SYLLABUS (DRAFT)
B.Sc. PROGRAMME IN INDUSTRIAL CHEMISTRY
Effective from
2014 admission

Respected Sir/Madam,

Please find attached herewith the draft syllabus for the undergraduate programme in Industrial Chemistry, under consideration by the board for approval. Opinion and suggestions for modification, inclusion and omissions are solicited.

Thanking you,

Calicut University
18-05-14

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INTRODUCTION :

The name of the programme shall be 'B . Sc. INDUSTRIAL CHEMISTRY'

The syllabus for the programme includes 80 % syllabus of B. Sc Chemistry Prrogramme of Calicut University along with special topics related to Industry in theory and practicals. The successful candidates will be eligible for post graduate studies in Chemistry (M.Sc. chemistry) and allied subjects. The course shall be for six semesters following the general undergraduate pattern. Each student has to carry out a project work under the supervision of a teacher nominated by the Head of Department in an Industrial establishment or in a research Institute or in the College. The candidate shall submit two duly certified copies at the end of the final semester. Viva Voce shall be based on the project report. For the evaluation of the Industrial Chemistry courses both theory and practical, separate examination board shall be constituted.

Scheme of Instruction

For the B.Sc. Industrial Chemistry programme, Chemistry forms the basic content together with special courses on Industrial Chemistry. Both theory and practicals are included for study during the six semesters.

A. Theory The total number of core theory courses is twelve one course each during the first four semesters, three courses each during fifth and four courses in the sixth semester and also one elective course in the sixth semester.

In the fifth semester under open course for students from other streams, three courses are prescribed.

1. Environmental chemistry
2. Chemistry in daily life
3. Food Science and Medicinal chemistry

In the sixth semester institution shall select one elective course from

1. Medicinal Chemistry and drug development
2. Introduction to Cheminformatics

B. Practical

Practicals corresponding to each core course will be conducted during the corresponding semesters. Examination for the core practical course covered in the first four semesters will be held at the end of the fourth semester. Two of the core course practicals shall be conducted in the fifth semester and two in the sixth semester. But the examination for them will be held at the end of sixth semester. All

practical examinations are of three hour duration. A duly certified record of practicals should be submitted during the examination.

C. Project

Project works will be carried out in fifth semester (two hours per week), but evaluation shall be conducted at the end of sixth semester. Not more than ten students can form a group and undertake a project. Each individual student should submit a copy of the project report duly attested by the supervising teacher and the Head of the department.

D. Study Tour

Students have to conduct an educational tour to a chemical industry/research institution of importance, in the fifth or sixth semester under the supervision of a teacher and submit a report on it, which will be evaluated at the end of sixth semester.

COURSE STRUCTURE

Credit Distribution

Semester	*Common course*			*Core course*	*Complementary course*		*Open course*	*Total*
	English	*Additional Language*	*General Course*		*Mathematics*	*Computer science*		
I	4+3	4		2	3	2	-	18
II	4+3	4		2	3	2	-	18
III	-	-	4 + 4	3	3	2	-	16
IV	-	-	4 + 4	3+4*	3	2+4*	-	24
V	-	-		3+3+3	-	-	2	11
VI	-	-		3+3+3+3+3 +4*+4*+4*+4*+2**	-	-	-	33
Total	**22**	**16**	**16**	**56**	**12**	**12**	**2**	**120**

*Practical **Project

Mark Distribution and Indirect Grading System

Mark system is followed instead of direct grading for each question. After external and internal evaluations marks are to be entered in the answer scripts. All other calculations, including grading, will be done by the university using the software. Indirect Grading System in 7 point scale is followed. Each course is evaluated by assigning marks with a letter grade (A^+, A, B, C, D, E or F) to that course by the method of indirect grading.

Mark Distribution

Sl. No.	*Course*	*Marks*
1	English	400
2	Additional Language	200
3	General course	400
3	Core course: Chemistry/ Industrial Chemistry	1750
4	Complementary course: Mathematics	400
5	Complementary course: Computer science	400
6	Open Course	50
	Total Marks	**3600**

Seven point Indirect Grading System

% of Marks	*Grade*	*Interpretation*	*Grade Point Average*	*Range of Grade points*	*Class*
90 and above	A^+	Outstanding	6	5.5 - 6	First Class with distinction
80 to below 90	A	Excellent	5	4.5 – 5.49	
70 to below 80	B	Very good	4	3.5 – 4.49	First Class
60 to below 70	C	Good	3	2.5 – 3.49	
50 to below 60	D	Satisfactory	2	1.5 – 2.49	Second Class
40 to below 50	E	Pass/Adequate	1	0.5 – 1.49	Pass
Below 40	F	Failure	0	0 – 0.49	Fail

CREDIT AND MARK DISTRIBUTION IN EACH SEMESTERS

Total Credits: 120; Total Marks: 3600

Semester	*Course*	*Credit*	*Marks*
I	Common course: English	4	100
	Common course: English	3	100
	Common course: Additional Language	4	100
	Core Course I: Theoretical and Inorganic Chemistry-I	2	100
	Complementary course: Mathematics	3	100
	Complementary course: Computer science	2	80
	Total	**18**	**580**
II	Common course: English	4	100
	Common course: English	3	100
	Common course: Additional Language	4	100
	Core Course II: Theoretical and Inorganic Chemistry-II	2	100
	Complementary course: Mathematics	3	100
	Complementary course: Computer science	2	80
	Total	**18**	**580**
III	General Course I	4	100
	General Course II	4	100
	Core Course III: Physical Chemistry-I	3	100
	Complementary course: Mathematics	3	100
	Complementary course: Computer science	2	80
	Total	**16**	**480**
IV	General Course III	4	100
	General Course IV	4	100
	Core Course IV: Organic Chemistry-I	3	100
	Core Course V: Inorganic Chemistry Practical-I	4	100
	Complementary course: Mathematics	3	100
	Complementary course: Computer science	2	80
	Complementary course: Computer science Practical	4	80
	Total	**24**	**660**
V	Core Course VI: Industrial Chemistry-I	3	100
	Core Course VII: Organic Chemistry-II	3	100
	Core Course VIII: Physical Chemistry-II	3	100
	Open course	2	50
	Total	**11**	**350**
VI	Core Course IX: Inorganic Chemistry-III	3	100
	Core Course X: Industrial Chemistry-II	3	100
	Core Course XI: Physical Chemistry-III	3	100
	Core Course XII: Advanced and Applied Chemistry	3	100
	Core Course XIII: Elective	3	100
	Core Course XIV: Organic Analysis & Gravimetry Practical	4	100
	Core Course XV: Inorganic Chemistry Practical II	4	100
	Core Course XVI: Industrial Chemistry Practical-II	4	100
	Core Course XVII: Industrial Chemistry Practical-III	4	100
	Core Course XVIII: Project Work	2	50
	Total	**33**	**950**

SYLLABUS

FOR

CORE COURSES

Core Course Structure
Total Credits: 56 (Internal: 20%; External: 80%)

Semester	*Code No*	*Course Title*		*Hrs/ Week*	*Total Hrs*	*Credit*	*Marks*
I	CHE1B01	Core Course I: Theoretical and Inorganic Chemistry-I		2	36	2	100
	-	Core Course V : Inorganic Chemistry Practical-I		2	36	-*	-
II	CHE2B02	Core Course II: Theoretical and Inorganic Chemistry-II		2	36	2	100
	-	Core Course V : Inorganic Chemistry Practical-I		2	36	-*	-
III	CHE3B03	Core Course III: Physical Chemistry-I		3	54	3	100
	-	Core Course V : Inorganic Chemistry Practical-I		2	36	-*	-
IV	CHE4B04	Core Course IV: Organic Chemistry-I		3	54	3	100
	CHE4B05(P)	Core Course V : Inorganic Chemistry Practical-I		2	36	4	100
V	IC5B01	Core Course VI: Industrial Chemistry-I		3	54	3	100
	CHE5B07	Core Course VII: Organic Chemistry-II		4	72	3	100
	CHE5B08	Core Course VIII: Physical Chemistry-II		4	72	3	100
	-	Core Course XIV: Organic Analysis & Gravimetry		5	90	-**	-
	-	Core Course XV: : Inorganic Chemistry Practical-II #		5	90	-**	-
	-	Core Course XVIII: Project Work		2	36	-**	-
VI	IC6B02	Core Course IX: Industrial Chemistry-I		3	54	3	100
	IC6B03	Core Course X: Inorganic Chemistry-III		3	54	3	100
	CHE6B11	Core Course XI: Physical Chemistry-III		3	54	3	100
	IC6B04	Core Course XII: Advanced and Applied Chemistry		3	54	3	100
	IC6B05(E1)	Core Course XIII: Elective***	1. Medicinal Chemistry and Drug development	3	54	3	100
	IC6B05(E2)		3. Introduction to Cheminformatics				
	IC6B06(P)	Core Course XIV: Organic Analysis & Gravimetry		-	-	4**	100
	IC6B07(P)	Core Course XV: Inorganic Chemistry Practical-II #		-	-	4**	100
	IC6B08(P)	Core Course XVI: Industrial Chemistry Practical-I		5	90	4	100
	IC6B09(P)	Core Course XVII: Industrial Chemistry Practical-II		5	90	4	100
	IC6B10(Pr)	Core Course XVIII: Project Work		-	-	2**	50
					Total	**56**	**1750**

* Exam will be held at the end of 4th semester

** Exam will be held at the end of 6th semester

*** An institution can choose any one among the three courses.

Includes industrial visit also. Marks: 85 (Inorganic Chemistry Practical–II) + 15 (Industrial visit).

SEMESTER I

Course Code: CHE1B01
Core Course I: THEORETICAL AND INORGANIC CHEMISTRY - I
Total Hours: 36; Credits: 2; Hours/Week: 2

Module I: Chemistry as a Discipline of Science (6 hrs)

What is Science? - Scientific statements - Scientific methods – Observation - Posing a question - Formulation of hypothesis – Experiment – Theory – Law - Revision of scientific theories and laws - Role of concepts and models in science - Scientific revolution.

Evolution of chemistry - Ancient speculations on the nature of matter - Early form of chemistry – Alchemy - Origin of modern chemistry - Branches of chemistry -Interdisciplinary areas involving physics and biology.

Objectives of Chemical Research - Research design. Components of a research project: Introduction, review of literature, scope, materials and methods, results and discussion, conclusions and bibliography.

