemistry,*Part1:*Smallscale Preparations,* CBS Publishers and Distributors.
	2. *UniversityHandBookofUndergraduateChemistryExperiments*,editedby Mukherjee, G. N. University of Calcutta, 2003.
	3. Mann,F.G.&Saunders,B.C.*PracticalOrganicChemistry,*PearsonEducation (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.*ComprehensivePracticalOrganicChemistry: Preparation and Quantitative Analysis,* University Press (2000).
	6. *PracticalWorkbookChemistry(Honours),UGBS,Chemistry*,Universityof Calcutta, 2015.

**GenericElectiveSyllabus**

**GE-2[Interdisciplinaryforotherdepartment]**

**GE-2: STATES OF MATTER & CHEMICAL KINETICS, CHEMICAL BONDING & MOLECULAR STRUCTUR, p-BLOCK ELEMENTS Credits06**

**(Credits:Theory-04,Practicals-02)**

**GE2 T : STATES OF MATTER & CHEMICAL KINETICS, CHEMICAL BONDING &MOLECULARSTRUCTUR,p-BLOCKELEMENTS Credits04**

**Theory:60Lectures**

***SectionA:PhysicalChemistry-I* (30Lectures)**

### KineticTheoryof GasesandRealgases:(SS) (10Lectures)

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 effusion

Nature of distribution of velocities, Maxwell’s distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases

Deviation of gases from ideal behavior; compressibilityfactor; Boyle temperature; Andrew’s and Amagat’s plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour; Existence of critical state, Critical constants in terms of vander Waals constants; Law of corresponding states

Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only)

### Liquids:(SKM) (06Lectures)

Definition of Surface tension, its dimension and principle of its determination using stalagmometer; Viscosityof aliquid and principle ofdetermination of coefficient of viscosity using Ostwald viscometer; Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

### Solids:(SKM) (06Lectures)

Forms of solids, crystal systems, unit cells, Bravais lattice types, Symmetry elements; Lawsof Crystallography - Law of constancy of interfacial angles, Law of rational indices; Miller indices ofdifferent planes and interplanardistance, Bragg’s law; Structures of NaCl, KCl and CsCl (qualitative treatment only); Defects in crystals; Glasses and liquid crystals.

### ChemicalKinetics:(SS) (08Lectures)

Introduction of rate law, Order and molecularity; Extent of reaction; rate constants; Rates of First, second and nth order reactions and their Differential and integrated forms (with derivation); Pseudo first order reactions; Determination of order of a reaction by half-life and differential method; Opposing reactions, consecutive reactions and parallel reactions Temperature dependenceofrateconstant;Arrheniusequation,energy ofactivation;Collision

theory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment)

### ReferenceBooks:

1. Barrow,G.M.*PhysicalChemistry*TataMcGraw‐Hill(2007).
2. Castellan,G.W.*PhysicalChemistry*4thEd.Narosa (2004).
3. Kotz,J.C.,Treichel,P.M.&Townsend,J.R.*GeneralChemistry*CengageLearningIndia Pvt. Ltd., New Delhi (2009).
4. Mahan,B.H.*University Chemistry*3rdEd.Narosa (1998).
5. Petrucci,R.H.*GeneralChemistry*5thEd.MacmillanPublishingCo.:New York(1985).
6. Chugh,K.L.,Agnish,S.L.*ATextBookofPhysicalChemistry*KalyaniPublishers
7. Bahl,B.S.,Bahl,A.,Tuli,G.D.,*EssentialsofPhysicalChemistry*S.Chand&Co.ltd.
8. Palit,S.R.,*ElementaryPhysicalChemistry*Book SyndicatePvt.Ltd.
9. Mandal,A.K.*DegreePhysicalandGeneralChemistry*SaratBookHouse
10. Pahari,S.,*PhysicalChemistry*NewCentral BookAgency
11. Pahari,S.,Pahari,D.,*ProblemsinPhysicalChemistry*NewCentral BookAgency

***SectionB:InorganicChemistry-II* (30Lectures)**

### ChemicalBondingandMolecularStructure:(PB) (16Lectures)

*Ionic Bonding:* General characteristics of ionic bonding*.* Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan’s rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

*Covalent bonding:* VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods. (including idea of *s- p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches.

### Comparativestudyofp-block elements:(SH) (14Lectures)

Group trends in electronic configuration, modification of pure elements, common oxidation states, inert pair effect, and their important compounds in respect of the following groups of elements:

* 1. B-Al-Ga-In-Tl
	2. C-Si-Ge-Sn-Pb
	3. N-P-As-Sb-Bi
	4. O-S-Se-Te
	5. F-Cl-Br-I

### ReferenceBooks:

1. Cotton,F.A.&Wilkinson, G.*BasicInorganicChemistry,* Wiley.
2. Shriver,D.F.&Atkins,P.W.*InorganicChemistry*,OxfordUniversityPress.
3. Wulfsberg,G.*InorganicChemistry,*VivaBooksPvt.Ltd.
4. Rodgers,G.E.*Inorganic&SolidStateChemistry,*CengageLearningIndiaLtd., 2008.

