UGC CBCS
TDC COURSE CURRICULUM
and
SYLLABI

CHEMISTRY

Submitted by:-

Dr. Pradip C. Paul
Head, Department of Chemistry
Chairman, BUGS-Chemistry
Assam University: Silchar.

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Modified as per CBCS Syllabus Structure Preparation Committee Meeting, March 28, 2017

Contents

Important Note:
Course content, Question Papers and Schedule of Examination shall be the same for DSC [Core for BSc with Chemistry] and GE [Hons with other Discipline] in accordance with sections 2.3, 2.1 and 3.2 of UGC's Instructional Template for facilitating implementation of CBCS.

***Reference*:**
UGC's Instructional Template for Facilitating Implementation of CBCS

2.3 P.S.:	*A **core** course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective* (**GE**)**.**
2.1	*Discipline Specific Elective (***DSE***) (***4** *for Honours and* **2** *for Regular courses)*
3.2	*Skill Enhancement Courses (***SEC***) (***2** *for Honours and* **4** *for Regular courses)***.**

CBCS UG - COURSE CURRICULUM (Basic structure)

B.Sc. (Honours)

CHEMISTRY (HONOURS)

CORE COURSE (C)		**Papers**	**x**	**Credits**	**Total Credits**
CORE	CHEMISTRY Theory + Practical	14	x	4 + 2	**84**
ELECTIVE COURSE (DSE and GE)					
DSE	Chemistry Theory + Practical	4	x	4 + 2	**24**
GE	Theory + Practical	4	x	4 + 2	**24**
	or		**or**		
	Theory + Tutorial	4	x	5 + 1	
GE Courses are Computer Science, Mathematics, Physics (*any one*).					
Ability Enhancement Courses					
Ability Enhancement Compulsory Courses (AECC) 1) English/MIL Communication 2) Environmental Science		2	x	4	**08**
Skill Enhancement Courses (SEC)		2	x	4	**08**
				Total Credits =	**148**

CBCS UG - Course Curriculum

B. Sc. with Chemistry

Discipline Specific Core (DSC) Courses		Papers	x	Credits	Total Credits
DSC	**DSC 1: Chemistry Theory + Practical**	4	x	4 + 2	**72**
	DSC 2: other subject Theory + Practical	4	x	4 + 2	
	DSC 3: other subject Theory + Practical	4	x	4 + 2	
	or				
	DSC 3: other subject Theory+Tutorial	4	x	5 + 1	
Discipline Specific Elective (DSE) Courses					
DSE	**DSE 1: Chemistry Theory + Practical**	2	x	4 + 2	**36**
	DSE 2: other subject Theory+Practical	2	x	4 + 2	
	DSE 3: other subject Theory+Practical	2	x	4 + 2	
	or				
	DSC E: other subject Theory+Tutorial	2	x	5 + 1	
Skill Enhancement Courses (SEC)		4	x	4	**16**
Ability Enhancement Compulsory Courses (AECC) 1) English/MIL Communication 2) Environmental Science		2	x	4	**08**
Each credit is equivalent to 1 hour of activity per week				**Total Credits =**	**132**

CBCS
TDC - SYLLABI

CHEMISTRY
(HONOURS)

SEMESTER-WISE COURSE STRUCTURE FOR CHOICE BASED CREDIT SYSTEM IN
B. Sc. Honours (CHEMISRY)

	CORE COURSE (14 papers)	**Ability Enhancement Compulsory Course (AECC) (2 papers)**	**Ability Enhancement Elective Course(AEEC) (Skill Based) (2 papers)**	**Elective: Discipline Specific DSE (4 papers)**	**Elective: Generic(GE) 4 papers *(To be taken from other discipline)***
I	CHEMISTRY-C-101 CHEMISTRY -C-102	Environmental Science			GE-1
II	CHEMISTRY -C-201 CHEMISTRY -C-202	English/MIL Communication			GE-2
III	CHEMISTRY -C-301 CHEMISTRY -C-302 CHEMISTRY -C-303		CHEMISRY-SEC-301		GE-3
IV	CHEMISTRY -C-401 CHEMISTRY -C-402 CHEMISTRY -C-403		CHEMISRY-SEC-401		GE-4
V	CHEMISTRY -C-501 CHEMISTRY -C-502			CHEMISRY-DSE-501 CHEMISRY-DSE -502	
VI	CHEMISTRY -C-601 CHEMISTRY -C-602			CHEMISRY-DSE -601 CHEMISRY-DSE -602	

Core Courses for Chemistry (Honours) with Course Code and Course Name

SEMESTER	Course No.	Course Name	Credit	Marks
I	**CHEMISTRY-C-101**	**Inorganic Chemistry –I** *Atomic Structure and Chemical Bonding*	4	70
	CHEMISTRY-C-101-LAB	***Practical***	2	30
	CHEMISTRY-C-102	**Physical Chemistry –I** *States of Matter and Ionic Equilibrium*	4	70
	CHEMISTRY-C-102-LAB	***Practical***	2	30
II	**CHEMISTRY-C-201**	**Organic Chemistry –I** *Hydrocarbons and Stereochemistry*	4	70
	CHEMISTRY-C-201-LAB	***Practical***	2	30
	CHEMISTRY-C-202	**Physical Chemistry –II** *Chemical Thermodynamics and its Applications*	4	70
	CHEMISTRY-C-202-LAB	***Practical***	2	30
III	**CHEMISTRY-C-301**	**Inorganic Chemistry –II** *s- & p-block Elements and Metallurgy*	4	70
	CHEMISTRY-C-301-LAB	***Practical***	2	30
	CHEMISTRY-C-302	**Organic Chemistry –II** *Halogen & Oxygen Containing Functional Groups*	4	70
	CHEMISTRY-C-302-LAB	***Practical***	2	30
	CHEMISTRY-C-303	**Physical Chemistry –III** *Phase Equilibria and Chemical Kinetics*	4	70
	CHEMISTRY-C-303-LAB	***Practical***	2	30
IV	**CHEMISTRY-C-401**	**Inorganic Chemistry –III** *Coordination Chemistry and its Applications*	4	70
	CHEMISTRY-C-401-LAB	***Practical***	2	30
	CHEMISTRY-C-402	**Organic Chemistry –III** *Heterocyclic Chemistry*	4	70
	CHEMISTRY-C-402-LAB	***Practical***	2	30
	CHEMISTRY-C-403	**Physical Chemistry –IV** *Electrochemistry*	4	70
	CHEMISTRY-C-403-LAB	***Practical***	2	30
V	**CHEMISTRY-C-501**	**Organic Chemistry –IV** *Biomolecules*	4	70
	CHEMISTRY-C-501-LAB	***Practical***	2	30
	CHEMISTRY-C-502	**Physical Chemistry –V** *Quantum Chemistry and Spectroscopy*	4	70
	CHEMISTRY-C-502-LAB	***Practical***	2	30
VI	**CHEMISTRY-C-601**	**Inorganic Chemistry –IV** *Organometallic Chemistry*	4	70
	CHEMISTRY-C-601-LAB	***Practical***	2	30
	CHEMISTRY-C-602	**Organic Chemistry –V** *Spectroscopy, Dyes and Polymers*	4	70
	CHEMISTRY-C-602-LAB	***Practical***	2	30

Discipline Specific Elective (DSE) Courses forChemistry Honours

SEMESTER	COURSE No.	*Couse Name*	Credit	Marks
V	**CHEMISTRY-DSE-501**	*Analytical Methods in Chemistry*	4	70
	CHEMISTRY-DSE-501-LAB	*Practical*	2	30
	CHEMISTRY-DSE-502	*Green Chemistry*	4	70
	CHEMISTRY-DSE-502-LAB	*Practical*	2	30
VI	**CHEMISTRY-DSE-601**	*Inorganic Materials of Industrial Importance*	4	70
	CHEMISTRY-DSE-601-LAB	*Practical*	2	30
	CHEMISTRY-DSE-602	***Dissertation* (*Project Work*)**	6	100

Skill Enhancement Courses (SEC)
(FOR CHEMISTRY HONOURS)

III	**CHEMISTRY-SEC-301**	*Analytical Clinical Biochemistry*	4	70
IV	**CHEMISTRY –SEC-401**	*Fuel Chemistry*	4	70

Semester wise list of Chemistry Generic Elective (GE) papers for the students taking Honours in other disciplines

SEMESTER	COURSE No. *Course Name*	Credit	Marks
I	**CHEMISTRY-GE-101** *Atomic Structure, Bonding, General Organic Chemistry and Aliphatic Hydrocarbons*	**4**	**70**
	CHEMISTRY-GE-101-LAB *Practical*	**2**	**30**
II	**CHEMISTRY-GE-201** *Chemical Energetics, Equilibria and Functional Group Organic Chemistry-I*	**4**	**70**
	CHEMISTRY-GE-201-LAB *Practical*	**2**	**30**
III	**CHEMISTRY-GE-301** *Solutions, Phase Equilibrium, Conductance, Electrochemistry and Functional Group Organic Chemistry-II*	**4**	**70**
	CHEMISTRY-GE-301-LAB *Practical*	**2**	**30**
IV	**CHEMISTRY-GE-401** *Transition metals, Coordination Chemistry, States of Matter and Chemical Kinetics*	**4**	**70**
	CHEMISTRY-GE-401-LAB *Practical*	**2**	**30**