Module II: Some Basic Chemical Concepts (3 hrs)

Symbol of elements – Atomic number and mass number - Atomic mass – Isotopes, isobars and isotones - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Oxidation number and valency – Variable valency - Equivalent mass.

Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, ppm and millimoles.

Module III: Analytical Chemistry - I (9 hrs)

Laboratory Hygiene and Safety: Storage and handling of chemicals. Simple first aids: Electric shocks, fire, cut by glass and inhalation of poisonous gases - Accidents due to acids and alkalies - Burns due to phenol and bromine. Disposal of sodium and broken mercury thermometer - Use of calcium chloride and silica gel in desiccators. Awareness of Material Safety Data Sheet (MSDS) – R & S Phrases (elementary idea only) – Safe laboratory practices – Lab safety signs.

Volumetric Analysis: Introduction - Primary and secondary standards – Standard solutions - Theory of titrations involving acids and bases, $KMnO_4$, $K_2Cr_2O_7$, I_2 and liberated I_2 - Complexometric titrations. Indicators: Theory of acid-base, redox, adsorption and complexometric indicators. Double burette method of titration: Principle and advantages.

Significant figures – Comparison of results.

Module IV: Atomic Structure (9 hrs)

Introduction based on historical development – John Dalton's atomic theory – Thomson’s atom model and its limitations – Rutherford’s atom model and its limitations - Failure of classical physics – Black body radiation - Planck’s quantum hypothesis - Photoelectric effect - Generalization of quantum theory -

Atomic spectra of hydrogen and hydrogen like atoms - Ritz-combination principle– Bohr theory of atom – Calculation of Bohr radius, velocity and energy of an electron - Explanation of atomic spectra – Rydberg equation - Limitations of Bohr theory - Sommerfeld modification - Louis de Broglie's matter waves – Wave-particle duality - Electron diffraction - Heisenberg's uncertainty principle.

Module V: Nuclear Chemistry (9 hrs)

Natural radioactivity – Modes of decay – Group displacement law – Theories of disintegration – Rate of decay – Decay constant – Half life period – Gieger-Nuttall rule – Radioactive equilibrium – Disintegration series – Transmutation reactions using protons, deutrons, α-particles and neutrons – Artificial radioactivity – Positron emission and K electron capture – Synthetic elements.

Nuclear stability – N/P ratio – Packing fraction – Mass defect – Binding energy – Nuclear forces – Exchange theory and nuclear fluid theory – Nuclear fission - Atom bomb – Nuclear fusion – Hydrogen bomb - Nuclear reactors - Nuclear reactors in India.

Isotopes: Detection – Aston's mass spectrograph – Separation of isotopes by gaseous diffusion method and thermal diffusion method – Application of radioactive isotopes – ^{14}C dating – Rock dating – Isotopes as tracers – Study of reaction mechanism (ester hydrolysis) – Radio diagnosis and radiotherapy.

Text Books

1. Jeffrey A. Lee, *The Scientific Endeavor: A Primer on Scientific Principles and Practice*, Pearson Education, 1999.
2. C.N.R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
3. Robert H. Hill and David Finster, *Laboratory Safety for Chemistry Students*, 1st Edition, Wiley, Hoboken, NJ, 2010.
4. M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
5. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
6. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1*, 5th Edition, S. Chand and Sons, New Delhi, 2012.
7. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
8. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edition, New Age International (P) Ltd., New Delhi, 1995 (Reprint 2005).
9. E.S.Gilreath- Fundemental Concepts of Inorganic Chemistry, McGraw-Hill Inc.,

References

1. T.F Gieryn, *Cultural Boundaries of Science*, University of Chicago Press, Chicago, 1999.
2. H. Collins and T. Pinch, *The Golem: What Everyone Should Know about Science*, Cambridge University Press, Cambridge, 1993.

3. C.R. Kothari, *Research Methodology: Methods and Techniques*, 2nd Revised Edition, New Age International Publishers, New Delhi, 2004.
4. *Guidance in a Nutshell - Compilation of Safety Data Sheets*, European Chemicals Agency, Finland, Version 1.0, December 2013.
5. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
6. B.K, Sen, *Quantum Chemistry – Including Spectroscopy*, 3rd Edition, Kalyani publishers, New Delhi, 2010.
7. D.A. McQuarrie, *Quantum Chemistry*, 2nd Edition, University Science Books, California, 2008.
8. R.K. Prasad, *Quantum Chemistry*, 4th Edition, New Age International (P) Ltd., New Delhi, 2012.
9. J.B. Rajam and L.D. Broglie, *Atomic Physics*, 7th Edition, S. Chand and Co. Pvt. Ltd., New Delhi, 1999.
10. S. Glasstone, *Source Book on Atomic Energy*, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, 1967.

SEMESTER II

Course Code: CHE2B02
Core Course II: THEORETICAL AND INORGANIC CHEMISTRY - II
Total Hours: 36; Credits: 2; Hours/Week: 2

Module I: Quantum Chemistry (12 hrs)

Operator algebra – Linear and Hermitian operators - Laplacian and Hamiltonian operators - Eigen functions and Eigen values of an operator - Postulates of quantum mechanics - Well behaved functions.

Time independent Schrödinger wave equation - Application to particle in a one dimensional box – Normalization of wave function - Particle in a three-dimensional box – Separation of variables - Degeneracy.

Application of Schrödinger wave equation to hydrogen atom – Conversion of Cartesian coordinates to polar coordinates - The wave equation in spherical polar coordinates (derivation not required) - Separation of wave equation - Radial and angular functions (derivation not required) – Orbitals and concept of Quantum numbers (n, l, m).

Radial functions - Radial distribution functions and their plots – Shapes of orbitals (s, p and d). Schrödinger equation for multi-electron atoms: Need for approximation methods.

Electron spin – Spin quantum number - Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.

Module II: Periodic Properties (6 hrs)

Modern periodic law – Long form periodic table. Periodicity in properties: Atomic and ionic radii - Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity. Electronegativity scales: Pauling and Mullikan scales. Effective nuclear charge – Slater rule and its applications – Polarising power. Diagonal relationship and anomalous behavior of first element in a group (basic idea only).

Module III: Chemical Bonding – I (9 hrs)

Introduction – Type of bonds – Octet rule and its limitations.

Ionic Bond: Factors favouring the formation of ionic bonds - Lattice energy of ionic compounds - Born-Lande equation (derivation not expected) – Solvation enthalpy and solubility of ionic compounds – Born-Haber cycle and its applications – Properties of ionic compounds - Polarisation of ions – Fajan's rule and its applications.

Covalent Bond: Lewis theory. VSEPR theory: Postulates - Applications - Shapes of BeF_2, BCl_3, $SnCl_2$, CCl_4, NH_3, H_2O, PF_5, SF_4, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6. Valence Bond Theory. Coordinate bond. Hybridization: Definition and characteristics - sp ($BeCl_2$, C_2H_2), sp^2 (BF_3, C_2H_4), sp^3 (CH_4, NH_3,

H_2O, NH_4^+, H_3O^+ and SO_4^{2-}), sp^3d (PCl_5), sp^3d^2 (SF_6) and sp^3d^3 (IF_7) hybridizations. Limitations of VBT. Properties of covalent compounds. Polarity of covalent bond – Percentage of ionic character – Dipole moment and molecular structure.

Module IV: Chemical Bonding – II (9 hrs)

Covalent Bond: Molecular Orbital Theory – LCAO - Bonding and anti bonding molecular orbitals – Bond order and its significance. MO diagrams of homonuclear and heteronuclear diatomic molecules: H_2, He_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, CO and NO – Comparison of bond length, magnetic behaviour and bond energy of O_2, O_2^+, O_2^{2+}, O_2^- and O_2^{2-}.

Resonance structures of borate, carbonate and nitrate ions – Comparison of bond energy.

Comparison of VB and MO theories.

Metallic Bond: Free electron theory, valence bond theory and band theory (qualitative treatment only) - Explanation of metallic properties based on these theories.

Intermolecular Forces: Introduction. Hydrogen bond: Intra and inter molecular hydrogen bonds - Effect on physical properties. Induction forces and dispersion forces: Van der Waals forces, ion-dipole, dipole-dipole, ion-induced dipole, dipole-induced dipole and induced dipole-induced dipole interactions.

Text Books

1. A.K. Chandra, *Introductory Quantum Chemistry*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 1994.
2. R.K. Prasad, *Quantum Chemistry*, 4th Edition, New Age International(P) Ltd., New Delhi, 2012.
3. B.K, Sen, *Quantum Chemistry – Including Spectroscopy*, 3rd Edition, Kalyani publishers, New Delhi, 2010.
4. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
5. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1*, 5th Edition, S. Chand and Sons, New Delhi, 2012.
6. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 2007.
7. R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press India Ltd., Hyderabad, 2009.

References

1. D.A. McQuarrie, *Quantum Chemistry*, 2nd Edition, University Science Books, California, 2008.
2. M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
3. P.W. Atkins and R.S. Friedman, *Molecular Quantum Mechanics*, 3rd Edition, Oxford University Press, New York, 1997.
4. I.N. Levine, *Quantum Chemistry*, 6th Edition, Pearson Education Inc., New Delhi, 2009.

5. Jack Simons, *An Introduction to Theoretical Chemistry*, 2nd Edition, Cambridge University Press, Cambridge, 2005.
6. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, John Wiley and Sons, New York, 2008.
7. E.S.Gilreath- Fundemental Concepts of Inorganic Chemistry, McGraw-Hill Inc.,

SEMESTER III

Course Code: CHE3B03
Core Course III: PHYSICAL CHEMISTRY– I
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Gaseous State (12 hrs)

Introduction - Postulates of kinetic theory of gases - Derivation of kinetic gas equation - Maxwell's distribution of molecular velocities - Root mean square, average and most probable velocities - Collision number - Mean free path - Collision diameter - Deviation from ideal behavior - Compressibility factor – Van der Waals equation of state (derivation required) - Virial equation - Expression of Van der Waals equation in virial form and calculation of Boyle temperature - PV isotherms of real gases - Continuity of states - Isotherm of Van der Waals equation - Critical phenomena - Critical constants and their determination - Relationship between critical constants and Van der Waals constants.