### GE2P-LAB:STATESOFMATTER&CHEMICALKINETICS,CHEMICAL BONDING & MOLECULAR STRUCTUR, p-BLOCK ELEMENTS

(**60Lectures) Credits02**

***SectionA:PhysicalChemistry-LAB:(SS+SKM)* (15x2=30Lectures)**

(Minimum**five**experimentstocomplete)

1. Surfacetensionmeasurement(useoforganicsolvents excluded)
	1. Determinationofthesurfacetensionofaliquidoradilutesolutionusinga Stalagmometer
	2. Studyofthevariationofsurfacetensionofadetergentsolutionwith concentration
2. Viscositymeasurement (useoforganicsolvents excluded)
	1. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald’s viscometer
	2. Study of the variation of viscosity of an aqueous solution with concentration ofsolute
3. Studythekinetics of thefollowingreactions
	1. Initialratemethod:Iodide-persulphatereaction
	2. Integratedratemethod:
		1. Acidhydrolysisofmethylacetatewithhydrochloricacid
		2. ComparethestrengthsofHClandH2SO4bystudyingkineticsof hydrolysis of methyl acetate

### ReferenceBooks:

1. *UniversityHandBookofUndergraduateChemistryExperiments*,editedby Mukherjee, G. N., University of Calcutta, 2003.
2. Palit,S.R.,*PracticalPhysicalChemistry*ScienceBook Agency
3. Mukherjee,N.G.,*SelectedExperimentsinPhysicalChemistry*J.N.Ghose&Sons
4. Dutta,S.K.,*PhysicalChemistryExperiments*BharatiBook Stall

***SectionB:InorganicChemistry-LAB:(PB+SH)* (30Lectures)**

Qualitativesemimicroanalysisofmixturescontainingthreeradicals.Emphasisshouldbe given to the understanding of the chemistry of different reactions.

AcidRadicals:Cl-,Br-,I-,NO2-,NO3-,S2-,SO42-,PO43-,BO33-, H3BO3.

BasicRadicals:Na+,K+, Ca2+,Sr2+, Ba2+,Cr3+,Mn2+,Fe3+,Ni2+,Cu2+,NH4+.

### ReferenceBooks:

1. Svehla,G.*Vogel’sQualitativeInorganicAnalysis*,PearsonEducation,2012.
2. Khosla,B.D.;Garg,V.C.&Gulati,A.*SeniorPracticalPhysicalChemistry,*R.Chand& Co.: New Delhi (2011).

# VidyasagarUniversity

***CurriculumforB.Sc(Honours)inChemistry***

### [ChoiceBasedCreditSystem] Semester-III

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Course** | **Course Code** | **Nameofthe Subjects** | **Course Type/ Nature** | **Teaching****Schemeinhour per week** | **Credit** | **Marks** |
| **L** | **T** | **P** |
| **CC-5** |  | **C5T:**Physical Chemistry-II | Core Course-5 | 4 | 0 | 0 | 6 | 75 |
| **C5P**:PhysicalChemistry-II |  | 0 | 0 | 4 |
| **CC-6** |  | **C6T:**Inorganic Chemistry-II | Core Course-6 | 4 | 0 | 0 | 6 | 75 |
| **C6P:**InorganicChemistry-II |  | 0 | 0 | 4 |
| **CC-7** |  | **C7T:**Organic Chemistry-III | Core Course-7 | 4 | 0 | 0 | 6 | 75 |
| **C7P:**OrganicChemistry-III |  | 0 | 0 | 4 |
| **GE-3** |  | **TBD** | Generic Elective-3 |  |  |  | 6 | 75 |
|  |  |  |  |  |  |  |  |
| **SEC-1** |  | **SEC1T:** Analytical ClinicalBiochemistry SEC1P: Analytical ClinicalBiochemistry**Or SEC1T:**Pharmaceutical Chemistry **SEC1P:**PharmaceuticalChemistry | Skill Enhancement Course-1 | 1 | 0 | 2 | 2 | 50 |
| **SemesterTotal** |  |  |  | **26** | **350** |

**L=**Lecture,**T=**Tutorial,**P=**Practical,**CC=**CoreCourse,**GE**=GenericElective,**SEC**=Skill Enhancement Course, **TBD =** to be decided

### GenericElective(GE)(Interdisciplinary)fromotherDepartment[Fourpapersaretobe taken and each paper will be of 6 credits]:

Papersaretobetakenfrom anyofthefollowingdiscipline:**Mathematics/Physics**

### /ComputerSc/Statistics/Geology/Electronics/zoology/Botany/Microbiology

**/Physiology/Biotechnology/Nutrition**

**ModalitiesofselectionofGenericElectives(GE)**:Astudentshallhavetochoose**04**

GenericElective(GE1toGE4)strictlyfrom**02**subjects/disciplinesofchoicetakingexactly

**02** courses from each subjects of disciplines. Such a student shall have to study thecurriculum of Generic Elective (GE) of a subject or discipline specified for the relevant semester.