CBCS
TDC - SYLLABI

B. Sc. with
CHEMISTRY

SEMESTER-WISE COURSE STRUCTURE FOR CHOICE BASED CREDIT SYSTEM IN

B. Sc. with Chemistry

	DISCIPLINE SPECIFIC CORE COURSE (DSC) (12 papers)	**Ability Enhancement Compulsory Course(AECC) (2 papers)**	**Skill Enhancement Course (SEC) (4 papers)**	**Discipline Specific Elective (DSE) (6 papers)**
I	CHEMISTRY-DSC-101 DSC- 2 A DSC- 3 A	Environmental Science		
II	CHEMISTRY-DSC-201 DSC- 2 B DSC- 3 B	English/MIL Communication		
III	CHEMISTRY-DSC-301 DSC- 2 C DSC- 3 C		CHEMISTRY-SEC-301	
IV	CHEMISTRY-DSC-401 DSC- 2 D DSC- 3 D		CHEMISTRY-SEC-401	
V			CHEMISTRY-SEC-501	CHEMISTRY-DSE-501 DSE-2 A DSE-3 A
VI			CHEMISTRY-SEC-601	CHEMISTRY-DSE-601 DSE-2 B DSE-3 B

CBCS: B. Sc. with Chemistry

Semester wise list of Chemistry papers to be studied as Discipline Specific Core (DSC) Courses by students of BSc with Chemistry (Regular)

SEMESTER	COURSE No. *Course Name*	Credit	Marks
I	**CHEMISTRY-DSC-101** *Atomic Structure, Bonding, General Organic Chemistry and Aliphatic Hydrocarbons*	4	70
	CHEMISTRY-DSC-101-LAB *Practical*	2	30
II	**CHEMISTRY-DSC-201** *Chemical Energetics, Equilibria and Functional Group Organic Chemistry-I*	4	70
	CHEMISTRY-DSC-201-LAB *Practical*	2	30
III	**CHEMISTRY-DSC-301** *Solutions, Phase Equilibrium, Conductance, Electrochemistry and Functional Group Organic Chemistry-II*	4	70
	CHEMISTRY-DSC-301-LAB *Practical*	2	30
IV	**CHEMISTRY-DSC-401** *Transition metals, Coordination Chemistry, States of Matter and Chemical Kinetics*	4	70
	CHEMISTRY-DSC-401-LAB *Practical*	2	30

Discipline Specific Elective (DSE) Courses

V	**CHEMISTRY-DSE-501** *Analytical Methods in Chemistry*	4	70
	CHEMISTRY-DSE-501-LAB *Practical*	2	30
VI	**CHEMISTRY-DSE-601** *Inorganic Materials of Industrial Importance*	4	70
	CHEMISTRY-DSE-601-LAB *Practical*	2	30

Skill Enhancement Courses (SEC)

III	**CHEMISTRY-SEC-301** *Analytical Clinical Biochemistry*	4	70
IV	**CHEMISTRY-SEC-401** *Fuel Chemistry*	4	70
V	**CHEMISTRY-SEC-501** *Chemistry of Cosmetics and Perfumes*	4	70
VI	**CHEMISTRY-SEC-601** *Pesticide Chemistry*	4	70

Detailed Syllabi

CHEMISTRY
(Honours)
(1st Semester)
Course No.:**CHEMISTRY-C-101**
(Inorganic Chemistry – I)
Atomic Structure & Chemical Bonding
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)
Objective of thiscourse is to emphasize on Atomic structure, bonding and periodicity

Unit 1: Atomic Structure

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. 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. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f-orbitals. Contour boundary and probability diagrams.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations.

Unit 2: Periodicity of Elements

s–, *p*–, *d*–, *f*– block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s*–&*p*– block.

(*a*) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

(*b*) Atomic radii (van der Waals)

(*c*) Ionic and crystal radii.

(*d*) Covalent radii (octahedral and tetrahedral)

(*e*) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.

(*f*) Electron gain enthalpy, trends of electron gain enthalpy.

(*g*) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.

Unit 3: Chemical Bonding I

(*i*) *Ionic bond*: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Madelung constant, Born-Haber cycle and its application, Solvation energy.

(*ii*) *Covalent bond*: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ– and π– bond approach) and bond lengths.

Unit 4: Chemical Bonding II

(i) Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

(ii) Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.

(iii) Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

(iv) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment).

Unit 5: Oxidation-Reduction

Redox reactions, balancing Redox equations by ion-electron method Standard Electrode Potential and its application to inorganic reactions, concept of formal Electrode Potential

Principles involved in volumetric analysis: Fe estimation by standard $KMnO_4$ solution, and $K_2Cr_2O_7$ solution.

Reference Books:

- Lee, J. D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B. E. and Mc Daniel, D. H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
- Atkins, P. W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
- Day, M. C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

CHEMISTRY LAB
(Honours)
(1st Semester)
Course No.:**CHEMISTRY-C-101-LAB**
(Inorganic Chemistry – I)
Practical

Contact Hours: 60; Credits: 02
Full Marks = 30 Pass Marks = 12
***Examination Time: 12 hours** (spread over two days)*

During examination, Two experiments(one from each of the Part I and Part II), to be assigned to each student by drawing lots.

1.	**Part I: Titrimetric Analysis**	**7 marks**
	(*i*) Calibration and use of apparatus	
	(*ii*) Preparation of solutions of different Molarity/Normality of titrants	
2.	**Part II: Oxidation-Reduction Titrimetry**	**14 marks**
	(*i*) Estimation of Fe (II) and oxalic acid using standardized $KMnO_4$ solution.	
	(*ii*) Estimation of Fe (II) with $K_2Cr_2O_7$solution.	
3.	**Viva – voce**	**2 marks**
4.	**Regularity in maintenance of Lab Notebook**	**2 marks**
5.	**Attendance**	**5 marks**

Reference Books:

- Vogel, A. I., A Textbook of Quantitative Inorganic Analysis, ELBS.
- Nad, A.K., Mahapatra, B., Ghoshal, A., An Advanced Course in Practical Chemistry, New Central Book Agency (P) Ltd., Kolkata, India.
- Das, Subhas C, Advanced Practical Chemistry for 3-Year Honours Course.

CHEMISTRY
(Honours)
(1st Semester)
Course No.:**CHEMISTRY-C-102**
(Physical Chemistry – I)
States of Matter & Ionic Equilibrium
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to emphasize on different states of matter and their mathematical treatment.

Unit 1: Gaseous State I

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity; variation of viscosity with temperature and pressure.

Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartitions of energy and degrees of freedom.

Unit 2: Gaseous State II

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Unit 3: Liquid State

Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

Unit 4: Solid State

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law. Defects in crystals. Glasses and liquid crystals.

Unit 5: Ionic Equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids.

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.

Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

Reference Books:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

CHEMISTRY LAB
(Honours)
(1st Semester)
Course No.:**CHEMISTRY-C-102-LAB**
(Physical Chemistry – I)
Practical

Contact Hours: 60; Credits: 02
Full Marks = 30 Pass Marks = 12
***Examination Time: 12 hours** (spread over two days)*

During examination, Two experiments (one from each of the Part I and Part II), to be assigned to each student by drawing lots.

1. Part I **10 marks**

a) Determination of transition temperature of the given substance by thermometric method (e.g., $MgSO_4$/$MnCl_2$/$Na_2SO_4.10H_2O$).
b) To determine the surface tension of glycerol/acetic acid/aniline solutions at different Concentrations and construction of graph.

2. Part II **11 marks**

a) Preparation of Sodium acetate-acetic acid buffer solutions of different pH
b) Preparation of Ammonium chloride-ammonium hydroxide buffer solutions of different pH
c) pH metric titration of strong acid/strong base,
d) pH metric titration of weak acid/strong base.

3. Viva – voce **2 marks**

4. Regularity in maintenance of Lab Notebook **2 marks**

5. Attendance **5 marks**

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W. H. Freeman & Co.: New York (2003).
- Nad, A.K., Mahapatra, B., Ghoshal, A., An Advanced Course in Practical Chemistry, New Central Book Agency (P) Ltd., Kolkata, India.
- Das, Subhas C., Advanced Practical Chemistry for 3-Year Honours Course.

CHEMISTRY
(Honours)
(2nd Semester)
Course No.:**CHEMISTRY-C-201**
(Organic Chemistry – I)
Hydrocarbons and Stereochemistry
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to impart knowledge on basic organic chemistry, hydrocarbon, stereochemistry and conformational analysis

Unit 1: Basics of Organic Chemistry

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit 2: Chemistry of Aliphatic Hydrocarbons

Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Electrophilic additions their mechanisms (Markownikoff / Anti Markownikoff addition), ozonolysis, reduction (catalytic and chemical). 1, 2-and 1, 4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl Benzene.

Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Unit 3: Aromatic and Polynuclear Hydrocarbons

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.

Unit 4: Stereochemistry

Fischer Projection, Newmann and Sawhorse Projection formulae and their inter-conversions; Geometrical isomerism: *cis–trans* and, *syn-anti* isomerism E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, molecules with two or more chiral-centres, diastereoisomers, meso structures, racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

Unit 5: Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane, monosubstituted, 1,2-, 1,3-, 1,4-Disubstitutedcyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams, Strain-less ring theory.

Reference Books:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
- Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

CHEMISTRY LAB
(Honours)
(2nd Semester)
Course No.:**CHEMISTRY-C-201-LAB**
(Organic Chemistry – I)
Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 12 hours** (spread over two days)*

During examination, Two experiments (one from each of the Part I and Part II), to be assigned to each student by drawing lots.

1. Part I: Purification: 10 marks

(a) Phthalic acid / Benzoic acid from hot water (using fluted filter paper and stem-less funnel)

(b) Acetanilide from boiling water

(c) Naphthalene/ m-Dinitrobenzene from ethanol

(d) Naphthalene/ camphor/phthalic acid (by sublimation)

2. Part II: Chromatographic separation 11 marks

(a) 2,4-Dinitrophenyl hydrazones of any two carbonyl compounds (e.g., benzophenone and benzyl; p-nitrobenzaldehyde and benzaldehyde) from their mixture and determination of Rf values (By Thin layer chromatography)

(b) Paper chromatographic separation and determination of R_f values of mixture of any three amino acids from their mixture (alanine, glycine and leucine or any other set). Spray reagent: Ninhydrin.