Module II: Thermodynamics – I (18 hrs)

Definition of thermodynamic terms - System – Surroundings - Types of systems - Intensive and extensive properties - State and path functions - Zeroth law of thermodynamics - First law of thermodynamics – Concept of heat, work, internal energy and enthalpy - Heat capacities at constant volume and at constant pressure & their relationship - Expansion of an ideal gas - Work done in isothermal expansion and reversible isothermal expansion - Calculation of W, q, ΔE and ΔH for expansion of an ideal gas under isothermal and adiabatic conditions - Joule-Thomson effect - Liquefaction of gases - Derivation of the expression for Joule Thomson coefficient – Inversion temperature.

Second law of thermodynamics - Need for the law - Different statements of the law - Carnot's cycle and its efficiency - Carnot theorem - Concept of entropy - Entropy as a state function - Entropy as a function of V & T and P & T - Entropy as a criteria of spontaneity and equilibrium.

Work and free energy functions - Criteria for reversible and irreversible processes - Gibbs-Helmholtz equation - Partial molar free energy - Concept of chemical potential - Gibbs-Duhem equation - Clapeyron equation - Clapeyron-Clausius equation and its application.

Module III: Thermodynamics – II (9 hrs)

Thermochemistry - Standard enthalpies of solution, combustion, neutralization, dissociation, formation and reaction – Hess's law – Variation of enthalpy of reaction with temperature – The Kirchhoff equation – Bond energies.

Third law of thermodynamics - Nernst heat theorem - Statement of third law.

Fundamental concepts of Statistical Thermodynamics - Permutations and combinations – Probability - Relation between entropy and probability - Stirling's approximation - Residual entropy and absolute entropy.

Module IV: Liquid State (6 hrs)

Introduction - Uniqueness of water. Vapour pressure: Explanation and its determination. Surface tension: Explanation and its determination. Parachor: Explanation and its determination - Application to structure

elucidation of compounds. Viscosity: Determination of molecular mass from viscosity measurements. Refraction: Refractive index – Molar refraction and optical exaltation – Application to structure elucidation.

Module V: Chemical Equilibria (9 hrs)

Introduction - Law of mass action - Law of chemical equilibrium - Equilibrium constant in terms of concentration, partial pressure and mole fractions - Relationship between Kc, Kp and Kx - Thermodynamic derivation of law of chemical equilibrium - Temperature dependence of equilibrium constant - Van't Hoff's equation - Homogeneous and heterogeneous equilibria - Le Chatelier's principle and its applications to chemical and physical equilibria.

Text Books

1. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition, Vishal Publishing Company, New Delhi, 2013.
2. P.L. Soni, O.P. Dharmarha and U.N. Dash, *Textbook of Physical Chemistry*, 23rd Edition, Sultan Chand & Sons, New Delhi, 2011.
3. J. Rajaram and J.C. Kuriacose, *Chemical Thermodynamics*, Pearson Education, New Delhi, 2013.
4. F. Daniels and R.A. Alberty, *Physical Chemistry*, 5th Edition, John Wiley and Sons, Canada, 1980.
5. Gurdeep Raj, *Advanced Physical Chemistry*, 35th Edition, Goel Publishing House, Meerut, 2009.

References

1. Gordon M. Barrow, *Physical Chemistry*, 5th Edition, Tata McGraw Hill Education, New Delhi, 2006.
2. K.L. Kapoor, *Physical Chemistry*, Volumes II and III, Macmillan Publishers, Noida, 2004.
3. S. Glasstone and D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edition, Macmillan & Company, UK, 1962.
4. W.J. Moore, *Physical Chemistry*, 5th Edition, Orient Longman, London, 1999.
5. R.P. Rastogi and R.R. Misra, *An Introduction to Chemical Thermodynamics*, 6th Edition, Vikas Publishing House Pvt. Ltd., Noida, 2002.
6. T.L. Hill, *Introduction to Statistical Thermodynamics*, Addison-Wesley, New York, 1987.
7. P.W. Atkins, *Physical Chemistry*, 8th Edition, Oxford University Press, New Delhi, 2006.
8. G.W. Castellan, *Physical Chemistry*, 3rd Edition, Addison-Wesley Educational Publishers Inc., U.S., 2004.
9. G.K. Vemula Palli, *Physical Chemistry*, Prentice Hall of India, New Delhi, 1997.
10. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing House, New Delhi, 2012.

SEMESTER IV

Course Code: CHE4B04
Core Course IV: ORGANIC CHEMISTRY– I
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Introduction to Organic Chemistry (3 hrs)

Historical development – Uniqueness of carbon – Classification of organic compounds - Homologous series - Functional groups (mention only) - Hybridization in organic compounds (mention only). Isomerism: Classification in to structural isomerism and stereo isomerism. Structural isomerism: Chain isomerism, position isomerism, functional isomerism, metamerism and ring-chain isomerism – Keto-enol tautomerism.

Module II: Stereochemistry (15 hrs)

Representation of Organic Molecules: Fischer, Flying wedge, Sawhorse and Newman projection formulae.

Stereoisomerism: Classification into conformational isomerism and configurational isomerism.

Conformational Isomerism: Conformations - Dihedral angle - Torsional strain - Conformational analysis of ethane and *n*-butane including energy diagrams – Conformations of glycol. Baeyer's strain theory – Merits and demerits. Conformations of cyclohexane - Axial and equatorial bonds - Ring flipping – Conformations of mono substituted cyclohexane.

Optical Isomerism: Definition – Specific rotation – Chirality and elements of symmetry – DL configuration - Enantiomers - Optical isomerism in glyceraldehyde, lactic acid and tartaric acid - Diastereomers – Meso compounds – Cahn-Ingold-Prelog rules - RS notations for acyclic optical isomers with one and two asymmetric carbon atoms - Erythro and threo representations (elementary idea only) - Racemic mixture - Resolution methods - Enantiomeric excess. Optical isomerism in compounds lacking asymmetric carbon atoms: Biphenyls and allenes. Asymmetric synthesis.

Geometrical Isomerism: cis-trans, *syn-anti* and EZ notations with examples - Methods of distinguishing geometrical isomers using melting point, dipole moment, solubility, cyclisation and heat of hydrogenation.

Module III: Reaction Mechanism: Basic Concepts (12 hrs)

Definition of reaction mechanism - Curved arrow formalism. Nature of bond fission: Homolysis and heterolysis. Types of reagents: Electrophiles and nucleophiles.

Resonance: Condition, rules and techniques of drawing resonance forms - Resonance energy - Calculation of resonance energy of benzene from heat of hydrogenation.

Electron Displacement Effects: Inductive effect: Definition – Characteristics - +I and -I groups. Applications: Comparison of acidity of (i) formic acid and acetic acid (ii) chlorobutanoic acids. Mesomeric effect: Definition – Characteristics - +M and -M groups. Applications: Comparison of basicity of aniline, *p*-nitroaniline and *p*-anisidine. Hyperconjugation: Definition – Characteristics. Examples: Propene, ethyl carbocation and ethyl free radical. Applications: Comparison of stabilities of (i) 1-butene and 2-butene (ii) toluene, ethyl benzene and *tert*-butyl benzene. Electromeric effect:

Definition – Characteristics - +E effect (addition of H^+ to ethene) and -E effect (addition of CN^- to acetaldehyde). Comparison of inductive effect, mesomeric effect and hyperconjugation: Comparison of electron density in benzene, toluene, phenol, chlorobenzene and nitrobenzene. Steric effect: Definition, reason and examples.

Reaction Intermediates: Carbocations, carbanions, free radicals and carbenes (definition, hybridization, structure, classification, formation, stability and important reactions) - Rearrangement of carbocations – Nitrenes (mention only).

Types and Subtypes of Organic Reactions: Substitution, addition, elimination and rearrangement (definition and simple examples only).

Module IV: Aliphatic Hydrocarbons (15 hrs)

Alkanes: Nomenclature – Isomerism – Preparation from alkenes, alkynes and alkyl halides (reduction and Wurtz reaction). Chemical properties: Halogenation (free radical substitution mechanism), aromatisation and isomerisation.

Cycloalkanes: Nomenclature - Preparation by Freund reaction.

Alkenes: Nomenclature – Isomerism. Preparation: Dehydrohalogenation of alkyl halides (Saytzeff's rule, mechanism not expected), dehalogenation of dihalides (stereochemistry expected) and dehydration of alcohols (mechanism expected). Chemical properties: Electrophilic addition - Addition of hydrogen (explanation of stability and heat of hydrogenation based on hyperconjugation and resonance), addition of halogens (mechanism and stereochemistry expected), addition of hydrogen halides (Markownikov and Anti-Markownikov addition with mechanism) and addition of water (mechanism expected) - *Cis* and *trans* hydroxylation, permanganate cleavage and ozonolysis.

Alkadienes: Classification into cumulated, conjugated and isolated dienes – Thiele's theory of partial valency - 1,4-addition of 1,3-butadiene – Diels-Alder reaction.

Alkynes: Nomenclature of alkynes and alkenynes – Isomerism – Berthelot's reaction - Preparation from dihalides and acetylides. Chemical properties: Electrophilic addition – Addition of hydrogen using Lindlar's catalyst and Na/liquid ammonia - Addition of halogens and hydrogen halides – Oxymercuration - Ozonolysis - Reaction with chromic acid and $KMnO_4$ - Acidity of 1-alkynes.

Comparison of electrophilic addition rate of alkenes and alkynes. Chemistry of the test for unsaturation: Bromine water, bromine in CCl_4 and Baeyer's reagent.

Module V: Aromatic Hydrocarbons (6 hrs)

Nomenclature and isomerism in substituted benzene, naphthalene and anthracene - Structure and stability of benzene (Kekule, Resonance and Molecular Orbital concepts). Electrophilic substitution reactions in benzene with mechanisms: Halogenation, nitration, sulphonation, Friedel-Craft's alkylation and acylation - Orientation of aromatic substitution – Ring activating and deactivating groups with examples - *ortho*, *para* and *meta* directing groups - Side chain oxidation.

Haworth synthesis of naphthalene – Nitration and sulphonation of naphthalene. Polycyclic arenes as carcinogens (simple examples only).

Module VI: Aromaticity (3 hrs)

Huckel's (4n+2) rule and its simple applications to benzenoid (benzene, naphthalene and anthracene) and non-benzenoid (furan, pyrrole, pyridine, indole, quinoline, cyclopropenyl cation, tropylium cation, cyclopentadienyl anion and annulenes) systems – Comparison of basicity of (i) pyrrole and pyridine (ii) indole and quinoline - Anti-aromatic compounds.