**Semester-III CoreCourse(CC)**

## CC-5:PhysicalChemistry-II Credits 06

**C5T:PhysicalChemistry-II Credits04**

**Theory:60Lectures**

1. **Transportprocesses:(SS) (15Lectures)**

Fick’s law: Flux, force, phenomenological coefficients & their inter-relationship (general form), different examples of transport properties

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

Conductance and transport number: Ion conductance; Conductance and measurement of conductance, cell constant, specific conductance and molar conductance; Variation ofspecific 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 electrolytes; Debye –Huckel theory of Ion atmosphere (qualitative)-asymmetric effect, relaxation effect andelectrophoretic effect; Ostwald's dilution law; Ionic mobility; Application of conductance measurement (determination of solubility product and ionic product of water); Conductometric titrations

Transportnumber, PrinciplesofHittorf’sandMoving-boundarymethod;Wieneffect,Debye-

Falkenhageneffect,Walden’srule

### ApplicationsofThermodynamics–I:(SKM) (25Lectures)

Partial properties and Chemical potential: Chemical potential and activity, partial molar quantities, relation between Chemical potential and Gibb's free energy and other thermodynamic state functions; variation of Chemical potential (μ) with temperature and pressure; Gibbs-Duhem equation; fugacity and fugacity coefficient; Variation of thermodynamicfunctionsforsystemswithvariablecomposition;Equationsofstatesforthese systems, Change in G, S H and V during mixing for binary solutions

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; Definitions of KP, KCand KX; van't Hoff's reaction isobar and isochore from different standardstates;Shiftingofequilibriumduetochangeinexternalparameterse.g.temperature

and pressure; variation of equilibrium constant with addition to inert gas; Le Chatelier's principle and its derivation

Nernst’s distribution law; Application- (findingout Kequsing Nernst dist lawfor KI+I2= KI3and dimerization of benzene

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

1. 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

### FoundationofQuantumMechanics:(SS) (20Lectures)

BeginningofQuantumMechanics:Wave-particleduality,lightasparticles:photoelectricand Compton effects; electrons as waves and the de Broglie hypothesis; Uncertainty relations (without proof)

Wave function: Schrodinger time-independent equation; nature of the equation, acceptability conditions imposed on the wave functions and probability interpretations of wave function

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

Particle in a box: Setting up of Schrodinger equation for one-dimensional box and itssolution; Comparison with free particle eigenfunctions and eigenvalues. Properties of PB wave functions (normalisation, orthogonality, probabilitydistribution); Expectation values of x, x2, pxand px2and their significance in relation to the uncertainty principle; Extension ofthe problem to two and three dimensions and the concept of degenerate energy levels

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

### ReferenceBooks:

* 1. Atkins,P.W.&Paula,J.de*Atkins’,PhysicalChemistry*,OxfordUniversityPress
	2. Castellan,G.W.*PhysicalChemistry*,Narosa
	3. McQuarrie, D. A. & Simons, J. D. *Physical Chemistry: A Molecular Approach*, Viva Press
	4. Levine,I.N.*PhysicalChemistry*,TataMcGraw-Hill
	5. Rakshit,P.C.,*PhysicalChemistry,*Sarat Book House
	6. Moore,W.J.*PhysicalChemistry*,OrientLongman
	7. Mortimer,R.G.*PhysicalChemistry*,Elsevier
	8. Denbigh,K.*ThePrinciplesofChemicalEquilibrium*CambridgeUniversityPress
	9. Engel,T. &Reid,P.*PhysicalChemistry*,Pearson
	10. Levine, I.N.*QuantumChemistry*,PHI
	11. Atkins,P.W.*MolecularQuantumMechanics*,Oxford
	12. Zemansky,M.W.&Dittman,R.H.*HeatandThermodynamics*,Tata-McGraw-Hill
	13. Rastogi,R.P.&Misra,R.R.*AnIntroductiontoChemicalThermodynamics*,Vikas
	14. Klotz,I.M.,Rosenberg,R.M.*ChemicalThermodynamics:BasicConceptsand Methods* Wiley
	15. Glasstone,S.*AnIntroductiontoElectrochemistry*,East-West Press