3. Viva – voce 2 marks

4. Regularity in maintenance of Lab Notebook 2 marks

5. Attendance 5 marks

Reference Books:

- Vogel, A. I., A Textbook of Qualitative Organic Analysis, ELBS.
- Nad, A.K., Mahapatra, B., Ghoshal, A., An Advanced Course in Practical Chemistry, New Central Book Agency (P) Ltd., Kolkata, India.
- Furniss, B. S.; Hannaford, A. J.; Smith, P. W. G.; Tatchell, A. R., Practical Organic Chemistry, 5th Ed., Pearson (2012)
- Mann, F. G. & Saunders, B. C., Practical Organic Chemistry, Pearson Education (2009)
- Das, Subhas C., Advanced Practical Chemistry for 3-Year Honours Course.

CHEMISTRY
(Honours)
(2nd Semester)
Course No.:**CHEMISTRY-C-202**
(Physical Chemistry – II)
Chemical Thermodynamics and its Applications
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to provide insight on Chemical Thermodynamics, their mathematical expressions and Applications

Unit 1: Chemical Thermodynamics I

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat (*q*), work (*w*), internal energy (*U*), and statement of first law; enthalpy (*H*), relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

Unit 2: Chemical Thermodynamics II

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Unit 3: Systems of Variable Composition

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Unit 4: Chemical Equilibrium

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants *Kp*, *Kc* and *Kx*. *Le Chatelier's Principle* (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

Unit 5: Solutions and Colligative Properties

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions.

Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Reference Books:

- Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., OUP (2011).
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics, CRC Press: NY (2011).
- Levine, I. N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
- Metz, C. R. 2000 Solved Problems in Chemistry, Schaum Series (2006)

CHEMISTRY LAB
(Honours)
(2nd Semester)
Course No.:**CHEMISTRY-C-202-LAB**
(Physical Chemistry – II)
Practical

Contact Hours: 60; Credits: 02
Full Marks = 30 Pass Marks = 12
***Examination Time: 12 hours** (spread over two days)*

During examination, two experiments to be assigned to each student by drawing lots

1. Physical Experiments: 10.5x2=21 marks

i. To determine the viscosity of glycerol/acetic acid solutions at different concentrations and construction of the graph.

ii. To determine the solubility of benzoic acid at different temperatures and to determine pH of the dissolution process.

iii. To determine the refractive index of a given liquid by Abbe refractometer and to find the specific and molar refraction.

iv. To determine the molecular mass by transition point method
(Solvent: Naphthalene /*m*-dinitrobenzene and Solute: Glucose/Urea)

2. Viva – voce 2 marks

3. Regularity in maintenance of Lab Notebook 2 marks

4. Attendance 5 marks

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Athawale, V. D. & Mathur, P. Experimental Physical Chemistry, New Age International: New Delhi (2001).

CHEMISTRY
(Honours)
(3rd Semester)
Course No.:**CHEMISTRY-C-301**
(Inorganic Chemistry – II)
s-, p- block Elements and Metallurgy

Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to provide insight on the chemistry of s-, p- block Elements, Noble gases,inorganic polymers and Metallurgy

Unit 1: Chemistry of *s*- and *p*- Block Elements

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of *s*- and *p*- block elements.

Hydrides and their classification ionic, covalent and interstitial.

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses.

Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

Unit 2: Noble Gases

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

Unit 3: Acids and Bases

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB), Application of HSAB principle.

Unit 4: Inorganic Polymers

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. borazines, silicates.

Unit 5: General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic processes and Mond's process, Zone refining.

Reference Books:

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J., Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
- Greenwood, N. N. & Earnshaw, Chemistry of the Elements, Butterworth Heinemann. 1997.
- Cotton, F. A. & Wilkinson, G., Advanced Inorganic Chemistry, Wiley, VCH, 1999.
- Miessler, G. L. & Donald, A. Tarr., Inorganic Chemistry 4th Ed., Pearson, 2010.
- Shriver & Atkins, Inorganic Chemistry 5th Ed.

CHEMISTRY LAB
(Honours)
(3rd Semester)
Course No.:**CHEMISTRY-C-301-LAB**
(Inorganic Chemistry – II)
Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 12 hours** (spread over two days)*

During examination, two experiments (one from each of the Part I and Part II), to be assigned to each student by drawing lots.

1.Part I: Iodo- / Iodimetric Titrations **14 marks**

(*i*) Estimation of Cu (II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).

(*ii*) Estimation of (i) arsenite and (ii) antimony iodimetrically

(*iii*) Estimation of available chlorine in bleaching powder iodometrically.

2.Part II: Inorganic preparations **7 marks**

(*i*) Cuprous Chloride, Cu_2Cl_2

(*ii*) Preparation of Manganese (III) phosphate, $MnPO_4.H_2O$

(*iii*) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

(*iv*) Preparation of Chrome alum.

3. Viva – voce **2 marks**

4. Regularity in maintenance of Lab Notebook **2 marks**

5. Attendance **5 marks**

Reference Books:

• Vogel, A. I., A Textbook of Quantitative Inorganic Analysis, ELBS (1978).

CHEMISTRY
(Honours)
(3rd Semester)
Course No.:**CHEMISTRY-C-302**
(Organic Chemistry – II)
Halogen and Oxygen Containing Functional Groups
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to provide insight on the synthesis and properties of organic compounds containing Halogen and Oxygen Containing Functional Groups

Unit 1: Chemistry of Halogenated Hydrocarbons

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. Nucleophilic aromatic substitution; SNAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Unit 2: Alcohols, Phenols, Ethers and Epoxides

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation & properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

Unit 3: Carbonyl Compounds

Structure, reactivity and preparation;

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-

substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, MPV). Addition reactions of unsaturated carbonyl compounds: Michael addition.

Unit 4: Carboxylic Acids and their Derivatives

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids;

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

Unit 5: Other Organic compounds

Preparation and reactions of thiols, thioethers and sulphonic acids.

Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Reference Books:

- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T. W. Organic Chemistry, John Wiley & Sons, Inc.

CHEMISTRY LAB
(Honours)
(3rd Semester)
Course No.:**CHEMISTRY-C-302-LAB**
(Organic Chemistry – II)
Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 12 hours** (spread over two days)*

During examination, two experiments (one from each of the Part I and Part II), to be assigned to each student by drawing lots.

1. Part I: Tests for functional groups **14marks**
Alcohols, phenols, carbonyl and carboxylic acid group.

2. Organic preparations: **7 marks**

i. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) and phenols (*β*-naphthol, vanillin) by conventional/green approach method.
ii. Benzoylation of one of the following amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) and one of the following phenols (*β*-naphthol, resorcinol, *p*-cresol) by Schotten-Baumann reaction.
iii. Nitration of Acetanilide/nitrobenzene by conventional method
iv. Nitration ofSalicylic acid (preferably by green approach using ceric ammonium nitrate).

The above derivatives should be prepared using 0.5-1 g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point.

3. Viva – voce **2 marks**

4. Regularity in maintenance of Lab Notebook **2 marks**

5. Attendance **5 marks**

Reference Books:

- Mann, F. G. & Saunders, B. C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B. S.; Hannaford, A. J.; Smith, P.W.G.; Tatchell, A. R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
- Ahluwalia, V. K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
- Ahluwalia, V. K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

CHEMISTRY
(Honours)
(3rd Semester)
Course No.:**CHEMISTRY-C-303**
(Physical Chemistry – III)
Phase Equilibria and Chemical Kinetics
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to emphasise in details on Phase Equilibria, Chemical Kinetics, catalysis and Surface chemistry.

Unit 1: Phase Equilibria I

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications.

Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems, water-chloroform-acetic acid system, triangular plots.

Unit 2: Phase Equilibria II

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

Unit 3: Chemical Kinetics

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Unit 4: Catalysis

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Unit 5: Surface chemistry

Physical adsorption, chemisorption, adsorption isotherms, nature of adsorbed state.

Reference Books:

- Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
- Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).
- McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
- Zundhal, S.S. Chemistry concepts and applications Cengage India (2011).
- Ball, D. W. Physical Chemistry Cengage India (2012).
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
- Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).
- Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).
- Laidler, K. J., Chemical Kinetics 3rd Ed., Pearson Education India (2008).
- Kapoor, K. L., A Textbook of Physical Chemistry – Vol. 1 – 6, 2nd Ed., Laxmi Publications-New Delhi (2011).

CHEMISTRY LAB
(Honours)
(3rd Semester)
Course No.:**CHEMISTRY-C-303-LAB**
(Physical Chemistry – III)
Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 12 hours** (spread over two days)*

During examination, two experiments (one from each of the Part I and Part II), to be assigned to each student by drawing lots.

1. Part I: Study of the equilibrium of the following reactions by the distribution method: 7 marks

(*i*) $I_2(aq) + I^- \rightarrow I_3^-(aq)$

(*ii*) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$

2. Part II: Study the kinetics of the following reactions(*any one*) 14 marks

a) Initial rate method: Iodide-persulphate reaction
b) Integrated rate method: Acid hydrolysis of methyl acetate with hydrochloric acid.
c) Integrated rate method: Saponification of ethyl acetate.
d) Comparison the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.
e) Adsorption: Verification of the Freundlich isotherms for adsorption of oxalic acid / acetic acid on activated charcoal.

3. Viva – voce 2 marks

4. Regularity in maintenance of Lab Notebook 2 marks

5. Attendance 5 marks

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W. H. Freeman & Co.: New York (2003).
- Jadav, J. B., Advance Physical Practical Chemistry, Goel Publishing House, New Delhi (1981).

CHEMISTRY
(Honours)
(4th Semester)
Course No.:**CHEMISTRY-C-401**
(Inorganic Chemistry – III)
Coordination Chemistry and its Applications
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to provide in-depth discussion on Coordination Chemistry and its Applications, extended to Biological systems

Unit 1: Coordination Chemistry I

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt).

Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

Unit 2: Coordination Chemistry II

IUPAC (2005) nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.