Text Books

1. L.G. Wade Jr., *Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
2. A. Bahl and B.S. Bahl, *Advanced Organic Chemistry*, 1st Multicolour Edition, S. Chand & Company, New Delhi, 2010.
3. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
4. C.N. Pillai, *Organic Chemistry for Undergraduates*, 1st Edition, University Press, Hyderabad, 2008.
5. S.C. Sharma and M.K. Jain, *Modern Organic Chemistry*, Vishal Publishing Company, New Delhi, 2014.
6. P.S. Kalsi, *Organic Reactions, Stereochemistry and Mechanism*, 4th Edition, New Age International Publishers, New Delhi, 2006.
7. Peter Sykes, A Book to Mechanism of Organic Chemistry

References

1. J. Clayden, N. Greeves and S. Warren, *Organic Chemistry*, 2nd Edition, Oxford University Press, New York, 2012.
2. D. Nasipuri, *Stereochemistry of Organic Compounds: Principles and Applications*, 3rd Edition, New Age International Publishers, New Delhi, 2011.
3. E.L. Eliel, *Stereochemistry of Carbon Compounds*, Tata McGraw Hill Publishing Company Ltd, New Delhi, 1992.
4. V.K. Ahluvaliya, *Organic Reaction Mechanisms*, 3rd Edition, Narosa Publishing House, New Delhi, 2007.
5. M.S. Singh, *Advanced Organic Chemistry: Reactions and Mechanisms*, Pearson Education, New Delhi, 2014.
6. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
7. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
8. John McMurry, *Fundamentals of Organic Chemistry*, 5th Edition, Brooks/Cole, Pacific Grove, California, 2002.
9. I.L. Finar, *Organic Chemistry Vol. I*, 5th Edition, Pearson Education, New Delhi, 2013.
10. G.M. Louden, *Organic Chemistry*, 4th Edition, Oxford University Press, New York, 2008.
11. Jerry March, *Advanced Organic Chemistry*, 5th Edition, John Wiley and Sons, New York, 2004.
12. R.T. Morrison, R.N. Boyd, *Organic Chemistry*, 7th Edition, Pearson Education, New Delhi, 2013.

SEMESTER IV

Course Code: CHE4B05(P)
Core Course V: INORGANIC CHEMISTRY PRACTICAL - I
Total Hours: 144; Credits: 4; Hours/Week: 2 (I, II, III & IV Semesters)

General Instructions

1. *Use safety coat, goggles, shoes and gloves in the laboratory.*
2. *For weighing, either electronic balance or chemical balance may be used.*
3. *For titrations double burette titration method must be used.*
4. *A minimum number of 21 experiments should be done, covering III to VII modules, to appear for the examination.*
5. *Practical examination will be conducted at the end of 4^{th} semester.*

Module I: Introduction to Volumetric Analysis

1. Weighing using chemical balance and electronic balance.
2. Preparation of standard solutions.

Module II: Technique of Quantitative Dilution

Any five experiments of the following types.

1. Preparation of 100 mL 0.2 M H_2SO_4 from commercial acid.
2. Preparation of 250 mL 0.025 M thiosulphate from 0.1 M thiosulphate.

Module III: Neutralization Titrations

1. Strong acid – strong base titration.
2. Strong acid – weak base titration.
3. Weak acid – strong base titration.
4. Estimation of NH_3 by indirect method.
5. Titration of HCl + CH_3COOH mixture *Vs* NaOH using two different indicators to determine the composition.
6. Estimation of borax: Standard sodium carbonate.

Module IV: Redox Titrations

a) Permanganometry

1. Estimation of oxalic acid.
2. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt.
3. Estimation of hydrogen peroxide.
4. Estimation of calcium.

b) Dichrometry

1. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using internal indicator.
2. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using external indicator.
3. Estimation of ferric iron (after reduction with stannous chloride) using internal indicator.

c) Iodimetry and Iodometry

1. Estimation of iodine.
2. Estimation of copper.
3. Estimation of chromium.

Module V: Precipitation Titration (using adsorption indicator)

1. Estimation of chloride in neutral medium.

Module VI: Complexometric Titrations

1. Estimation of zinc.
2. Estimation of magnesium.
3. Estimation of calcium.
4. Determination of hardness of water.

Module VII: Some Estimations of Practical Importance

1. Determination of acetic acid content in vinegar by titration with NaOH.
2. Determination of alkali content in antacid tablets by titration with HCl.
3. Determination of copper content in brass by iodometric titration.
4. Determination of available chlorine in bleaching powder.
5. Determination of COD of water samples.
6. Estimation of citric acid in lemon or orange.
7. Determination of manganese content in pyrolusite.

References

1. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
3. G.D. Christian, *Analytical Chemistry*, 7th Edition, John Wiley and Sons, New York, 2013.
4. A.L. Underwood, *Quantitative Analysis*, 6th Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 1999.
5. D.N. Bajpai, O.P. Pandey and S. Giri, *Practical Chemistry; For I, II & III B. Sc.* Students, S. Chand & Company Ltd, New Delhi, 2012.

SEMESTER V

Course Code: IC5B01
Core Course VI: INDUSTRIAL CHEMISTRY - I
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I (5 Hrs)

Unit process, unit operations, flow diagrams, Energy balance and material balance (basic concepts only). Fuels, calorific value, Basic concepts of I S O

Module II (5 Hrs)

Fluid flow, stream line flow. Turbulent flow, viscosity –Reynold's number.

Newtonian and non Newtonian liquids. Heat transfer. Types of heat exchangers. (Shell type and plate type.) Refrigeration cycles. Safety in chemical industry. First aids.

Module III (3 Hrs)

Inorganic materials of industrial importance –(alumina, clays, mica,) ceramics, Molecular sieves, NASICON. Fullerides (Basic concept only). Adhesives-Type, classification, preparation methods, uses.

Module IV Polymers (9Hrs)

Basic concepts –branched and network polymers. Classification and nomenclature . Properties of polymers. Mol wt. glass transition temperature solubility and viscoelasticity. Manufacture and uses of PF resins.

Importance of polymers in controlled drug delivery and packaging.

Polymer processing, compounding (blending, moulding, casting, drawing, rolling).

Conducting polymers. PA, PPP, PPg(SN)x etc. Synthetic inorganic polymers, silicones, polyphosphazenes,-manufacture and application.

Module – V (5 Hrs)

Soaps and detergents-Basic chemical compositions of soaps, manufacture (Cold, semi boiled and full boiled processes).

Surface active agents, builders, additives, fillers. Basic concepts of perfuming and colouring. Bio-degradability.

Cosmetics – basic concepts – composition – production and classification of creams – sunscreen and suntan lotions –deodorants talcum powder – dentifiers, lipsticks.

Module VI (5 Hrs)

Food processing –colouring and flavouring agents, food preservation –viscosity builders – bulking agents, artificial sweetners – food adulteration –packaging and catering.

Module VII (7 Hrs)

Fundamental concepts or theory and industrial application of particle size analyzer spectrophotometry –flame, photometry –AAS -Xray flouorescence ion selective electrodes –chromatography.- Chromatographic methods for separation, concentration and characterization of organic compounds – Column chromatography, Paper, TLC & Gas – Liquid Chromatography.

Module VIII (5 Hrs)

Effluent treatment –principles of aerobic and anaerobic effluent treatment –adsorption –filters –sedimentation ,electrostatic methods –wet scrubbers –mist eliminators –brief idea of about waste recycling and its importance, solid waste management

Module IX Dyes (10 Hrs)

Basic Concepts, Classification –methods of dyeing –acid –direct -reactive –disperse –vat cationic sulphur –indigo –azo phthalocyanine –dyes. Synthetic Dyes A brief idea of metal complex dye stuffs. (introduction to natural dyes and it's importance in cotton textile dyeing.) fluorescent and brightening agents. Paints –varnishes and lacquers. Non textile uses of dyestuffs Health hazards.

References:

1. Nano Science And Technology.-

   V.S Muraleedharan –A Subramannian –Ane books put Ltd

2. Unit process and chemical engineering- Chathopadhyaya

3. Chemical Process Principles – Hougens

4. Industrial Chemistry – B K Sharma

5. Cosmetics preparation and practice – vandana publications

6. Hand book of cottage industries – Small Business publications

7. Industrial effluents – Manivasakam

8. Food Chemistry – B Sreelakshmi

9. Food chemistry – L H Meyer

10. Instrumental methods of analysis – Williard Merit,dean,settle

11. A text book of polymer science – Bill Meyer,

12. Polymer Science V R Gowariker,N V Viswanathan,sreedhar

13. Text Book of Environmental chemistry and Pollution-S S Dara

SEMESTER V

Course Code: CHE5B07
Core Course VII: ORGANIC CHEMISTRY - II
Total Hours: 72; Credits: 3; Hours/Week: 4

Module I: Halogen Compounds (9 hrs)

Nomenclature – Classification - Isomerism. Preparation of alkyl halides: From alcohols, Swarts reaction, Finkelsain reaction and allylic bromination of alkenes. Preparation of aryl halides: From benzene and diazonium salts. Nucleophilic substitution reactions: S_N^1 & S_N^2 mechanisms - Characteristics and energy profile diagrams - Comparison of rate of alkyl, aryl, allyl and vinyl halides. Elimination reactions: E1 & E2 mechanisms and their characteristics - Saytzeff's rule. Substitution *Vs* elimination. Nucleophilic aromatic substitution reaction with mechanism: Elimination–addition and addition–elimination mechanisms - Benzyne intermediate. Distinction between nuclear and side chain halogenated hydrocarbons. Uses of $CHCl_3$, CHI_3, $CF_3CHClBr$ and CF_2Cl_2 – Uses and health effects of CCl_4.

Module II: Organometallic Compounds (3 hrs)

Preparation and synthetic applications of Grignard reagent, organozinc compounds and organolithium compounds.