### C5P: Physical Chemistry-II(SS+SKM) Credits02 LAB

**(60Lectures)**

**Experiment1:**Studyofviscosityofunknown liquid(glycerol,sugar)withrespectto water

**Experiment 2:** Determination of partition coefficient for the distribution of I2between water and CCl4

**Experiment 3:** Determination of Keqfor KI +I2= KI3, using partition coefficient betweenwater and CCl4

**Experiment4:**Conductometrictitrationofanacid(strong,weak/monobasic,dibasic)against base strong

**Experiment5:**Studyof saponificationreactionconductometrically

**Experiment6:**VerificationofOstwald’s dilutionlawanddetermination ofKaofweak acid

### SuggestedReadings:

1. Viswanathan,B.,Raghavan,P.S.*PracticalPhysicalChemistry*VivaBooks (2009)
2. Mendham,J.,A.I.Vogel’sQuantitativeChemicalAnalysis6thEd., Pearson
3. Harris,D.C.*QuantitativeChemicalAnalysis*.6thEd.,Freeman(2007)
4. Palit,S.R.,De,S.K.*PracticalPhysicalChemistry*ScienceBook Agency
5. *UniversityHandBookofUndergraduateChemistryExperiments*,editedby Mukherjee, G. N., University of Calcutta
6. Levitt,B.P.edited*Findlay’sPracticalPhysical Chemistry*LongmanGroup Ltd.
7. Gurtu,J.N.,Kapoor,R.,*AdvancedExperimentalChemistry*S.Chand&Co.Ltd.

## CC-6:InorganicChemistry-II Credits 06

**C6T:InorganicChemistry-II Credits04**

**Theory:60 Lectures**

**ChemicalBonding-I:(SH) (24Lectures)**

1. *Ionic bond:* 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 andimportanceofKapustinskiiexpressionforlatticeenergy.Madelungconstant,Born-Haber cycle and its application, Solvation energy. Defects in solids (elementary idea).Solubility energetics of dissolution process.
2. *Covalent bond:* Polarizing power and polarizability, ionic potential, Fazan’s rules.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, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main groups chemistry) and multiple bonding (σ and π bond approach).

### ChemicalBonding-II:(PB) (24Lectures)

1. 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: *gerade*, *ungerade,* HOMO, LUMO. Orbital mixing,. MO diagrams of H2, Li2, Be2, B2, C2, N2, O2, F2, and their ions wherever possible; Heteronuclear molecular orbitals: CO, NO, NO+, CN-, HF, BeH2, CO2and H2O. Bond properties: bond orders, bond lengths.
2. *Metallic Bond:* Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
3. *Weak Chemical Forces:* 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.

### Radioactivity:(SH) (12Lectures)

Nuclear stability and nuclear binding energy. Nuclear forces: meson exchange theory.Nuclear models (elementary idea): Concept of nuclear quantum number, magic numbers. Nuclear Reactions: Artificial radioactivity, transmutation of elements, fission, fusion and spallation. Nuclear energy and power generation. 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.

### SuggestedReadings:

* 1. Lee,J.D.*ConciseInorganicChemistry,5thEd.,*WileyIndiaPvt.Ltd.,2008.
	2. Huheey,J.E.;Keiter,E.A.&Keiter,R.L.*InorganicChemistry,Principlesof*

*StructureandReactivity 4thEd.,*HarperCollins1993,Pearson,2006.

* 1. Douglas,B.E.andMcDaniel,D.H.*Concepts&ModelsofInorganicChemistry*

Oxford,1970.

* 1. Porterfield,H.W.,*InorganicChemistry,*Second Edition,AcademicPress,2005.
	2. Purecell,K.F.andKotz,J.C.,*AnIntroductiontoInorganicChemistry*,Saunders: Philadelphia, 1980.
	3. Cotton, F.A., Wilkinson, G., & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.;* Wiley India.
	4. Gillespie, R. J. and Hargittai, I., The VSEPR Model of Molecular Geometry, Prentice Hall (1992).
	5. Albright,T.,*Orbitalinteractionsinchemistry,*JohnWileyandSons(2005).
	6. Mingos,D.M.P.,*Essentialtrendsininorganicchemistry*.OxfordUniversityPress (1998).
	7. Miessler,G. L.,Fischer, P.J.,Tarr,D.A.,*InorganicChemistry,*Pearson, 5thEdition.
	8. Kaplan,I.,*NuclearPhysics,*Addison-WesleyPublishingCompanyInc.London,1964.
	9. Friedlander,G.,Kennedy,J.W.,Macias,E.S.AndMiller,J.M.,*NuclearandRadiochemistry*, Wiley, 1981.

### C6P:InorganicChemistry-II-Lab Credits02

**Inorganic Chemistry-II (LAB) (60Lectures) Iodo-/ Iodimetric Titrations:(PB)**

1. EstimationofCu(II)
2. EstimationofVitaminC
3. Estimationof(i)arsenite and(ii)antimonyintartar-emetic iodimetrically
4. Estimationofavailablechlorineinbleachingpowder.

### Estimationofmetalcontentinsomeselective samples:(SH)

1. EstimationofCuin brass.
2. EstimationofCrand Mnin Steel.
3. EstimationofFeincement.

### SuggestedReadings:

1. Mendham,J.,*A.I.Vogel’sQuantitativeChemicalAnalysis*6thEd.,Pearson,2009.

**CC-7:OrganicChemistry-III Credits06**

**C7T:OrganicChemistry-III Credits04**

**Theory:60Lectures**

**Chemistryofalkenesand alkynes:(NKH) (15Lectures)**

*Addition to C=C:* mechanism (with evidence wherever applicable), reactivity,regioselectivity(Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions:hydrogenation,halogenations,iodolactonisation,hydrohalogenation,hydration,

oxymercuration-demercuration, hydroboration-oxidation, epoxidation, *syn* and *anti*- hydroxylation, ozonolysis, addition of singlet and triplet carbenes; electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylicand benzylic bromination in competition with brominations across C=C; use of NBS; Birch reduction of benzenoid aromatics; interconversion of *E* - and *Z* - alkenes; contra- thermodynamic isomerization of internal alkenes.