Unit 3: Transition Elements

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Ebsworth diagrams). Difference between the first, second and third transition series. Chemistry of Cr and Mn in various oxidation states (excluding their metallurgy).

Unit 4: Lanthanoids and Actinoids

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

Unit 5: Bioinorganic Chemistry

Metal ions present in biological systems, classification of elements according to their action in biological system.Excess and deficiency of some trace metals.

Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, use of chelating agents in medicine.

Reference Books:

- Purcell, K. F & Kotz, J. C. Inorganic Chemistry W. B. Saunders Co, 1977.
- Huheey, J. E., Inorganic Chemistry, Prentice Hall, 1993.
- Lippard, S. J. & Berg, J. M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
- Cotton, F. A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999
- Basolo, F, and Pearson, R. C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
- Greenwood, N. N. & Earnshaw A., Chemistry of the Elements, Butterworth Heinemann, 1997.

CHEMISTRY LAB
(Honours)
(4th Semester)
Course No.:**CHEMISTRY-C-401-LAB**
(Inorganic Chemistry – III)
Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 12 hours** (spread over two days)*

During examination, two experiments (one from each of the Part I and Part II), to be assigned to each student by drawing lots

1. Part I: Gravimetric Analysis: **14 marks**

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).

ii. Estimation of copper as CuSCN

iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.

2. Part II: Inorganic Preparations: **7 marks**

i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$

ii. Sodium trioxalatochromate (III)

iii. Tetraamminecarbonatocobalt (III) ion

iv. Potassium tris(oxalate)ferrate (III)

3. Viva – voce **2 marks**

4. Regularity in maintenance of Lab Notebook **2 marks**

5. Attendance **5 marks**

Reference Books:

• Vogel, A. I., A Textbook of Quantitative Inorganic Analysis, ELBS. 1978

CHEMISTRY
(Honours)
(4th Semester)
Course No.:**CHEMISTRY-C-402**
(Organic Chemistry – III)
Heterocyclic Chemistry
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to provide knowledge on the preparation and properties of different classes of heterocyclic organic compounds. Emphases is given to heterocyclic compounds of both synthetic and natural origin.

Unit 1: Nitrogen Containing Functional Groups

Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3°amines with Hinsberg reagent and nitrous acid. Diazonium Salts: Preparation and their synthetic applications.

Unit 2: Heterocyclic Compounds - I

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis).

Unit 3: Heterocyclic Compounds - II

Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, DoebnerMiller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction. Derivatives of furan: Furfural and furoic acid.

Unit 4: Alkaloids

Natural occurrence, General structural features, Isolation and their physiological action.
Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

Unit 5: Terpenes

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and α-terpineol.

Reference Books:

- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
- Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
- Singh, J.; Ali, S. M. & Singh, J. Natural Product Chemistry, Prajati Parakashan (2010).

CHEMISTRY LAB
(Honours)
(4th Semester)
Course No.:**CHEMISTRY-C-401-LAB**
(Inorganic Chemistry – III)
Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 12 hours** (spread over two days)*

During examination, one experiments to be assigned to each student by drawing lots

1. Qualitative Organic analysis **21 marks**

Detection of elements (N, S and halogens) and functional groups, determination of melting points and preparation of suitable derivatives to identify the given organic compounds (Preferable by capillary method)

2. Viva – voce **2 marks**

3. Regularity in maintenance of Lab Notebook **2 marks**

4. Attendance **5 marks**

Reference Books:

- Mann, F. G. & Saunders, B. C. Practical Organic Chemistry, Pearson Education (2009).
- Furniss, B. S.; Hannaford, A. J.; Smith, P. W. G.; Tatchell, A. R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
- Ahluwalia, V. K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
- Ahluwalia, V. K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

CHEMISTRY
(Honours)
(4th Semester)
Course No.:**CHEMISTRY-C-403**
(Physical Chemistry – IV)
Electrochemistry
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to provide knowledge on Electrochemistry, various laws governing electrochemical processes and their applications.

Unit 1: Conductance I

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.

Unit 2: Conductance II

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

Unit 3: Electrochemistry I

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.

Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.

Unit 4: Electrochemistry II

Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH valuesusing hydrogen/glass electrodes.
Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

Unit 5: Electrical & Magnetic Properties of Atoms and Molecules

Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement.

Reference Books:

- Atkins, P. W & Paula, J. D. Physical Chemistry, 9th Ed., Oxford University Press (2011).
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
- Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Rogers, D. W. Concise Physical Chemistry Wiley (2010).
- Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005).
- Puri, B.R., Sharma, L.R., Pathania, M.S., Principles of Physical Chemistry, Vishal Publishing Co., Punjab (India).
- Glasstone, Samuel, An Introduction To Electrochemistry,Affiliated East West Press Private, Limited., Maurice Press.
- Raj, Gurdeep, Advanced Physical Chemistry, Krishna Prakashan Media (P) Ltd., New Delhi (1978).

CHEMISTRY LAB
(Honours)
(4th Semester)
Course No.:**CHEMISTRY-C-403-LAB**
(Physical Chemistry – IV)
Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 12 hours** (spread over two days)*

During examination, two experiments to be assigned to each student by drawing lots.

1. Physical experiments: 10.5x2=21marks

1. pH metric titration of HCl against standard NaOH
2. To determine the strength of the given acid conductometrically using standard alkali solution.
3. Determination of equivalent conductances of a strong electrolyte at various dilutions and verification of Onsagar equation.
4. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
5. Conductometric titration of a mixture of strong and weak acid *vs* strong base.
6. pH metric titration of a mixture of strong and weak acid *vs* strong base.
7. Potentiometric titration of ferrous ammonium sulphate against standard $K_2Cr_2O_7$/ $KMnO_4$ and determination of redox potential of Fe(II)- Fe(III) system.

2. Viva – voce 2 marks

3. Regularity in maintenance of Lab Notebook 2 marks

4. Attendance 5 marks

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W. H. Freeman & Co.: New York (2003).
- Jadav, J. B., Advance Physical Practical Chemistry, Goel Publishing House, New Delhi (1981).
- Palit, S. R. and De, S.K., Practical Physical Chemistry Science Book Agency.
- Das, R.C. and Behra, B., Experimental Physical Chemistry, McGraw Hill.

CHEMISTRY
(Honours)
(5th Semester)
Course No.:**CHEMISTRY-C-501**
(Organic Chemistry – IV)
Biomolecules
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to provide knowledge on the selected types ofnaturally occurring organic compounds, their synthesis, physiological importance and pharmaceutical applications

Unit 1: Nucleic Acids

Components of nucleic acids, Nucleosides and nucleotides;

Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides.

Unit 2: Amino Acids, Peptides and Proteins

Amino acids, Peptides and their classification.

α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis;

Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis.

Unit 3: Enzymes

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes.

Mechanism of enzyme action, factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance.

Unit 4: Lipids

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number.

Unit 5: Pharmaceutical Compounds: Structure and Importance

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An

elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Reference Books:

- Berg, J. M., Tymoczko, J. L. and Stryer, L. Biochemistry. 6th Edition. W. H. Freeman and Co (2006).
- Nelson, D. L., Cox, M. M. and Lehninger, A. L. Principles of Biochemistry. 4th Edition. W. H. Freeman and Co (2009).
- Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/ McGraw-Hill (2009).

CHEMISTRY LAB
(Honours)
(5th Semester)
Course No.:**CHEMISTRY-C-501-LAB**
(Organic Chemistry – IV)
Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 12 hours** (spread over two days)*

During examination, two experiments (one from each of the Part I and Part II), to be assigned to each student by drawing lots.

1. Part I: Organic synthesis: 7 marks

(a) Acetylation of salicylic acid, aniline, and hydroquinone, benzoylation of aniline and phenol.

(b) Aliphatic electrophilic substitution: preparation of iodoform from acetone/ethanol.

(c) Aromatic electrophilic substitution: preparation of m-dinitrobenzene/preparation of methyl orange.

2. Part II: Organic quantitative analysis: 14 marks

(i) Estimation of glucose/cholesterol/ urea/uric acid by colorimeteror by chemical methods.

(ii) Determination of saponification equivalent of an ester

3. Viva – voce 2 marks

4. Regularity in maintenance of Lab Notebook 2 marks

5. Attendance 5 marks

Reference Books:

- Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
- Arthur, I. V. Quantitative Organic Analysis, Pearson.

CHEMISTRY
(Honours)
(5th Semester)
Course No.:**CHEMISTRY-C-502**
(Physical Chemistry – V)
Quantum Chemistry & Spectroscopy
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to provide knowledge on Quantum Chemistry &Molecular Spectroscopy and Photochemistry

Unit 1: Quantum Chemistry I

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box", quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.

Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Unit 2: Quantum Chemistry II

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.

Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2.

Comparison of LCAO-MO and VB treatments of H_2 (only wave functions, detailed solution not required) and their limitations. Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH).

Unit 3: Molecular Spectroscopy I

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic molecules.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, fundamental frequencies, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Unit 4: Molecular Spectroscopy II

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of simple organic molecules.

Unit 5: Photochemistry

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photosensitized reactions, quenching. Chemiluminescence.

Reference Books: (C XIII)

- Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
- Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill.
- House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA.
- Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
- Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press.
- Macqurre, D. A., Quantum Chemistry.
- Atkins, Peter W. and Friedman, Ronald S., Molecular Quantum Mechanics 5th Edition.

CHEMISTRY LAB
(Honours)
(5th Semester)
Course No.:**CHEMISTRY-C-502-LAB**
(Physical Chemistry – V)
Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 12 hours** (spread over two days)*

During examination, two experiments (one from each of the Part I and Part II), to be assigned to each student by drawing lots.

1. Physical Experiments: 10.5x2=21 marks

I. Verification of Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration

II. Determination of the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.

III. Study of the kinetics of iodination of propanone in acidic medium.

IV. Determination of the amount of iron present in a sample using 1,10-phenathroline.

V. Determination of the dissociation constant of an indicator (phenolphthalein).

VI. Study of the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

2. Viva – voce 2 marks

3. Regularity in maintenance of Lab Notebook 2 marks

4. Attendance 5 marks

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W. H. Freeman & Co.: New York (2003).