Module III: Hydroxy Compounds (12 hrs)

Alcohols: Nomenclature – Classification - Isomerism. Preparation: From alkenes (hydration, hydroboration oxidation and oxymercuration-demercuration reactions) and carbonyl compounds (reduction and with Grignard reagent). Preparation of ethanol from molasses – Preparation of rectified spirit and absolute alcohol - Power alcohol, proof spirit and denatured spirit (mention only). Chemical properties: Reactions involving cleavage of O-H bonds (acidity and esterification), oxidation (with PCC, Collin's reagent, Jone's reagent and $KMnO_4$) and catalytic dehydrogenation - Pinacol–pinacolone rearrangement (mechanism expected) - Chemistry of methanol poisoning – Harmful effects of ethanol in the human body. Test for alcohols: Luca's test and Victor Meyer's test.

Phenols: Nomenclature - Classification. Preparation: From cumene and sulphonic acid. Chemical properties: Acidity (substituent effects), bromination, nitration, sulphonation, Riemer-Tiemann reaction (mechanism expected), Kolbe reaction and Liebermann's nitroso reaction. Distinction between alcohols and phenols. Preparation and applications of phenolphthalein, fluorescein, eosin and alizarin – Reason for the colour change of phenolphthalein with pH. Uses of phenol.

Module IV: Ethers and Epoxides (6 hrs)

Ethers: Nomenclature – Isomerism - Preparation by Williamson's synthesis. Reactions of ethers: Acidic cleavage and Claisen rearrangement (mechanism expected) - Zeisel's method of estimation of methoxy groups. Crown ethers: Nomenclature and importance in organic synthesis.

Epoxides: Nomenclature – Preparation from alkenes – Acid and base catalyzed ring opening reactions.

Module V: Aldehydes and Ketones (9 hrs)

Nomenclature – Isomerism. Preparation: From alcohols, cyanides, acid chlorides, calcium carboxylates and Etard's reaction. Chemical properties: Nucleophilic addition (addition of water, HCN, bisulphite, alcohol and Grignard reagent - Comparison of nucleophilic addition rate of aliphatic and aromatic aldehydes and ketones), addition-elimination reactions (with hydroxyl amine, hydrazines, semicarbazide, ammonia and amines), reduction (Clemmenson, Wolff-Kishner, metal hydride and MPV reductions) and oxidation (with $KMnO_4$, Tollen's reagent, Fehling's solution, Benedict's reagent, bromine water and Oppenauer oxidation) – Acidity of α-hydrogen - Aldol condensation (mechanism expected) – Claisen-Schmidt, Knoevenagel, benzoin and Perkin's reactions - Haloform reaction – Iodoform test. Cannizarro reaction (mechanism expected) and Beckmann rearrangement (mechanism expected). Preparation and uses of vanillin. Distinction between aldehydes and ketones.

Module VI: Carboxylic Acids and Sulphonic Acids (12 hrs)

Carboxylic Acids: Nomenclature – Isomerism. Preparation: Hydrolysis of nitrile and carboxylation of Grignard reagent. Chemical properties: Acidity (effect of substituent on the acidity of aliphatic and aromatic carboxylic acids) - HVZ reaction - Decarboxylation - Kolbe electrolysis (mechanism expected) - Action of heat on dicarboxylic acids – Blanc's rule. Preparation, reactions and uses of oxalic acid, cinnamic acid and citric acid - Role of lactic acid in exercise - Preparation and reactions of acid derivatives (acid chlorides, esters, amides and acid anhydrides) – Comparison of boiling point and reactivity of acid derivatives - Ascend and descend in carboxylic acid series.

Sulphonic Acids: Preparation and properties of benzene sulphonic acid – Tosylation - Synthesis and application of saccharin.

Comparison of acidity of alcohols, phenols, carboxylic acids and sulphonic acids.

Module VII: Nitrogen Compounds (15 hrs)

Nitro Compounds: Nitro-aci tautomerism - Difference between alkyl nitrites and nitro alkanes - Nef's reaction - Reduction products of nitrobenzene in various media – Harmful effects of nitrobenzene in the human body. Explosives: Definition - TNT, nitroglycerine, RDX and ANFO (structural formula and chemistry behind the explosion).

Amines: Nomenclature – Isomerism. Preparation: From alkyl halides, nitro compounds, nitriles, isonitriles and amides - Hofmann's bromamide reaction, Schmidt reaction and Gabriel phthalmide synthesis. Chemical properties: Basicity (effect of substituents on the basicity of aliphatic and aromatic amines), carbylamine reaction, conversion of amine to alkene (Hofmann's elimination with mechanism and stereochemistry), acylation and reaction with nitrous acid. Electrophilic substitution reactions of aniline: Halogenation, nitration and sulphonation. Preparation and uses sulpha drugs – Structural formula of sulphapyridine, sulphadiazine, sulphathiazole and sulphaguanidine. Separation of amines by Hinsberg's method.

Diazonium Salts: Preparation and synthetic applications of benzene diazonium chloride. Preparation of methyl orange - Reason for its colour change with pH.

Carbonic Acid Derivatives: Preparation and properties of urea and semicarbazide – Estimation of urea (hypobromite method and urease method) - Basicity of guanidine.

Module VIII: Heterocyclic & Active Methylene Compounds (6 hrs)

Heterocyclic Compounds: Classification – Nomenclature - Preparation and properties of furan, pyridine and indole.

Active Methylene Compounds: Examples – Preparation of ethyl acetoacetate by Claisen condensation (mechanism expected) - Tautomerism - Synthetic applications of ethylacetoacetate.

Text Books

1. L.G. Wade Jr., *Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
2. A. Bahl and B.S. Bahl, *Advanced Organic Chemistry*, 1st Multicolour Edition, S. Chand & Company, New Delhi, 2010.
3. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
4. C.N. Pillai, *Organic Chemistry for Undergraduates*, 1st Edition, University Press, Hyderabad, 2008.
5. S.C. Sharma and M.K. Jain, *Modern Organic Chemistry*, Vishal Publishing Company, New Delhi, 2014.

References

1. J. Clayden, N. Greeves and S. Warren, *Organic Chemistry*, 2nd Edition, Oxford University Press, New York, 2012.
2. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
3. V.K. Ahluwaliya, *Organic Reaction Mechanisms*, 4th Edition, Narosa Publishing House, New Delhi, 2013 (Reprint).
4. John McMurry, *Fundamentals of Organic Chemistry*, 5th Edition, Brooks/Cole, Pacific Grove, California, 2002.
5. I.L. Finar, *Organic Chemistry Vol. I*, 5th Edition, Pearson Education, New Delhi, 2013.
6. G.M. Louden, *Organic Chemistry*, 4th Edition, Oxford University Press, New York, 2008.
7. Jerry March, *Advanced Organic Chemistry*, 5th Edition, John Wiley and Sons, New York, 2004.
8. R.T. Morrison, R.N. Boyd, *Organic Chemistry*, 7th Edition, Pearson Education, New Delhi, 2013.
9. T.L. Gilchrist, *Heterocyclic Chemistry*, 3rd Edition, Pearson Education, New Delhi, 1997.

SEMESTER V

Course Code: CHE5B08
Core Course VIII: PHYSICAL CHEMISTRY - II
Total Hours: 72; Credits: 3; Hours/Week: 4

Module I: Kinetics & Catalysis (12 hrs)

Kinetics: Chemical kinetics and its scope - Rate of a reaction - Factors influencing the rate of a reaction - Rate law - Order and molecularity - Derivation of rate constants for first, second (with same and different reactants), third (with same reactants only) and zero order reactions with examples (graphical representations needed) - Half life period (derivation for first and n^{th} order reactions) - Methods to determine the order of a reaction - Steady state approximation - Parallel reactions, opposing reactions, consecutive reactions and chain reactions with examples (elementary idea only) - Effect of temperature on reaction rates - Arrhenius equation - Determination and significance of Arrhenius parameters - Theories of reaction rates - Collision theory - Derivation of rate equation for bimolecular reactions using collision theory - Transition state theory - Expression for rate constant based on equilibrium constant and thermodynamic aspects (derivation not required) - Unimolecular reactions - Lindemann mechanism.

Catalysis: Homogeneous and heterogenous catalysis - Theories of homogenous and heterogenous catalysis - Enzyme catalysis - Michaelis-Menten equation (derivation not required).

Module II: Photochemistry (6 hrs)

Introduction - Difference between thermal and photochemical processes - Beer Lambert's law. Laws of photochemistry: Grothus-Draper law and Stark-Einstein's law of photochemical equivalence. Quantum yield and its explanation – Photosynthesis - Photochemical hydrogen-chlorine and hydrogen-bromine reactions. Photophysical processes: Jablonski diagram – Fluorescence – Phosphorescence. Non-radiative processes: Internal conversion and inter system crossing. Photosensitization – Chemiluminescence. Chemistry of vision.

Module III: Adsorption & Colloids (9 hrs)

Adsorption: Introduction - Difference between adsorption and absorption - Chemisorption and physisorption - Factors affecting adsorption. Adsorption isotherms: Freundlich and Langmuir isotherms (derivation required) - Multilayer adsorption - BET equation (derivation not needed) and its applications to surface area measurements. Applications of adsorption.

Colloids: Types and classification - Preparation and purification of colloids - Kinetic, optical and electrical properties of colloids - Protective colloids - Gold number - Hardy-Schulze rule. Emulsions and gels: Properties and applications – Surfactants. Electrical double layer - Zeta potential - Donnan membrane equilibrium - Dorn effect – Applications of colloids.

Module IV: Phase Equilibria (9 hrs)

Introduction - Phase, component and degree of freedom - Gibbs phase rule and its derivation. One component systems: Water and sulphur systems. Two component systems: Simple eutectic system (lead-silver system) - Pattinson's process - Two component systems involving formation of compounds with

congruent melting points (zinc-magnesium system and ferric chloride-water system) - Two component systems involving formation of compounds with incongruent melting points (sodium sulphate-water system). Freezing mixtures - Thermal analysis – Cooling curve method - Deliquescence and efflorescence.

Liquid-liquid equilibria - Partially miscible and immiscible liquid systems – CST - Upper CST and lower CST - Steam distillation. Nernst distribution law: Derivation and applications.

Module V: Chromatography (9 hrs)

Introduction – Definition – Classification - Principles and applications of column chromatography, thin layer chromatography, paper chromatography, ion exchange chromatography, gel permeation chromatography, gas chromatography and high performance liquid chromatography - Rf values.

Module VI: Spectroscopy (18 hrs)

Interaction of electromagnetic radiation with matter - Energy levels in molecules - Born-Oppenheimer approximation.

Rotational Spectroscopy: Introduction - Rigid rotor - Expression for energy - Selection rules - Intensities of spectral lines - Determination of bond lengths of diatomic molecules.