*Addition to C≡C (in comparison to C=C):* mechanism, reactivity, regioselectivity (Markownikoffandanti-Markownikoffaddition)andstereoselectivity; 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.

### AromaticSubstitution:(NKH) (10Lectures)

*Electrophilic aromatic substitution:* mechanisms and evidences in favour of it; orientationand reactivity; reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reaction; one-carbon electrophiles (reactions: chloromethylation, Gatterman-Koch, Gatterman, Houben-Hoesch, Vilsmeier-Haack, Reimer-Tiemann, Kolbe-Schmidt); *Ipso* substitituion.

*Nucleophilic aromatic substitution:* addition-elimination mechanism and evidences in favour of it; SN1 mechanism; cine substitution (benzyne mechanism), structure of benzyne.

### CarbonylandRelated Compounds:(AP) (30Lectures)

*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:benzoincondensation,CannizzaroandTischenkoreactions,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 lead tetraacetate oxidation of 1,2-diols.

*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-enolatesand silyl enol ethers) in connection with alkylation, acylation and aldol type reaction.

*Elementary ideas of Green Chemistry:* Twelve (12) principles of green chemistry; planningof green synthesis; common organic reactions and their counterparts: reactions: Aldol, Friedel-Crafts, Michael, Knoevenagel, Cannizzaro, benzoin condensation and Dieckmann condensation.

*Nucleophilic addition to α,β-unsaturated carbonyl system:* general principle and mechanism (withevidence);directandconjugateaddition,additionofenolates(Michaelreaction),Stetter reaction, Robinson annulation.

*Substitution at sp2 carbon (C=O system):* mechanism (with evidence): *B*AC2, *A*AC2, *A*AC1, *A*AL1 (in connection to acid and ester); acid derivatives: amides, anhydrides & acyl halides (formation and hydrolysis including comparison).

### Organometallics:(NKH) (5Lectures)

*Grignard reagent; Organolithiums; Gilman cuprates:* preparation and reactions (mechanism with evidence); addition of Grignard and organolithium to carbonyl compounds; substitution on -COX; directed ortho metalation of arenes using organolithiums, conjugate addition by Gilman cuprates;Corey-House synthesis; abnormal behavior of Grignard reagents; comparison of reactivity among Grignard, organolithiums and organocopper reagents; Reformatskyreaction; Blaise reaction; concept of *umpolung* and base-nucleophile dichotomy in case of organometallic reagents.

### SuggestedReadings:

1. Clayden,J.,Greeves,N.,Warren,S.*OrganicChemistry,*Secondedition,Oxford University Press 2012.
2. Sykes,P.*AguidebooktoMechanisminOrganic Chemistry,*PearsonEducation,2003.
3. Smith,J.G.*OrganicChemistry*, TataMcGraw-HillPublishingCompanyLimited.
4. Carey,F.A.,Guiliano,R.M.*OrganicChemistry*,Eighthedition,McGrawHill Education, 2012.
5. Loudon,G.M.*Organic Chemistry*,Fourthedition,OxfordUniversityPress,2008.
6. Norman, R.O. C., Coxon, J. M. *Principles of Organic Synthesis*, Third Edition, NelsonThornes, 2003.
7. Morrison, R. N. & Boyd, R. N. *OrganicChemistry*, DorlingKindersley(India)Pvt.Ltd. (Pearson Education).
8. Finar,I.L.*OrganicChemistry(Volume1),*Pearson Education.
9. GrahamSolomons,T.W.,Fryhle, C.B.*OrganicChemistry,*John Wiley&Sons,Inc.
10. March,J.*AdvancedOrganicChemistry*,Fourthedition,Wiley.
11. Jenkins, P. R., *Organometallic Reagents in Synthesis*, Oxford ChemistryPrimer, Oxford University Press.
12. Ward,R.S.,*BifunctionalCompounds*,OxfordChemistryPrimer,OxfordUniversity Press.
13. Ahluwalia,V.K.*StrategiesforGreenOrganicSynthesis*,ANEBooksPvt.Ltd.