CHEMISTRY
(Honours)
(6th Semester)
Course No.:**CHEMISTRY-C-601**
(Inorganic Chemistry – IV)
Organometallic Chemistry
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to emphases on the basics knowledge on Organometallic compounds, their chemistry, application in catalysis and inorganic reaction mechanisms

Unit 1: Organometallic Compounds - I

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands.

Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series.

Ferrocene: Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

Unit 2: Organometallic Compounds - II

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds.

Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures.

Unit 3: Reaction Kinetics and Mechanism

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

Unit 4: Catalysis by Organometallic Compounds

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinsons Catalyst)
2. Hydroformylation (Co salts)
3. Synthetic gasoline (Fischer Tropsch reaction)
4. Synthesis gas by metal carbonyl complexes

Unit 5: Principles in Qualitative Analysis

Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.

Reference Books:

- Vogel, A. I. Qualitative Inorganic Analysis, Longman, 1972.
- Svehla, G. Vogel's Qualitative Inorganic Analysis, 7th Ed., Prentice Hall.
- Cotton, F. A. G.; Wilkinson & Gaus, P. L. Basic Inorganic Chemistry 3rd Ed.; Wiley India,
- Huheey, J. E.; Keiter, E. A. & Keiter, R. L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
- Sharpe, A. G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005
- Douglas, B. E.; McDaniel, D. H. & Alexander, J. J. Concepts and Models in Inorganic Chemistry 3rd Ed., John Wiley and Sons, NY, 1994.
- Greenwood, N. N. & Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
- Lee, J. D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.
- Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
- Shriver, D. D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
- Basolo, F. & Person, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.
- Purcell, K. F. & Kotz, J. C., Inorganic Chemistry, W. B. Saunders Co. 1977
- Miessler, G. L. & Donald, A. Tarr, Inorganic Chemistry 4th Ed., Pearson, 2010.
- Collman, James P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books, 1987.
- Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals. New York, NY: John Wiley, 2000.
- E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
- P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- B.K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut.

CHEMISTRY LAB
(Honours)
(6th Semester)
Course No.:**CHEMISTRY-C-601-LAB**
(Inorganic Chemistry – IV)
Practical

Contact Hours: 60; Credits: 02
Full Marks = 30 Pass Marks = 12
***Examination Time: 12 hours** (spread over two days)*

During examination, one Inorganic mixture to be assigned to each student by drawing lots.

1. Qualitative Inorganic Analysis **21 marks**

Qualitative analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$,

PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+},

Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}

Mixtures should preferably contain one interfering anion,

or insoluble component e.g., $BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3

or combination of anions e.g. CO_3^{2-} and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^-

and I^-, B^- rand I^-, NO_3^- and Br^-, NO_3^- and I^-.

Spot tests should be done whenever possible.

2. Viva – voce **2 marks**

3. Regularity in maintenance of Lab Notebook **2 marks**

4. Attendance **5 marks**

Reference Books:

- Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla.
- Marr & Rockett Inorganic Preparations.

CHEMISTRY
(Honours)
(6th Semester)
Course No.:**CHEMISTRY-C-602**
(Organic Chemistry – V)
Spectroscopy, Carbohydrates,Dyes and Polymers
Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Objective of this course is to impart knowledge on Application of Spectroscopy (UV-Vis, IR and NMR), Carbohydrates,Dyes and Polymers (with preparation and applications)

Unit 1: Organic Spectroscopy I

UV Spectroscopy: Types of electronic transitions, λmax, Chromophores and Auxochromes; Application of Woodward Rules for calculation of λ-max for the following systems: α, β-unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular.Applications of UV for identification of simple organic molecules.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Fingerprint region and its significance; application in functional group analysis.Applications of IR for identification of simple organic molecules.

Unit 2: Organic Spectroscopy II

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Interpretation of NMR spectra of simple compounds.Applications of NMR for identification of simple organic molecules.

Unit 3: Carbohydrates

Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani Fischer synthesis and Ruff degradation;

Disaccharides – Structure elucidation of sucrose.

Polysaccharides – Elementary treatment of starch and cellulose.

Unit 4: Dyes

Classification, Colour and constitution; Mordant and Vat Dyes; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes – Phenolphthalein and Fluorescein.

Unit 5: Polymers

Introduction and classification of polymers; Number average molecular weight, Weight average molecular weight, Degree of polymerization, Polydispersity Index.

Polymerisation reactions- Addition and condensation- Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics– thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene);

Fabrics – natural and synthetic fabrics (acrylic, polyester);

Rubbers – natural and synthetic rubbers: Buna-S, Chloroprene and Neoprene; Vulcanization.

Reference Books:

- Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Billmeyer, F. W. Textbook of Polymer Science, John Wiley & Sons, Inc.
- Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. Polymer Science, New Age International (P) Ltd. Pub.
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
- Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Prakashan (2010).

CHEMISTRY LAB
(Honours)
(6th Semester)
Course No.:**CHEMISTRY-C-602-LAB**
(Organic Chemistry – V)
Practical

Contact Hours: 60; Credits: 02
Full Marks = 30 Pass Marks = 12
***Examination Time: 12 hours** (spread over two days)*

During examination, two experiments, to be assigned to each student by drawing lots.

1. The following experiments to be carried out 10.5x2-21 marks

i. Extraction of caffeine from tea leaves.

ii. Preparation of sodium polyacrylate.

iii. Preparation of urea formaldehyde.

iv. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.

v. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).

vi. Preparation of methyl orange.

2. Viva – voce 2 marks

3. Regularity in maintenance of Lab Notebook 2 marks

4. Attendance 5 marks

Reference Books:

- Vogel, A.I. Quantitative Organic Analysis, Part 3, Pearson (2012).
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education , (2009).
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,University Press (2000).
- Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

CHEMISTRY
(Honours)
(5th Semester)
Course No.:**CHEMISTRY-DSE-501**

Analytical Methods in Chemistry

Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1: Qualitative and quantitative aspects of analysis

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Unit 2: UV-Visible and IR Spectrometry

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry:Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.

Unit 3: Flame Atomic Absorption and Emission Spectrometry

Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Unit 4: Thermal and electro-analytical methods of analysis

Theory of thermo-gravimetry (TG), basic principle of instrumentation.Techniques for quantitative estimation of Ca and Mg from their mixture.
Classification of electro-analytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points.

Unit 5: Separation techniques

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions.
Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.Qualitative and quantitative aspects of chromatographic methods of analysis: TLC and HPLC.

Reference Books:

- Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed., The English Language Book Society of Longman.
- Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed., Wardsworth Publishing Company, Belmont, California, USA, 1988.
- Christian, Gary D; Analytical Chemistry, 6th Ed., John Wiley & Sons, New York, 2004.
- Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W. H. Freeman, 2001.
- Khopkar, S. M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
- Skoog, D. A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
- Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
- Ditts, R.V. Analytical Chemistry – Methods of separation.
- Skoog, Douglas A., West, Donald M., Holler, F. James and Crouch, Stanley R., Fundamentals of Analytical Chemistry, 9th Edition.

CHEMISTRY LAB
(Honours)
(5th Semester)
Course No.:**CHEMISTRY-DSE-501-LAB**

Practical

Contact Hours: 60; Credits: 02
Full Marks = 30 Pass Marks = 12
***Examination Time: 6 hours** (one day)*

During examination, two experiments to be assigned to each student by drawing lots

1. Experiments **10.5x2=21 marks**

i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.
ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.
iii) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.
iv) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC
v) Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
vi) Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
vii) Analysis of soil: determination of pH of soil, total soluble salt, estimation of calcium, magnesium, phosphate, nitrate
viii) Separation of metal ions from their binary mixture.
ix) Separation of amino acids from organic acids by ion exchange chromatography.
x) Determination of dissolved oxygen in water.
xi) Determination of chemical oxygen demand (COD).

2. Viva – voce **2 marks**

3. Regularity in maintenance of Lab Notebook **2 marks**

4. Attendance **5 marks**

Reference Books:

- Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H.Jeffery and others) 5thEd., The English Language Book Society of Longman.
- Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7thEd., Wardsworth Publishing Company, Belmont, California, USA, 1988.

CHEMISTRY
(Honours)
(5th Semester)
Course No.:**CHEMISTRY-DSE-502**

Green Chemistry

Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1: Introduction to Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.
Limitations/ Obstacles in the pursuit of the goals of Green Chemistry. Green Chemistry in sustainable development.

Unit 2: Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products.

Unit 3: Designing a Chemical synthesis

Designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solvent-less processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization –careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents;designing of biodegradable products; prevention of chemical accidents; strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Unit 4: Examples of Green Synthesis/ Reactions I

Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, citral, ibuprofen,paracetamol, furfural.
Microwave assisted reactions: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols). Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation.

Unit 5: Examples of Green Synthesis/ Reactions II

Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.

Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", a nonmetallicoxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses.

Reference Books:

- V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
- P.T. Anastas & J.K. Warner: Oxford Green Theory and Practical, University Press (1998).
- A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
- M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
- M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

CHEMISTRY LAB
(Honours)
(5th Semester)
Course No.:**CHEMISTRY-DSE-502-LAB**

Practical

Contact Hours: 60; Credits: 02
Full Marks = 30 Pass Marks = 12
***Examination Time: 6 hours** (one days)*

During examination, two experiments (one from each of the Part I and Part II), to be assigned to each student by drawing lots.

1. Part I: 10 marks

a. Safer Stating Materials
The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch – study of effect of concentration on clock reaction

b. Using Renewable Resources
Preparation of biodiesel from vegetable oil.