Vibrational Spectroscopy: Simple harmonic oscillator – Energy levels - Force constant - Selection rules – Anharmonicity - Fundamental frequencies – Overtones – Fingerprint region - Group frequency concept - Degree of freedom for polyatomic molecules - Modes of vibrations of CO_2 and H_2O.

Raman Spectroscopy: Basic principles – Qualitative treatment of rotational Raman effect - Vibrational Raman spectra - Stokes & anti-stokes lines and their intensity difference - Selection rules - Mutual exclusion principle.

Electronic Spectroscopy: Basic principles - Frank-Condon principle - Electronic transitions - Singlet and triplet states - Dissociation energy of diatomic molecules – Chromophore and auxochrome - Bathochromic and hypsochromic shifts.

Nuclear Magnetic Resonance (NMR) Spectroscopy: Proton NMR and ^{13}C NMR – Principle - Number and position of signals - Chemical shift - Intensity of signals - Different scales – Spin-spin coupling.

Electron Spin Resonance (ESR) Spectroscopy: Principle - Hyperfine structure - ESR of methyl, phenyl and cycloheptatrienyl radicals.

Module VII: Molecular Symmetry and Group Theory (9 hrs)

Elements of symmetry of molecules – Identity, proper axis of rotation, reflection plane, inversion centre and improper axis of rotation – Schonflies notation – Combinations of symmetry operations – Mathematical group – Point group classification of simple molecules – C_{nv}, C_{nh}, D_{nh}. Group multiplication table for C_{2v}, C_{3v} and C_{2h}.

Text Books

1. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition, Vishal Publishing Company, New Delhi, 2013.
2. F. Daniels and R.A. Alberty, *Physical Chemistry*, 5th Edition, John Wiley & Sons, Canada, 1980.
3. Gurdeep Raj, *Advanced Physical Chemistry*, 35th Edition, Goel Publishing House, Meerut, 2009.
4. S. Glasstone and D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edition, MacMillan & Company, UK, 1962.
5. J. Rajaram and J.C. Kuriacose, *Kinetics and Mechanism of Chemical Transformation*, 1st Edition, Macmillan India Ltd., New Delhi, 1993.
6. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney, *Vogel's Textbook of Quantitative Chemical Analysis*, 5th Edition, John Wiley & Sons, Inc., New York, 1989.
7. C.N. Banwell and E.M. McCash, *Fundamentals* of *Molecular Spectroscopy*, 4th Edition, McGraw–Hill Publishing Company Limited, New Delhi, 2002.
8. Gurudeep R. Chatwal and Sham K. Anand, *Spectroscopy: Atomic and Molecular*, 5th Edition, Himalaya Publishing House, New Delhi, 2013.
9. K. Veera Reddy, *Symmetry & Spectroscopy of Molecules*, 2nd Edition, New Age International, New Delhi, 2009.

References

1. K. Laidler, *Chemical Kinetics*, 3rd Edition, Pearson Education, New Delhi, 2004.
2. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing House, New Delhi, 2012.
3. K.L. Kapoor, *Physical Chemistry Vol. 3&5*, Macmillan Publishers, Noida, 2004.
4. G.K. Vemula Palli, *Physical Chemistry,* Prentice Hall of India, New Delhi, 1997.
5. P.W. Atkins, *Physical Chemistry*, 8th Edition, Oxford University Press, New Delhi, 2006.
6. G.M. Barrow, *Physical Chemistry*, 5th Edition, McGraw Hill, London, 1992.
7. W.J. Moore, *Physical Chemistry*, 5th Edition, Orient Longman, London, 1999.
8. N. Kundu and S.K. Jain, *Physical Chemistry*, S. Chand & Company, New Delhi, 1999.
9. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
10. B.K. Sharma, *Instrumental Methods of Chemical Analysis*, 24th Edition, Geol Publishing House, Meerut, 2005.
11. G.M. Barrow, *Introduction to Molecular Spectroscopy*, McGraw Hill, London, 1962.
12. P.R. Singh and S.K. Dixit, *Molecular Spectroscopy: Principles and Chemical Applications*, S. Chand & Company, New Delhi 1980.
13. P.K. Bhattacharya, *Group Theory and its Chemical Applications*, Himalaya Publishing House, New Delhi, 1986.
14. F.A. Cotton, *Chemical Applications of Group Theory*, 3rd Edition, John Wiley & Sons, New York, 1990.

Course Code: IC6B02

Core Course IX: INDUSTRIAL CHEMISTRY - II

Total Hours: 54; Credits: 3; Hours/Week: 3

Module I (6 Hrs)

Historic Background, Development of pharmaceutical industry in India, Brief idea on IP,BP,USP,EP, and NF. Pharmaceutical jurisprudence. Brief idea on GMP and SOP's., NABL

Module II (7 Hrs)

Pharmacognosy - Introduction to plant classification and crude drugs. Cultivation, collection, preservation and storage of medicinal plants. Identification of plants –microscopic examination –leaf content and paliside ratio, stomatal number – stomatal index, vein islet number vein termination number – crude fiber content.

Evaluation of crude drugs- Loss of drying at 105 ° C. ash content – acid insoluble ash-sulphated ash-moisture content- extractive value – volatile oil content foreign organic matter. Microscopic examination and estimation of starch.

Module III (11 Hrs)

Phytochemistry – Introduction to phytochemistry –fats -different types of waxes volatile oils – saponins -flavones – flavanoids - tannins glycosides and alkaloids- Isolation procedures for active ingredients – Vinca alkaloid - deosgenin.

Module IV (10 Hrs)

Pharmaceutical Quality Control and Preparation:- Sterility testing pyrogen testing glass testing bulk density of powders. Asceptic condition –need for sterilization - different methods of sterilization. Different routes of drug administration – formulation of drugs – ointments, tablets - capsules – syrup I. P - elixirs, injectables, isotonic solutions Eye preparation.

Module V (20 Hrs)

Various types of drugs with examples. Basic raw materials, Process of manufacture, mode of action and efficient handling of the following bulk drugs - Sulfa drugs (Sulfamethoxasole) - Anti Microbial Agents

(Chloramphenicol, Furazlidine) - Anti Tubercular drugs (Isoniacid, Rifampicin) Analgesics (Salicylic Acid, Paracetamole)-NSAIDS (Ibuprofen, Mefenamic acid) - Steroidal Hormones (progestrone, testostereone), β - blockers (propranalol, atenalol) - Cardio Vascular agents (methyl dopa, Heparin) - Antihistamines (chloropheneramine maleate, citracene hydrochloride), Anti viral drugs (acilovir)

References:

1. IP , NF

2. Medicinal Chemistry –V K Ahluvalia, Madhu Chpora- Ane books put Ltd –(Page 1 to 19).

3. Pharmacognosy –Mohammed Ali

4. Pharmaceutical Jurisprudence – M K Jain

5. Pharmaceutical Chemistry – Kapoor and Kapoor

6. Experimental Methods in chemical analysis

7. Industrial Chemistry – B K Sharma

8. Environmental Chemistry -S S Dara

9. Text book of pharmaceutical organic chemistry –Mohammed Ali - CBS Publishers

10. Text book of pharmaceutical organic chemistry- Jayasree Gosh

11. Organic Pharmaceutic Chemistry- Harkishan singh and v K Kapoor

SEMESTER VI

Course Code: IC6B03
Core Course X: INORGANIC CHEMISTRY - III
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Analytical Chemistry - II (6 hrs)

Qualitative Analysis: Applications of solubility product and common ion effect in the precipitation of cations – Interfering acid radicals and their elimination (oxalate, fluoride, borate, phosphate, chromate, arsenite and arsenate) - Introduction of micro scale experiments in inorganic and organic qualitative analysis & their advantages.

Gravimetric analysis - Co-precipitation and post precipitation - Accuracy and precision – Classification and minimization of errors - Sampling and its types (elementary idea only).

Module II: Representative Elements - I (9 hrs)

Hydrogen: Position in the periodic table – Isotopes of hydrogen (separation method not needed) – Difference between *ortho* and *para* hydrogen.

Alkali and Alkaline Earth Metals: Comparative study based on electronic configuration, oxidation state, size, density, melting point, boiling point, electrode potential, ionization energy, metallic character, flame colour and hydration enthalpy - Reactivity with oxygen and water – Thermal stability and solubility of sulphates and carbonates – Basicity of hydroxides - Anomalous properties of lithium and beryllium - Diagonal relationship between lithium and magnesium & beryllium and aluminium - Preparation and uses of sodium carbonate and plaster of Paris - Structure of $BeCl_2$.

Boron Family: Electronic configuration, size, melting point, boiling point, density, standard electrode potential, ionization energy, electronegativity and oxidation state - Inert pair effect - Reactivity with water, hydrogen and halogen – Comparison of Lewis acidity of boron halides - Anomalous behavior of boron - Diagonal relationship between boron and silicon - Preparation, properties, structure and uses of diborane, boric acid, borazine and boron nitride – Structure of $AlCl_3$.

Carbon Family: Electronic configuration, catenation, size, melting point, boiling point, density, standard electrode potential, ionization energy, electronegativity and oxidation state - Inert pair effect - Reactivity with water, hydrogen and halogen - Allotropy – Structure and hybridization of diamond and graphite – Fullerenes (mention only) – Amorphous carbon. Anomalous properties of carbon.

Module III: Representative Elements - II (12 hrs)

Nitrogen Family: Electronic configuration, size, ionization energy, electronegativity, oxidation state, atomicity and allotropy - Hydrides (comparison of boiling point, reducing property, basic strength and bond angle) – Structure of oxides N and P - Oxy acids of N and P (structure and acidic strength only) – Anomalous properties of nitrogen - Preparation, properties and uses of ammonia and nitric acid.

Oxygen Family: Electronic configuration, size, ionization energy, electronegativity, oxidation state and atomicity - Hydrides (comparison of boiling point and bond angle) – Structure of SO_2 and SO_3 - Oxy and peroxy acids of sulphur (structure and acidic strength only) – Anomalous properties of oxygen -

Preparation, properties, structure and uses of ozone, hydrogen peroxide and sulphuric acid – Role of selenium in xerography.