### C7P: Organic Chemistry-III –Lab(NKH+AP) Credits02 LAB (60 Lectures)

**Experiment-1:QualitativeAnalysisof SingleSolidOrganic Compounds**

* 1. Detectionofspecialelements(N,S,Cl,Br)byLassaigne’stest
	2. Solubilityandclassification(solvents:H2O,5%HCl,5% NaOHand5%NaHCO3)
	3. Detection of the following functional groups by systematic chemical tests:aromatic amino (-NH2), aromatic nitro (-NO2), amido (-CONH2, including imide), phenolic –OH, carboxylic acid (-COOH), carbonyl (-CHO and >C=O); only one test for each functional group is to be reported.
	4. Meltingpointofthe given compound
	5. Preparation, purification and melting point determination of a crystalline derivative ofthe given compound
	6. Identificationofthecompoundthroughliteraturesurvey.

Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups with relevant derivatisation in known and unknown (**at least six)** organic compounds.

### SuggestedReadings:

* + 1. Vogel, A. I. *Elementary Practical Organic Chemistry,* Part 2: *Qualitative OrganicAnalysis,* CBS Publishers and Distributors.
		2. *UniversityHandBookofUndergraduateChemistryExperiments*,editedbyMukherjee, G. N. University of Calcutta, 2003.
		3. Mann,F.G.&Saunders,B.C.*PracticalOrganicChemistry,*PearsonEducation (2009).
		4. Furniss,B.S.,Hannaford,A.J.,Smith,P.W.G.,Tatchell,A.R.*PracticalOrganic Chemistry,*5th Ed.,Pearson (2012).
		5. Clarke,H.T.,*AHandbookofOrganicAnalysis(QualitativeandQuantitative)*, Fourth Edition, CBS Publishers and Distributors (2007).
		6. *Practical WorkbookChemistry (Honours), UGBS, Chemistry*, Universityof Calcutta, 2015.

**SkillEnhancementCourse (SEC)**

## SEC-1:AnalyticalClinicalBiochemistry Credits: 02

**SEC1T:AnalyticalClinicalBiochemistry Credits: 01**

### THEORY:30Lectures

**Basicunderstandingofthestructures,propertiesandfunctionsofcarbohydrates,lipids and proteins:(NKH)**

Reviewofconceptsstudiedinthecorecourse:

*Carbohydrates:*Biologicalimportanceofcarbohydrates,Metabolism,Cellularcurrencyof energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.

Isolationand characterizationofpolysachharides.

*Proteins:*Classification,biologicalimportance;Primaryandsecondaryand tertiarystructures ofproteins:α-helixandβ-pleatedsheets,Isolation,characterization,denaturationofproteins. *Enzymes:* Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in “Green Chemistry” and Chemical Industry.

*Lipids:* Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.Lipoproteins.Properties,functionsandbiochemicalfunctionsofsteroid hormones.

Biochemistryofpeptidehormones.

*StructureofDNA*(Watson-Crickmodel)andRNA,GeneticCode,BiologicalrolesofDNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.

*Enzymes*:Nomenclature,classification,effectofpH,temperatureonenzymeactivity,enzyme inhibition.

### Biochemistryofdisease:Adiagnosticapproachbyblood/urine analysis.(SH)

*Blood:* Composition and functions of blood, blood coagulation. Blood collection and preservationofsamples.Anaemia,Regulation,estimationandinterpretationofdataforblood sugar, urea, creatinine, cholesterol and bilirubin.

*Urine:*Collectionandpreservationofsamples.6.Formationofurine.Compositionand estimation of constituents of normal and pathological urine.

## SEC1P:AnalyticalClinicalBiochemistry Credits: 01

### Practicals:(SH+NKH)

Identificationand estimationofthe following:

1. Carbohydrates–qualitativeandquantitative.
2. Lipids–qualitative.
3. Determinationoftheiodinenumberofoil.
4. Determinationofthesaponificationnumberof oil.
5. DeterminationofcholesterolusingLiebermann-Burchard reaction.
6. Proteins–qualitative.
7. Isolationofprotein.
8. Determinationofproteinbythe Biuretreaction.
9. Determinationofnucleic acids

### ReferenceBooks:

* + Cooper,T.G.*ToolofBiochemistry*.Wiley-Blackwell (1977).
	+ Wilson,K.&Walker,J.*PracticalBiochemistry.* Cambridge UniversityPress(2009).
	+ Varley,H., Gowenlock, A.H&Bell,M.:*PracticalClinicalBiochemistry,*Heinemann,
	+ London(1980).
	+ Devlin,T.M.,*TextbookofBiochemistrywithClinicalCorrelations*,JohnWiley&
	+ Sons, 2010.
	+ Berg,J.M.,Tymoczko,J.L. &Stryer, L.*Biochemistry*,W.H.Freeman,2002.
	+ Talwar,G.P.&Srivastava,M.*TextbookofBiochemistryandHumanBiology*,3rdEd.
	+ PHILearning.
	+ Nelson,D.L.&Cox,M.M.*LehningerPrinciplesofBiochemistry*,W.H.Freeman,
	+ 2013.
	+ O.Mikes,R.A.Chalmers:*LaboratoryHandbookofChromatographicMethods*,D.
	+ VanNostrand&Co.,1961.