2. Part II:Green Reactions 11 marks

a) Reaction between furan and maleic acid in water and at room temperature rather than inbenzene and reflux.
b) Extraction of D-limonene from orange peel using liquid CO2 prepared form dry ice.
c) Mechanochemical solvent free synthesis of azomethines
d) Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
e) Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

3. Viva – voce 2 marks

4. Regularity in maintenance of Lab Notebook 2 marks

5. Attendance 5 marks

Reference Books:

- Anastas, P.T & Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press (1998).
- Kirchoff, M. & Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC (2002).
- Ryan, M.A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).

- Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore CISBN 978-93-81141-55-7 (2013). 56
- Cann, M.C. & Connelly, M. E. Real world cases in Green Chemistry, American Chemical Society (2008).
- Cann, M. C. & Thomas, P. Real world cases in Green Chemistry, American Chemical Society (2008).
- Pavia, D. L. Lamponan, G. H. &Kriz, G.S. W B Introduction to organic laboratory.

CHEMISTRY
(Honours)
(6th Semester)
Course No.:**CHEMISTRY-DSE-601**

Inorganic Materials of Industrial Importance

Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1: Silicate Industries

Glass:Glassy state and its properties, classification (silicate and non-silicateglasses).Manufacture and processing of glass. Composition and properties of the following types ofglasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics:Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and thesetting process, quick setting cements.

Unit 2: Fertilizers

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Unit 3: Surface Coatings

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings, metal spraying and anodizing.

Unit 4: Batteries

Primary and secondary batteries, battery components and their role, Characteristics ofBattery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

Unit 6: Alloys

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon, decarbonization,demanganization, desulphurization, dephosphorisation) and surface treatment (argon treatment, heat treatment,nitriding, carburizing). Composition and properties of different types of steels.

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, WileyPublishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
- B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut.

CHEMISTRY LAB
(Honours)
(6th Semester)
Course No.:**CHEMISTRY-DSE-601-LAB**

Practical

Contact Hours: 60; Credits: 02
Full Marks = 30 Pass Marks = 12
***Examination Time: 6 hours** (one days)*

During examination, one experiment, to be assigned to each student by drawing lots.

1. Experiments **21 marks**

a. Determination of free acidity in ammonium sulphate fertilizer.

b. Estimation of Calcium in Calcium ammonium nitrate fertilizer.

c. Estimation of phosphoric acid in superphosphate fertilizer.

d. Electroless metallic coatings on ceramic and plastic material.

e. Determination of composition of dolomite (by complexometric titration).

f. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.

g. Analysis of Cement.

2. Viva – voce **2 marks**

3. Regularity in maintenance of Lab Notebook **2 marks**

4. Attendance **5 marks**

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, WileyPublishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
- B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut.

CHEMISTRY
(Honours)
(6th Semester)
Course No.:**CHEMISTRY-DSE-602**

Dissertation

(*Project Work*)

(Credits: 06)

Full Marks: 100 **Pass Marks: 40**

One project work on inorganic / organic / physical / analytical / biochemical / environmental / agricultural chemistry. Submission of the project report in bound form and presentation of the project in front of the external examiner.

Distribution of marks

(a)	**Internal Assessment**	(Regularity, timely completion and submission of project report, maintenance of project Dairy)	30 marks
(b)	**Project Report**	(Proper documentation of literature, data, discussion etc. and logical flow of work undertaken)	30 marks
(c)	**Presentation**		20 marks
(d)	**Viva/Defense**		20 marks
		Total:	**100 marks**

Guidelines to Project Work:

1. Students shall undertake the project work related to chemistry only under the guidance of teacher(s) from the department and strict monitoring by the Department. Project work on inorganic / physical / analytical / biochemical / environmental / agricultural or others related interface areas may be undertaken. Project work can be experimental, theoretical or both. The following activities have been outlined as guidelines (not exhaustive):

(a) Physiochemical studies (pH, conductivity, turbidity, etc.) of different wetlands (ponds, lakes, river etc.)

(b) Analysis of iron in pond / tube well / river water.

(c) Analysis of Ca^{2+} / Mg^{2+} / As^{3+} / As^{5+} in soil / water samples.

(d) Adulteration detection activities.

(e) Extraction and preliminary characterization of useful chemicals (as far as possible) from plants.

(f) Solubility, surface tension, and viscosity measurements of some solution of practical relevance, (cough syrup, soap solution, pesticides, fertilizers,... etc.)

(g) Pollution related activities.

(h) Nutrition related activities, (essential metal detection in food, cereals, pulses, fruits etc.)

(i) Heavy metal uptake / sequestering activities, (from nature and laboratory based experiments.

2. Head of the Department must provide the service of a teacher for supervising the project work of each group. A teacher can guide more than one group, if necessary.

3. No two groups in the same institution are permitted to do project work on the same problem.

4. The UG level project work is a group activity, maximum number of students being limited to three. However, each student shall prepare and submit the project report separately and each student must present the Project Report before the external examiner during project evaluation.

5. The project report must be hard bound, spiral bound or paper back and each student must submit a copy of the Project Report to keep in the department.

6. The project report shall be divided as:

Chapter I: Introduction

Chapter II: Review of literature

Chapter III: Scope of the research problem

Chapter IV: Materials and methods

Chapter V: Results and discussion

Chapter VI: Conclusion and Scope of future studies

Chapter VII: References.

Reference Books:

- M. A. Malati, An Investigative, Integrated Approach to Practical Project Work; Mid-Kent College of Higher/Further Education, UK (October 1999); Imprint: Woodhead Publishing; ISBN: 978-1-898563-47-1.
- Geoffrey, P. Haydn, S., Practical Inorganic Chemistry: Preparations, reactions and instrumental methods; Science Paperbacks; (1974); ISBN: 978-0-412-16150-6 (Print) 978-94-017-2744-0 (Online).

- Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) Practical skills in chemistry. 2nd Ed., Prentice-Hall, Harlow.
- Hibbert, D. B. & Gooding, J. J. (2006) Data analysis for chemistry. Oxford University Press.
- Topping, J. (1984) Errors of Observation and their Treatment. 4th Ed., Chapman Hall, London.
- Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis. Cambridge Univ. Press (2001) 487 pages.
- Chemical Safety Matters – IUPAC – IPCS, Cambridge University Press, 1992.

CHEMISTRY
(Honours)
(3rd Semester)
Course No.:**CHEMISTRY-SEC-301**

Analytical Clinical Biochemistry

Contact Hours: 60; Credits: 04
Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]
Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]
(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1: Carbohydrates

Biological importance of carbohydrates. Glycolysis, Alcoholic and Lactic acid fermentations.

Unit 2: Proteins and Enzymes

Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.

Enzymes: Nomenclature, Characteristics (mention of Ribozymes) and Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, effect of pH, temperature on enzyme activity, enzyme inhibition.

Unit 2: Lipids and Hormones

Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipoproteins.

Hormones: Properties, functions and biochemical functions of steroid hormones.

Unit 4: Blood and Urine:

Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia.

Urine: Collection and preservation of samples. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

Unit 5: Biochemistry of disease

A diagnostic approach by blood analysis, urine analysis. Interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

Practicals (Demonstrations and Hands-on)

Identification of the following:

1. Carbohydrates.
2. Lipids.
3. Protein by the Biuret reaction.

Reference Books:

- T. G. Cooper: Tool of Biochemistry.
- Keith Wilson and John Walker: Practical Biochemistry.
- Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
- Thomas M. Devlin: Textbook of Biochemistry.
- Jeremy M. Berg, John L Tymoczko, Lubert Stryer: Biochemistry.
- G. P. Talwar and M Srivastava: Textbook of Biochemistry and Human Biology.
- A. L. Lehninger: Biochemistry.
- O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods

CHEMISTRY

(4th Semester)

Course No.:**CHEMISTRY-SEC-401**

Fuel Chemistry

Contact Hours: 60; Credits: 04

Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]

Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]

(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1: Review of energy sources (renewable and non-renewable).
Classification of fuels and their calorific value.

Unit 2: *Coal*: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals.

Unit 3: *Petroleum and Petrochemical Industry*: Composition of crude petroleum; Different types of petroleum products and their applications. Principle and process of fractional distillation, Cracking – Thermal and catalytic cracking; Qualitative treatment of non-petroleum fuels- LPG, CNG, LNG, bio-gas, fuels derived from biomass, fuel from waste; synthetic fuels – gaseous and liquids.

Unit 4: *Petrochemicals*: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Unit 5: *Lubricants*: Classification of lubricants, lubricating oils (conducting and non-conducting), Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants – viscosity index, cloud point, pore point.

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
- P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- B. K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut.

CBCS
TDC SYLLABI

B. Sc. with
CHEMISTRY

The following papers (**CHEMISTRY-DSC-101 to 104**) to be offered both as:

Discipline Specific Core (DSC) Courses *for students of BSc with Chemistry (Regular)*

and

Generic Elective (GE) Courses *for students from other Honours Disciplines*

CHEMISTRY

(1st Semester)

Course No.:**CHEMISTRY-DSC-101/ CHEMISTRY-GE-101**

Atomic Structure, Bonding,
General Organic Chemistry and Aliphatic Hydrocarbons

Contact Hours: 60; Credits: 04

Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]

Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]

(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Section A: Inorganic Chemistry

Unit 1: Atomic Structure

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. Shapes of *s, p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number (m_s).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Unit 2: Chemical Bonding and Molecular Structure

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.

Section B: Organic Chemistry

Unit 3: Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting *p*K values. Aromaticity: Benzenoids and Hückel's rule.

Unit 4: Aliphatic Hydrocarbons

Alkanes: (Up to 5 Carbons):
Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent.
Reactions: Free radical Substitution: Halogenation.

Alkenes: (Up to 5 Carbons):
Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule).
Reactions: cis-addition (*alk*. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti Markownikoff's addition), Hydration, Ozonolysis.

Alkynes: (Up to 5 Carbons):
Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinaldihalides.
Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. $KMnO_4$.