Halogens: Electronic configuration, size, electron affinity, standard reduction potential, bond energy, electronegativity and oxidation state - Hydrides (acidic strength, reducing property and boiling point) – Oxy acids of chlorine (structure and acidic strength only) – Structure of ClO_2 – Electropositive character of iodine - Anomalous properties of fluorine - Preparation and uses of hydrochloric acid - General preparation and properties of interhalogen compounds (study of individual members not required) – Structure and hybridization of ClF_3, ICl_3 and IF_5 - Comparison of properties of halogens and pseudohalogens (cyanogen as example) – Structure of polyhalide ions.

Noble Gases: Discovery – Occurrence – Separation by charcoal adsorption method - Structure of oxides, fluorides and oxy fluorides of xenon - Reaction of xenon fluorides with water – Uses of noble gases.

Module IV: Inorganic Polymers & Non-aqueous Solvents (9 hrs)

Inorganic Polymers: Structure and applications of silicones and silicates. Phosphazenes: Preparation, properties and structure of di and tri phosphonitrilic chlorides. SN compounds: Preparation, properties and structure of S_2N_2, S_4N_4 and $(SN)_x$.

Non-aqueous Solvents: Classification - General properties - Self ionization and leveling effect – Reactions in liquid ammonia and liquid SO_2.

Module V: Environmental Pollution (12 hrs)

Air pollution: Major air pollutants - Oxides of carbon, nitrogen and sulphur - Particulates – London smog and photochemical smog. Effects of air pollution: Acid rain, green house effect and depletion of ozone. Control of air pollution - Alternate refrigerants. Bhopal Tragedy (a brief study).

Water pollution: Water pollution due to sewage and domestic wastes – Industrial effluents – Agricultural discharge – Eutrophication. Quality of drinking water - Indian standard and WHO standard. Water quality parameters: DO, BOD and COD – Determination of BOD and COD. Toxic metals in water (Pb, Cd and Hg) - Minamata disaster (a brief study). Control of water pollution - Need for the protection of water bodies.

Thermal pollution, noise pollution and radioactive pollution (Sources, effects and consequences) - Hiroshima, Nagasaki and Chernobyl accidents (a brief study).

Local environmental movements: Silent Valley, Plachimada, Narmada.

Pollution Control Board: Duties and responsibilities.

Module VI: Solid Waste Management (6 hrs)

House hold, municipal and industrial solid waste - Non-degradable, degradable and biodegradable waste – Hazardous waste - Pollution due to plastics. Solid waste management: Recycling, digestion, dumping, incineration, land treatment and composting. Impacts of medical waste and E-waste & their disposal. Energy production from waste.

Text Books

1. A.I. Vogel, *A Textbook of Quantitative Inorganic Analysis*, 3rd Edition, Longmans, Green, London, 1962.
2. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
3. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, Oxford University Press, New Delhi 2008.
4. P.L. Soni and Mohan Katyal, *Textbook of Inorganic Chemistry*, 20th Edition, S. Chand and Sons, New Delhi, 2013.
5. R. Gopalan, *Inorganic Chemistry for Undergraduates,* Universities Press, Hyderabad, 2009.
6. S.S. Dara, *A Textbook of Environmental Chemistry and Pollution Control*, 8th Edition, S. Chand and Sons, New Delhi, 2008 (Reprint).
7. B.K. Sharma and H. Kaur, *Environmental Chemistry*, Goel Publishing House, Meerut, 1996.

References

1. J. Mendham. R.C. Denney, J.D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
3. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity*, 4th Edition, Pearson Education, New Delhi, 2013.
4. B. Doughlas, D.H. McDaniel and J.J. Alexander, *Concepts and Models in Inorganic Chemistry*, 3rd Edition, John Wiley and Sons, New York, 1994.
5. D.F. Shriver and P. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press, New York, 2010.
6. Gary L. Miessler, Paul J. Fischer and Donald A. Tarr, *Inorganic Chemistry*, 5th Edition, Prentice Hall, New Jersey, 2013.
7. Wahid U. Malik, G.D. Tuli and R.D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010 (Reprint).
8. Gurudeep Raj, *Advanced Inorganic Chemistry Vol-I*, 33rd Edition, Krishna Prakashan Media (P) Ltd., Meerut, 2014.
9. Gurudeep Raj, *Advanced Inorganic Chemistry Vol-II*, 31st Edition, Krishna Prakashan Media (P) Ltd., Meerut, 2008.
10. A.G. Sharpe and H.J. Emeleus, *Modern Aspects of Inorganic Chemistry*, 4th Edition, UBs Publisher's Distributors Ltd., New Delhi, 2000.
11. A.K. De., *Environmental Chemistry*, 6th Edition, New Age International (P) Ltd., New Delhi, 2006.
12. A.K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.

SEMESTER VI

Course Code: CHE6B11
Core Course XI: PHYSICAL CHEMISTRY - III
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Electrochemistry – I (12 hrs)

Faraday's laws and applications – Conductance - Specific conductance, molar conductance and equivalent conductance - Measurement of equivalent conductance - Variation of conductance with dilution - Migration of ions and Kohlrausch's law - Arrhenius theory of electrolyte dissociation and its limitations - Weak and strong electrolytes - Ostwald's dilution law, its uses and limitations - Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only) - Debye-Falkenhagen and Wein effects - Transport number and its determination by Hittorf's and moving boundary methods. Applications of conductivity measurements: Determination of degree of dissociation, ionic product of water and solubility product of sparingly soluble salts - Conductometric titrations.

Module II: Electrochemistry – II (15 hrs)

Galvanic cells - Reversible cells - Reversible electrodes - Types of reversible electrodes - Reference electrodes - Standard hydrogen electrode, calomel electrode and quinhydrone electrode - Standard electrode potential - Electrochemical series - Nernst equation for electrode potential and EMF of a cell - Relationship between free energy and electrical energy - Gibbs Helmholtz equation to galvanic cells. Concentration cells: Concentration cells with and without transference - Liquid junction potential. Application of EMF measurements: Solubility of sparingly soluble salts - Determination of pH - pH measurement using glass electrode - Potentiometric titrations - Hydrogen-oxygen fuel cell - Electrochemical theory of corrosion of metals.

Module III: Ionic Equilibria (6 hrs)

Theories of acids and bases: Arrhenius, Lowry-Bronsted and Lewis theories – Levelling and differentiating solvents – pKa, pKb and pH - Applications of common ion effect and solubility product – Hydrolysis of salts of all types – Degree of hydrolysis - Hydrolysis constant and its relation with k_w. Buffer solutions – Mechanism of buffer action - Buffer index – Henderson equation – Applications of buffers.

Module IV: Solutions (6 hrs)

Kinds of solutions - Solubility of gases in liquids – Henry's law and its applications - Raoult's law - Ideal and non ideal solutions - Dilute solutions - Colligative properties - Qualitative treatment of colligative properties - Relative lowering of vapour pressure - Elevation of boiling point - Depression in freezing point - Osmotic pressure - Reverse osmosis and its applications - Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) - Abnormal molecular mass – Van't Hoff factor.

Module V: Solid State – I (12 hrs)

Nature of solid state – Amorphous and crystalline solids - Law of constancy of interfacial angles - Law of rational indices - Space lattice and unit cell - Miller indices - Seven crystal systems and fourteen Bravais lattices - X-ray diffraction - Bragg's law (derivation required) - Simple account of rotating crystal method and powder pattern method - Analysis of powder patterns of NaCl, CsCl and KCl - Simple, face centered and body centered cubic systems - Identification of cubic crystals from inter-planar ratio - Close packing of spheres - Structure of simple ionic compounds of the type AB (NaCl and CsCl) and AB_2 (CaF_2).

Module VI: Solid State – II (3 hrs)

Defects in crystals. Stoichiometric defects: Schottky and Frenkel defects. Non-stoichiometric defects: Metal excess, deficiency and impurity defects. Semi conductors: Intrinsic and extrinsic conduction (elementary idea). Liquid crystals: Classification and applications (elementary idea).

Text Books

1. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition, Vishal Publishing Company, New Delhi, 2013.
2. P.L. Soni, O.P. Dharmarha and U.N. Dash, *Textbook of Physical Chemistry*, 23rd Edition, Sultan Chand & Sons, New Delhi, 2011.
3. S. Glasstone, *An Introduction to Electrochemistry,* East-West Press Pvt. Ltd., New Delhi, 2007 (Reprint).
4. Gurdeep Raj, *Advanced Physical Chemistry*, 35th Edition, Goel Publishing House, Meerut, 2009.
5. S. Glasstone and D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edition, Macmillan & Company, New York, 1962.
6. C.N.R. Rao and J. Gopalakrishnan, *New Directions in Solid State Chemistry*, 2nd Edition, Cambridge University Press, Cambridge, 1997.

References

1. J. Bockris, O'M and A.K.N. Reddy, *Modern Electrochemistry*, Kluwer Academic/Plenum Publishers, New York, 2000.
2. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing House, New Delhi, 2012.
3. K.L. Kapoor, *Physical Chemistry*, Macmillan Publishers, Noida, 2004.
4. G.K. Vemula Palli, *Physical Chemistry,* Prentice Hall of India, New Delhi, 1997.
5. P.W. Atkins, *Physical Chemistry*, 8th Edition, Oxford University Press, New Delhi, 2006.
6. G.M. Barrow, *Physical Chemistry*, 5th Edition, McGraw Hill, London, 1992.
7. W.J. Moore, *Physical Chemistry*, 5th Edition, Orient Longman, London, 1999.
8. S.H. Maron and C.F. Pruton, *Principles of Physical Chemistry*, Macmillan Company, New York, 1968.
9. F. Daniels and R.A. Alberty, *Physical Chemistry*, 5th Edition, John Wiley and Sons, Canada, 1980.
10. L.V. Azaroff, *Introduction to Solids*, Tata McGraw Hill Publishing Company, New Delhi, 1960.

SEMESTER VI

Course Code: IC6B04
Core Course XII: ADVANCED AND APPLIED CHEMISTRY
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Nanochemistry (6 hrs)

Historical introduction to nanochemistry - Nanosize domain - Classification of nanomaterials (0D, 1D and 2D) - Size dependence of material properties - Surface area to volume ratio and its significance - Variation in electronic and optical properties. Introduction to metal nanoparticles (gold, silver and platinum nanoparticles), semiconductor nanoparticles or quantum dots (CdS and CdSe nanoparticles) and metal oxide nanoparticles (zinc oxide, iron oxide, silica and titania nanoparticles). Carbon nanostructures: Fullerenes, carbon nanotubes and graphene (elementary idea only). Applications of nanomaterials in electronics, optics, catalysis, medicine and in environment related issues (detailed discussion not required).