**Or**

## SEC-1:PharmaceuticalChemistry Credits: 02

### SEC1T: Pharmaceutical Chemistry Credits:01 Theory: 30 Lectures

**Drugs&Pharmaceuticals:(PB)**

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representativedrugsofthefollowingclasses:analgesicsagents,antipyreticagents, antiinflammatoryagents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

**Fermentation:(PB)**

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics;Penicillin,Cephalosporin,ChloromycetinandStreptomycin,(iii)Lysine,Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

### SEC1P: Pharmaceutical Chemistry Credits:01 Practicals:(PB+AP)

1. PreparationofAspirinanditsanalysis.
2. Preparationofmagnesiumbisilicate (Antacid).

**ReferenceBooks:**

* + Patrick,G. L.*IntroductiontoMedicinalChemistry,OxfordUniversity*Press,UK,

2013.

* + Singh,H.&Kapoor,V.K.*MedicinalandPharmaceuticalChemistry,*Vallabh Prakashan, Pitampura, New Delhi, 2012.
	+ Foye,W.O.,Lemke,T.L.&William,D.A.:*PrinciplesofMedicinalChemistry*,4th ed., B.I. Waverly Pvt. Ltd. New Delhi.

**GenericElectiveSyllabus**

## GE-3[Interdisciplinaryforotherdepartment]

**GE3:ChemicalEnergetics,Equilibria,OrganicChemistry-II**

### Credits06 GE3T: Chemical Energetics, Equilibria, Organic Chemistry-II Credits 04 Theory: 60 Lectures

**SectionA:PhysicalChemistry-II(30Lectures)**

### ChemicalEnergetics:(SKM) (14Lectures)

Intensiveandextensivevariables;stateandpathfunctions;isolated,closedandopen 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 Standard states; Heats of reaction; enthalpyof formation of molecules and ions and enthalpyof combustion and its applications; Laws of thermochemistry; bond energy, bond dissociation energyand resonance energyfrom thermochemical data, Kirchhoff’s equations and effect of pressure on enthalpy of reactions; Adiabatic flame temperature; explosion temperature Statement of the second law of thermodynamics;Conceptofheatreservoirsand heatengines;Carnotcycle;Physicalconcept of Entropy; Carnot engine, refrigerator and efficiency; Entropy change of systems and surroundings for various processes and transformations; Auxiliary state functions (G and A) and Criteria for spontaneity and equilibrium.

### ChemicalEquilibrium:(SKM) (08Lectures)

Thermodynamic conditions for equilibrium, degree of advancement; Variation of free energy with degree of advancement; Equilibrium constant and standard Gibbs free energy change; Definitions of KP, KC and KX and relation among them; van’t Hoff’s reaction isotherm, 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

### IonicEquilibria:(SS) (08Lectures)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization,ionizationconstantandionicproductofwater; Ionizationofweakacidsandbases, pH scale, common ion effect; Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts; Buffer solutions; Solubility and solubility product of sparingly soluble salts – applications of solubility product principle

### SuggestedReadings:

1. Barrow,G.M.*PhysicalChemistry*TataMcGrawHill(2007).
2. Castellan,G.W.*PhysicalChemistry*4thEd.Narosa (2004).
3. Kotz,J.C.,Treichel,P.M.&Townsend,J.R.*GeneralChemistry*Cengage LearningIndia Pvt. Ltd., New Delhi (2009).
4. Mahan,B.H.*UniversityChemistry*3rdEd.Narosa (1998).
5. Ekambaram,S.*GeneralChemistry*,Pearson.
6. Petrucci,R.H.*GeneralChemistry*5thEd.MacmillanPublishingCo.:NewYork(1985).
7. Chugh,K.L.,Agnish, S.L.*ATextBookofPhysicalChemistry*KalyaniPublishers
8. Bahl,B.S.,Bahl,A.,Tuli,G.D.,*EssentialsofPhysicalChemistry*S.Chand&Co.ltd.
9. Palit,S.R.,*ElementaryPhysicalChemistry*BookSyndicatePvt.Ltd.
10. Mandal,A.K.*DegreePhysicalandGeneralChemistry*SaratBookHouse
11. Pahari,S.,*PhysicalChemistry*NewCentralBookAgency
12. Pahari,S.,Pahari,D., *ProblemsinPhysicalChemistry*NewCentralBookAgency

**Section-B:OrganicChemistry-II (30Lectures)**

Functionalgroupapproachforthefollowingreactions(preparations&reactions)to be studied in context to their structures.

### AromaticHydrocarbons:(NKH) 06 Lectures

*Benzene: Preparation*: from phenol, by decarboxylation, from acetylene, from Benzene sulphonic acid. *Reactions*: electrophilic substitution (general mechanism); nitration (with mechanism), halogenations (chlorination and bromination), sulphonation and Friedel-Craft’s reaction(alkylationandacylation)(upto4carbonsonbenzene);sidechain oxidationofalkyl benzenes (up to 4 carbons on benzene).

### OrganometallicCompounds:(AP) (2Lectures)

Introduction;*Grignardreagents*:*Preparations*(fromalkylandarylhalide);conceptof

*umpolung;*Reformatskyreaction.