Unit 5: Aromatic Hydrocarbons

Preparation of benzene from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions benzene: Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

Reference Books:

- J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
- F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
- Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.
- James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
- T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.
- I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand

CHEMISTRY LAB

(1st Semester)

Course No.:**CHEMISTRY-DSC-101-LAB/ CHEMISTRY-GE-101-LAB**

Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 6 hours** (One day)*

During examination, two experiments (one from each of the Section A and Section B), to be assigned to each student by drawing lots

Time:* 6 *hours (One day)

1.*Section A: Inorganic* **14 marks**

i. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.

ii. Estimation of oxalic acid by titrating it with $KMnO_4$.

iii. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

iv. Estimation of Fe (II) ions by titrating it with $KMnO_4$.

v. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

2.*Section B: Organic* **7 marks**

i. Detection of characterized element (N, S, Cl, Br, I) in the given organic compound.

ii. Separation of mixtures by Chromatography: Measure the R_f value in each case (combination of two compounds to be given)

(a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

(b) Identify and separate the sugars present in the given mixture by paper chromatography.

3. Viva – voce **2 marks**

4. Regularity in maintenance of Lab Notebook **2 marks**

5. Attendance **5 marks**

Reference Books:

- Vogel's Qualitative Inorganic Analysis, A. I. Vogel, Prentice Hall, 7th Ed.
- Vogel's Quantitative Chemical Analysis, A. I. Vogel, Prentice Hall, 6th Ed.
- Textbook of Practical Organic Chemistry, A. I. Vogel, Prentice Hall, 5th Ed.
- Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

CHEMISTRY

(2nd Semester)

Course No.:**CHEMISTRY-DSC-201 / CHEMISTRY-GE-201**

Chemical Energetics, Equilibria and Functional Organic Chemistry

Contact Hours: 60; Credits: 04

Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]

Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]

(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Section A: Physical Chemistry

Unit 1: Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature– Kirchhoff's equation.

Unit 2: Equilibria

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle. Relationships between *Kp*, *Kc* and *Kx* for reactions involving ideal gases.

Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, 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.

Section B: Organic Chemistry

Unit 3: Alkyl and Aryl Halides

Alkyl Halides: (Up to 5 Carbons): Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions. Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides:*Preparation*: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. *Reactions* (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Unit 4: Alcohols, Phenols and Ethers: (Up to 5 Carbons)

Alcohols: Preparation: Preparation of 1^o, 2^o and 3^o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, *alk*. $KMnO_4$, acidic dichromate, conc. HNO_3). Diols: (Up to 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case): Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Schotten – Baumann Reaction.

*Ethers (aliphatic and aromatic):*Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde): Preparation: from acid chlorides and from nitriles. Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's Reaction, Wittig Reaction, Benzoin Condensation. Clemensen Reduction and Wolff Kishner Reduction. Meerwein-Pondorff Verley Reduction.

Unit 5: Stereochemistry & Carbohydrates

Stereochemistry: Concept of chirality (upto two carbon atoms). Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds. Nomenclature: *cis- trans*, R/ S (for up to 2 chiral carbon atoms) and E / Z (for up to two C=C systems).

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

Reference Books:

- I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
- G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
- G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
- R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4^{th} Ed. Narosa (2004).

CHEMISTRY LAB

(2nd Semester)

Course No.:**CHEMISTRY-DSC-201-LAB/ CHEMISTRY-GE-201-LAB**

Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 6 hours** (one day)*

During examination, three experiments (one from Section A and two from Section B; experiment (i) of Section B is compulsory), to be assigned to each student by drawing lots

1. *Section A: Physical Chemistry*: 11 marks

I) Thermochemistry

i. Determination of heat capacity of a calorimeter.

ii. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

iii. Determination of enthalpy of ionization of acetic acid.

iv. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).

v. Determination of enthalpy of hydration of copper sulphate.

vi. Study of the solubility of benzoic acid in water and determination of ΔH.

II) Ionic equilibria

a) 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 (at least three different materials to be given to per student per experiment) and preparation of a comparative document.

b) Preparation of Sodium acetate-acetic acid buffer solutions of different pH (the observed data to be compared with theoretical values)

c) Preparation of Ammonium chloride-ammonium hydroxide buffer solutions of different pH (the observed data to be compared with theoretical values)

2. *Section B: Organic Chemistry* 5+5=10 marks

i. *Purification* of organic compounds by crystallization (from water and alcohol) and distillation.

ii. *Criteria of Purity*: Determination of melting and boiling points.

***iii*.** *Organic Preparations*: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

(a) Bromination of Phenol/Aniline

(b) Benzoylation of amines/phenols

(c) Oxime and 2, 4-dinitrophenylhydrazone of aldehyde/ketone

3. Viva – voce **2 marks**

4. Regularity in maintenance of Lab Notebook **2 marks**

5. Attendance **5 marks**

Reference Book:

- A. I. Vogel: Textbook of Practical Organic Chemistry, 5th Ed. Prentice-Hall.
- F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
- B. D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

CHEMISTRY

(3rd Semester)

Course No.:**CHEMISTRY-DSC-301 / CHEMISTRY-GE-301**

Solutions, Phase Equilibrium, Conductance, Electrochemistry and Functional Group Organic Chemistry-II

Contact Hours: 60; Credits: 04

Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]

Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]

(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Section A: Physical Chemistry

Unit 1: Solutions and Phase Equilibrium

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. Distillation of solutions. Azeotropes.

Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule. Phase diagrams of one-component systems (water and sulphur).

Unit 2: Conductance and Electrochemistry

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch's law of independent migration of ions.

Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data.

Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge.

Section B: Organic Chemistry

Unit 3: Carbonyls (aliphatic and aromatic) and Carboxylic acids

Formaldehyde, acetaldehyde, acetone and benzaldehyde: Preparation: from acid chlorides and from nitriles. Reactions – Reaction with HCN, ROH, NaHSO3, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's Reaction, Wittig Reaction, Benzoin Condensation. Clemensen Reduction and Wolff Kishner Reduction. Meerwein-Pondorff Verley Reduction.

Carboxylic acids (aliphatic and aromatic): Preparation: Acidic and Alkaline hydrolysis of esters. Reactions: Hell – Vohlard - Zelinsky Reaction.

Unit 4: Amines

Amines (Aliphatic and Aromatic): (Up to 5 carbons): Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Unit 5: Carbohydrates, Amino Acids, Peptides and Proteins

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides.

Amino Acids, Peptides and Proteins: *Preparation of Amino Acids*: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis. *Reactions of Amino acids*: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

Reference Books:

- G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
- G. W. Castellan: Physical Chemistry 4th Ed. Narosa (2004).
- J. C. Kotz, P. M. Treichel, J. R. Townsend, General Chemistry, Cengage
- Learning India Pvt. Ltd.: New Delhi (2009).
- B. H. Mahan: University Chemistry, 3rd Edn. Narosa (1998).
- R. H. Petrucci, General Chemistry, 5th Ed., Macmillan Publishing Co.: New York (1985).
- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
- Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman.

CHEMISTRY LAB

(3rd Semester)

Course No.:**CHEMISTRY-DSC-301-LAB / CHEMISTRY-GE-301-LAB**

Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 6 hours** (one day)*

During examination, two experiments (one from each of the Section A and Section B), to be assigned to each student by drawing lots

1. *Section A: Physical Chemistry*: 7 marks

I) Phase Equilibria

i. Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.

ii. Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.

iii. Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

II) Conductance

i. Determination of cell constant

ii. Perform the following conductometric titrations:

- ***a.*** Strong acid vs. strong base
- ***b.*** Weak acid vs. strong base

2. *Section B: Organic Chemistry*: 14 marks

Systematic Qualitative Organic Analysis of Organic Compounds possessing mono-functional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

3. Viva – voce 2 marks

4. Regularity in maintenance of Lab Notebook 2 marks

5. Attendance 5 marks

Reference Books:

- A.I.Vogel: Textbook of Practical Organic Chemistry, Prentice Hall, 5th Ed.
- F. G. Mann & B. C. Saunders: Practical Organic Chemistry, Orient Longman, 1960.
- B. D. Khosla: Senior Practical Physical Chemistry, R. Chand & Co.
- Ahluwalia, V. K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

CHEMISTRY

(4th Semester)

Course No.:**CHEMISTRY-DSC-401 / CHEMISTRY-GE-401**

Transition metals,Coordination Chemistry,
States of Matter and Chemical Kinetics

Contact Hours: 60; Credits: 04

Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]

Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]

(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Section A: Inorganic Chemistry

Unit 1: *Transition Series* Elements (*3d* series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

Unit 2: *Coordination Chemistry*

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6).Structural and stereoisomerism in complexes with coordination numbers 4 and 6.Drawbacks of VBT.

IUPAC (2005)system of nomenclature.

Crystal Field Theory (CFT): Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry.Factors affecting the magnitude of D.Spectrochemical series.Comparison of CFSE for Oh and Td complexes,Tetragonal distortion of octahedral geometry.

Section B: Physical Chemistry

Unit 3: Gases, Liquids and Solids

Gases: Kinetic Theory of Gases: Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation.

Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO_2.

Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.

Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision number and mean free path of molecules.

Viscosity of gases, effect of temperature/pressure on coefficient of viscosity (qualitative treatment only).

Unit 4: Liquids and Solids

Liquids: Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

Solids: Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. Bragg's law. Structures of NaCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Unit 5: Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

Reference Books:

- G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
- G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
- B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
- J. D. Lee: A New Concise Inorganic Chemistry, ELBS.
- F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
- D. F. Shriver and P. W. Atkins: Inorganic Chemistry, OUP.
- Gary Wulfsberg: Inorganic Chemistry, Viva Books Pvt. Ltd.

CHEMISTRY LAB

(4th Semester)

Course No.:**CHEMISTRY-DSC-401-LAB / CHEMISTRY-GE-401-LAB**

Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 6 hours** (one day)*

During examination, two experiments (one from each of the Section A and Section B), to be assigned to each student by drawing lots

1. *Section A: Inorganic Chemistry* **14 marks**

A.Semi-micro qualitative analysis (two anions and two cations and excluding insoluble salts) out of the following::

Cations: Pb^{2+}, Ag^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, NH_4^+.