### Aryl Halides:(AP) (3Lectures)

*Preparation:* (chloro-, bromo- and iodobenzene): from phenol, Sandmeyer reactions. *Reactions (Chlorobenzene):* nucleophilic aromatic substitution (replacement by –OH group) and effect of nitro substituent (activated nucleophilic substitution).

**Alcohols, Phenols and Ethers:(NKH) (11 Lectures)** *Alcohols:* (up to 5 Carbons). *Preparation:* 1°-, 2°- and 3°- alcohols: using Grignard reagent, reductionofaldehydes,ketones,carboxylicacidandesters;*Reactions:*Withsodium,HX (Lucastest),oxidation(alkalineKMnO4,acidicdichromate,concentratedHNO3); Oppenauer oxidation;

*Diols: Preparation* (with OsO4); pinacol- pinacolone rearrangement (with mechanism) (*with symmetrical diols* only).

*Phenols: Preparation:* cumene hydroperoxide method, from diazonium salts; acidic nature of phenols; *Reactions:* electrophilic substitution: nitration and halogenations;

Reimer -Tiemann reaction, Houben–Hoesch condensation, Schotten –Baumann reaction,Fries rearrangement and Claisen rearrangement.

*Ethers:Preparation:*Williamson’sethersynthesis;*Reaction*:cleavageofetherswithHI.

### Carbonyl Compounds:(AP) (08Lectures)

*AldehydesandKetones (aliphaticandaromatic):* (Formaldehye,acetaldehyde, acetoneand benzaldehyde):*Preparation:*fromacidchlorides,fromnitrilesandfromGrignardreagents; general properties of aldehydes and ketones; *Reactions:* with HCN, ROH,

NaHSO3, NH2-G derivatives and with Tollens’ and Fehling’s reagents; iodoform test; aldol condensation (with mechanism); Cannizzaro reaction (with mechanism),Wittig reaction, benzoin condensation; Clemmensen reduction, Wolff- Kishner reduction and Meerwein- Pondorff- Verley (MPV) reduction.

### SuggestedReadings:

1. Sethi,A.*ConceptualOrganicChemistry;*NewAgeInternational Publisher.
2. Parmar,V.S.*ATextBookofOrganicChemistry*,S.Chand& Sons.
3. Madan,R.L.*OrganicChemistry*,S.Chand& Sons.
4. Wade,L.G.,Singh,M.S.,*OrganicChemistry,Pearson*.
5. Finar,I. L.*OrganicChemistry*(*Volume1*),DorlingKindersley(India)Pvt.Ltd.(Pearson Education).
6. Morrison,R.T.&Boyd,R.N.*OrganicChemistry*,DorlingKindersley(India)Pvt.Ltd. (Pearson Education).
7. Bahl,A.&Bahl,B.S.*AdvancedOrganicChemistry,*S.Chand,2010.

### GE-3P:LAB:Practicals Credits02

(**60Lectures) Practicals:(NKH+SS)**

**SectionA:PhysicalChemistry-LAB(15x2=30Lectures)**

(Minimum**five**experimentstocomplete)

(I)Thermochemistry(Any**three**)

1. Determinationofheatcapacityofcalorimeterfor differentvolumes
2. Determinationofenthalpyofneutralizationofhydrochloricacidwithsodium hydroxide
3. Determinationofenthalpyofionizationofaceticacid
4. Determinationofenthalpyofhydrationofcoppersulphate

(II)IonicEquilibria(Any**two**)

1. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter and compare it with the indicator method
2. Preparation of buffer solutions and find the pH of an unknown buffer solution by colour matching method (using following buffers)
	1. Sodiumacetate-aceticacid
	2. Ammoniumchloride-ammonium hydroxide
3. Studyofthe solubilityof benzoicacidinwater

### SuggestedReadings:

1. *UniversityHandBookofUndergraduateChemistryExperiments*,editedbyMukherjee,

G.N., UniversityofCalcutta, 2003.

1. Palit,S.R.,*PracticalPhysicalChemistry*ScienceBook Agency
2. Mukherjee,N.G.,*SelectedExperimentsinPhysicalChemistry*J.N.Ghose&Sons
3. Dutta,S.K.,*PhysicalChemistryExperiments*BharatiBook Stall

## SectionB:OrganicChemistry-LAB

### Identificationofapureorganic compound

*Solid compounds*: oxalic acid, tartaric acid, succinic acid, resorcinol, urea, glucose, benzoicacid and salicylic acid.

*LiquidCompounds*:methylalcohol,ethylalcohol,acetone,aniline,dimethylaniline,benzaldehyde, chloroform and nitrobenzene

### SuggestedReadings:

1. Bhattacharyya,R.C,*AManualofPracticalChemistry.*
2. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5thedition, 1996.
3. Mann,F.G.&Saunders,B.C.*PracticalOrganicChemistry*Orient-Longman, 1960.