Anions: CO_3^{2-}, NO^{2-}, NO^{3-}, SO_4^{2-}, Cl^-, Br^-, I^-, BO_3^3, PO_4^{3-}.

Spot tests should be done whenever possible.

B. (*i*) Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.

(*ii*) Determine the composition of the Fe^{3+}-salicylic acid complex solution by Job's method.

(*iii*) Estimation of (*a*) Mg^{2+} or (*b*) Zn^{2+} by complexometric titrations using EDTA.

(*iv*) Estimation of total hardness of a given sample of water by complexometric titration.

(*v*) Determination of concentration of Na^+ and K^+ using Flame Photometry.

2.*Section B: Physical Chemistry* **7marks**

I. Surface tension measurement (*use of organic solvents excluded*).
Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

II. Viscosity measurement (*use of organic solvents excluded*).
Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

III. Chemical Kinetics
Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate

3. Viva – voce **2 marks**

4. Regularity in maintenance of Lab Notebook **2 marks**

5. Attendance **5 marks**

Reference Books:

- A. I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Ed.
- A. I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Ed.

CHEMISTRY

(5th Semester)

Course No.:**CHEMISTRY-DSE-501**

Analytical Methods in Chemistry

Contact Hours: 60; Credits: 04

Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]

Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]

(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1: Qualitative and Quantitative aspects of Analysis

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Unit 2: UV-Visible and IR Spectrometry

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.

Unit 3: Flame Atomic Absorption and Emission Spectrometry:

Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Unit 4: Thermal and Electro-analytical Methods of Analysis:

Theory of thermo-gravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.
Classification of electro-analytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points.

Unit 5: Separation Techniques:

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions.
Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: TLC and HPLC.

Reference Books:

- Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed., The English Language Book Society of Longman.
- Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed., Wardsworth Publishing Company, Belmont, California, USA, 1988.
- Christian, Gary D; Analytical Chemistry, 6th Ed., John Wiley & Sons, New York, 2004.
- Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W. H. Freeman, 2001.
- Khopkar, S. M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
- Skoog, D. A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
- Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
- Ditts, R.V. Analytical Chemistry – Methods of separation.

CHEMISTRY LAB

(5th Semester)

Course No.:**CHEMISTRY-DSE-501-LAB**

Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 6 hours** (One day)*

During examination, two experiments to be assigned to each student by drawing lots.

1. Experiments **21 marks**

i. Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.

ii. Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.

iii. Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.

iv. Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

v. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

vi. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.

vii. Analysis of soil: determination of pH of soil, total soluble salt, estimation of calcium, magnesium, phosphate, nitrate

viii. Separation of metal ions from their binary mixture.

ix. Separation of amino acids from organic acids by ion exchange chromatography.

x. Determination of dissolved oxygen in water.

xi. Determination of chemical oxygen demand (COD).

2. Viva – voce **2 marks**

3. Regularity in maintenance of Lab Notebook **2 marks**

4. Attendance **5 marks**

Reference Books:

- Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G. H. Jeffery and others) 5th Ed., The English Language Book Society of Longman.
- Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed., Wardsworth Publishing Company, Belmont, California, USA, 1988.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.

CHEMISTRY

(6th Semester)

Course No.:**CHEMISTRY-DSE-601**

Inorganic Materials of Industrial Importance

Contact Hours: 60; Credits: 04

Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]

Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]

(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1: Silicate Industries:

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

Unit 2: Fertilizers

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Unit 3: Surface Coatings

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings, metal spraying and anodizing.

Unit 4: Batteries

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

Unit 6: Alloys

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon, decarbonization, demanganization, desulphurization, dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
- B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut.

CHEMISTRY LAB

(6th Semester)

Course No.:**CHEMISTRY-DSE-601-LAB**

Practical

Contact Hours: 60; Credits: 02

Full Marks = 30 Pass Marks = 12

***Examination Time: 6 hours** (One day)*

During examination, two experiments to be assigned to each student by drawing lots.

1. Experiments **21 marks**

a. Determination of free acidity in ammonium sulphate fertilizer.

b. Estimation of Calcium in Calcium ammonium nitrate fertilizer.

c. Estimation of phosphoric acid in superphosphate fertilizer.

d. Electroless metallic coatings on ceramic and plastic material.

e. Determination of composition of dolomite (by complexometric titration).

f. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.

g. Analysis of Cement.

h. Preparation of pigment (zinc oxide).

2. Viva – voce **2 marks**

3. Regularity in maintenance of Lab Notebook **2 marks**

4. Attendance **5 marks**

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
- B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut.

CHEMISTRY

(3rd Semester)

Course No.:**CHEMISTRY-SEC-301**

Analytical Clinical Biochemistry

Contact Hours: 60; Credits: 04

Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]

Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]

(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1: Carbohydrates

Biological importance of carbohydrates. Glycolysis, Alcoholic and Lactic acid fermentations.

Unit 2: Proteins and Enzymes

Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.

Enzymes: Nomenclature, Characteristics (mention of Ribozymes) and Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, effect of pH, temperature on enzyme activity, enzyme inhibition.

Unit 2: Lipids and Hormones

Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipoproteins.

Hormones: Properties, functions and biochemical functions of steroid hormones.

Unit 4: Blood and Urine:

Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia.

Urine: Collection and preservation of samples. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

Unit 5: Biochemistry of disease

A diagnostic approach by blood analysis, urine analysis. Interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

Practicals (Demonstrations and Hands-on)

Identification of the following:

1. Carbohydrates.
2. Lipids.
3. Protein by the Biuret reaction.

Reference Books:

- T. G. Cooper: Tool of Biochemistry.
- Keith Wilson and John Walker: Practical Biochemistry.
- Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
- Thomas M. Devlin: Textbook of Biochemistry.
- Jeremy M. Berg, John L Tymoczko, Lubert Stryer: Biochemistry.
- G. P. Talwar and M Srivastava: Textbook of Biochemistry and Human Biology.
- A. L. Lehninger: Biochemistry.
- O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods

CHEMISTRY

(6th Semester)

Course No.:**CHEMISTRY-SEC-401**

Fuel Chemistry

Contact Hours: 60; Credits: 04

Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]

Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]

(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1: Review of energy sources (renewable and non-renewable).
Classification of fuels and their calorific value.

Unit 2: *Coal*: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals.

Unit 3: *Petroleum and Petrochemical Industry*: Composition of crude petroleum; Different types of petroleum products and their applications. Principle and process of fractional distillation, Cracking – Thermal and catalytic cracking; Qualitative treatment of non-petroleum fuels- LPG, CNG, LNG, bio-gas, fuels derived from biomass, fuel from waste; synthetic fuels – gaseous and liquids.

Unit 4: *Petrochemicals*: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Unit 5: *Lubricants*: Classification of lubricants, lubricating oils (conducting and non-conducting), Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants – viscosity index, cloud point, pore point.

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
- P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- B. K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut.

CHEMISTRY

(5th Semester)

Course No.:**CHEMISTRY-SEC-501**

Chemistry of Cosmetics and Perfumes

Contact Hours: 60; Credits: 04

Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]

Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]

(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

A general study including composition and uses of the following:

Unit 1: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel

Unit 2: Creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours

Unit 3: Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone

Unit 4: Preparation of the following: (*any two*)

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.

Unit 5: Preparation of the following: (*any two*)

1. Preparation of face cream.
2. Preparation of nail polish
3. Preparation of nail polish remover.

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
- P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- B. K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut.

CHEMISTRY

(4th Semester)

Course No.:**CHEMISTRY-SEC-601**

Pesticide Chemistry

Contact Hours: 60; Credits: 04

Full Marks = 70[End Semester Exam (50) Internal Assessment (20)]

Pass Marks = 28 [End Semester Exam (20) Internal Assessment(08)]

(In the End-semester examination, two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1: General Introduction:

General introduction to pesticides (natural and synthetic), History of pesticides, Classification of pesticides on chemical nature and accordingto target species, Nature of damage and management of following pests:Public health pests (mosquitoes), Agricultural pests (Boll worms, sucking pests),Domestic pests (Bed bugs, cockroaches).

Unit 2: Effects:

Benefits and adverse effects of pesticides (natural and synthetic), Action of pesticide on nervous system, Toxicology of organophosphates, carbamates and organochlorines: signs, symptoms and medical treatment for poisoning. Pesticides residues, causes of pesticideresidues in atmosphere, water, soil and their effects.

Unit 3: Formulatons:

Definition, purposeof formulation, brief account& types-synergists and adjuvantsused in formulations. Conventional formulations: Dry formulations (concept, diluents and carriers used), Liquid formulations (Concept, true solutions, colloidal solutions and suspentions, brief account of solution & oil concentrates)

Changing concepts of pesticides:Environmental and user friendly formulation, Suspension concentrates, Controlled release formulations (CR) - importance, advantages, preparation of various types of CR, Micro encapsulated formulation. Biopesticides:Definition, *Bacillus thuringiensis*, insect viruses and entomopathogenic fungi – characteristics, mechanism of action and application

Unit 4: Activity:

Structure and mode of action of the followings:

Insecticides: chlorinated hydrocarbons, organophosphates, carbamates. Fungicides: Carbendazim, Copper oxy chloride, Dithianon, Strobilurin fungicides. Nematicides: aliphatic halogen compounds, methyl isocyanate liberators..

Unit 5: Representative Pesticides:

Synthesis and technical manufacture and uses of representative pesticides in the following classes:

Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion);
Carbamates (Carbofuran and carbaryl); Quinones (Chloranil);
Anilides (Alachlor and Butachlor).

Practicals (Demonstrations and Hands-on)

1. To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
2. Preparation of simple organophosphates, phosphonates and thiophosphates

Reference Book:

- R. Cremlyn: Pesticides, John Wiley.