Module II: New Vistas in Chemistry (9 hrs)

Green Chemistry: Introduction - Environmental concern on chemical industry and need of green chemistry – Origin of green chemistry – Twelve principles of green chemistry with explanations - Atom economy and microwave assisted reactions - Green solvents - Green synthesis of ibuprofen. Microwave and ultrasound assisted green synthesis: Aldol condensation, Diels-Alder reaction and Williamson's synthesis.

Supramolecular Chemistry: Introduction – Concepts of primary and secondary structures with examples (structures of protein and DNA) - Molecular recognition - Host-guest interactions - Types of non-covalent interactions.

Combinatorial Chemistry: Introduction – Combinatorial synthesis (elementary idea only). Applications of combinatorial synthesis in drug discovery (brief study).

Module III: Introduction to Computational Chemistry (6 hrs)

General Introduction to Computers: Operating systems and programming languages (basic idea only).

Excel Spread Sheets: Basic operations, functions, charts and plots - Linear and non-linear regression - Curve fitting.

Conceptual Background of Molecular Modeling: Molecular mechanic (force field) and molecular orbital (*ab initio* and semi-empirical) methods for molecular geometry optimization and computation of basic molecular properties (elementary idea only).

Module IV: Coordination Chemistry (15 hrs)

Bonding theories: Review of Werner's theory and Sidgwick's concept of coordination – EAN rule - Valence bond theory - Geometries of coordination numbers 4 and 6 – Structural and stereo isomerism in coordination compounds. - Limitations of VBT. Crystal filed theory - Splitting of *d*-orbitals in octahedral, tetrahedral, tetragonal and square planar complexes – Factors affecting crystal field splitting - CFSE of low spin and high spin octahedral complexes - Spectrochemical series - Explanation of

geometry, magnetism and colour - Merits and demerits of Crystal field theory. Molecular orbital theory for octahedral complexes (with sigma bonds only).

Stability of complexes: Inert and labile complexes - Factors influencing stability.

Application of complexes in qualitative and quantitative analysis.

Module VI: Structure Elucidation Using Spectral Data (9 hrs)

Application of spectral techniques in the structural elucidation of organic and inorganic compounds.

UV-Vis: λ_{max} calculation for dienes and α,β unsaturated carbonyl compounds - UV spectra of butadiene, acetone, methyl vinyl ketone and benzene.

IR: Concept of group frequencies - IR spectra of alcohols, phenols, amines, ethers, aldehydes, ketones, carboxylic acids, esters and amides.

^1H NMR: Chemical shift – Spin-spin splitting - PMR spectra of $CHBr_2CH_2Br$, ethyl alcohol, acetaldehyde, acetone, propanoic acid and toluene

Module VII: Applied Organic Chemistry – II (9 hrs)

Cosmetics: Chemicals used in and health effects of hair dye, perfumes, antiperspirants, cleansing creams (cold creams, vanishing creams and bleach creams), sun screen preparations, UV absorbers, skin bleaching agents, depilatories, nail polishes, lipsticks and eye liners - Turmeric and Neem preparations - Vitamin oil. Harmful effects of cosmetics.

Pesticides: Insecticides, herbicides, rodenticides and fungicides (definition and examples) – Structure of Endosulfan, DDT and BHC - Harmful effects of pesticides. Endosulfan disaster in Kerala (brief study).

Food Chemistry: Common food adulterants in various food materials and their identification: Milk, vegetable oils, tea, coffee powder, rice and chilly powder. Methods of preservation: Drying, pasteurization, refrigeration, vacuum packing, use of salt and pickling. Food additives: Food preservatives, artificial sweeteners and antioxidants (definition and examples, structures not required) - Structure of BHT, BHA and Ajinomoto – Common permitted and non-permitted food colours (structures not required) – Artificial ripening of fruits and its health effects. Modern food: Definition and health effects of fast foods, instant foods, dehydrated foods, junk foods and condiments - Composition and health effects of chocolates and soft drinks. Harmful effects of modern food habits. Natural food: Composition and advantages of milk - Importance of regional and seasonal fruits – Composition, importance and medical uses of coconut water and Neera - Advantages of traditional Kerala foods.

Text Books

1. M.A. Shah and Tokeer Ahmad, *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House, New Delhi, 2010.
2. V.K. Ahluwaliya, *Green Chemistry*, Narosa Publishing House, New Delhi, 2011.
3. P.S. Kalsi and J.P. Kalsi, *Bioorganic, Bioinorganic and Supramolecular Chemistry*, 1st Edition, New Age International Publishers (P) Ltd., New Delhi, 2007.
4. W. Bannwarth and B. Hinzen, *Combinatorial Chemistry - From Theory to Application*, 2nd Edition, Wiley-VCH, 2006.

5. E. Joseph Billo, *Excel for Chemists - A Comprehensive Guide*, 3rd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2011.
6. Andrew R. Leach, *Molecular Modelling: Principles and Applications*, 2nd Edition Prentice Hall, 2001.
7. V.R. Gowarikar, *Polymer Chemistry*, New Age International (P) Ltd., New Delhi, 2010.
8. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
9. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
10. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
11. M.S.R. Winter, *A Consumer's Dictionary of Cosmetic Ingredients*, 7th Edition, Three Rivers Press, New York, 2009.
12. H.S. Rathore and L.M.L. Nollet, *Pesticides: Evaluation of Environmental Pollution*, CRC Press, USA, 2012.
13. B. Srilakshmi, *Food Science*, 5th Edition, New Age Publishers, New Delhi, 2010.
14. Satya Prakash, *Advanced Inorganic Chemistry*, *Volume 2*, S. Chand and Sons, New Delhi, 2005.
15. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, Oxford University Press, New Delhi 2008.
16. R. Gopalan and V. Ramalingam, *Concise Coordination Chemistry*, 1st Edition, Vikas Publishing House, New Delhi, 2001.
17. Wahid U. Malik, G.D. Tuli and R.D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010 (Reprint).
18. I.L. Finar, *Organic Chemistry Vol. II*, 5th Edition, Pearson Education, New Delhi, 2013.
19. R.M. Silverstein and F.X. Webster, *Spectrometric Identification of Organic Compounds*, 6th Edition, John Wiley and Sons, New York, 2004.
20. Y.R. Sharma, *Elementary Organic Spectroscopy*, 4th Edition, S. Chand & Company Ltd., New Delhi, 1012 (Reprint).

References

1. T. Pradeep**,** *A Textbook of Nanoscience and Nanotechnology*, McGrawhill, New Delhi, 2012.
2. V.S. Muralidharan and A. Subramania, *Nano Science and Technology*, CRC Press, London, 2008.
3. Andrew P. Dicks, *Green Organic Chemistry in Lecture and Laboratory*, CRC Press, University of Toronto, Ontario, Canada, 2011.
4. M. Kirchhoff and M. Ryan, *Greener Approaches to Undergraduate Chemistry Experiments*, American Chemical Society, Washington, DC, 2002.

5. Helena Dodziuk, *Introduction to Supramolecular Chemistry*, Springer, New York, 2002.
6. A.W. Czarnik and S.H. DeWitt, *A Practical Guide to Combinatorial Chemistry*, 1st Edition, American Chemical Society, 1997.
7. John Walkenbach, *Excel 2013 Formulas*, 1st Edition, Wiley, New York, 2013.
8. S. Wilson, *Chemistry by Computer: An Overview of the Applications of Computers in Chemistry*, Plenum Publishing, New York, 1986.
9. Fred W. Billmeyer, Jr., *Textbook of Polymer Science*, 3rd Edition, John Wiley & Sons, Singapore, 1994.
10. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Edition, S. Chand and Company Ltd., New Delhi, 1999.
11. G. Thomas, *Fundamentals of Medicinal Chemistry,* John Wiley & Sons Ltd., 2006.
12. B. Siva Sankar, *Food Processing and Preservation,* Prentice–Hall of India Pvt. Ltd., New Delhi, 2002.
13. F.A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edition, Wiley India Pvt. Ltd., New Delhi, 2009 (Reprint).
14. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity*, 4th Edition, Pearson Education, New Delhi, 2013.
15. D.F. Shriver and P. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press, New York, 2010.

SEMESTER VI

Course Code: IC6B05 (E1)

Core Course XIII: Elective 1. Medicinal Chemistry and Drug Development

Total Hours: 54; Credits: 3; Hours/Week: 3

Module I (24 Hrs) Drug design and development –

Concept of drug -discovery of a drug, discovery of Librium, discovery of penicilin –discovery of lead compounds and lead modification. prodrugs and soft drugs; Random Screening –non random screening Structure-activity relationship (SAR), quantitative structure-activity relationship (QSAR); The Hammet equation –Taft equation- The pharmacophore identification modification structural - functional groups structural modification to increase potency. Homologation, chain branching, ring chain transformation – extension of structures –Isosters/ bio – isosters

Factors affecting bioactivity – resonance, inductive effect, isosterism, bio-isosterism, spatial considerations; Theories of drug activity –occupancy theory, rate theory, induced fit theory Concept of drug receptors – elementary treatment of drug-receptor interactions;

Drug Targets - Receptors –Enzymes- Nucleic Acids -Non-receptor targets Physico-chemical parameters – lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials; Factors affecting modes of drug administration, absorption, metabolism and elimination; Significance of drug meta-bolism in medicinal chemistry.

Drug designing using QSAR computer assistant design –application of other modeling techniques.

Module II Introduction to Pharmacopoeias (20 Hours)

Dosage Forms: Dosage forms and their classification on the basis of physical state with important characteristics: Solid Dosage forms including powders, capsules, cachets, Pills, tablets and suppositories.
Liquid dosage forms including collodions, aromatic waters, inhalations, injections, lotions, mouth washes, nasal drops and ophthalmic drops.
Sterilization: Need for sterilization, sterilization by heat processes viz sterilization by dry heat using hot air oven, flaming and I.R. radiations. Moist heat sterilization processes including autoclaving, heating with bactericide, Tantalization or fractional sterilization.

Module III-(6 hours) Pharmaceutical excipients. Glidants, lubricants, diluents, preservatives, antioxidants –emulsifying agents –coating, colouring and flavoring agents –binders viscosity builders –gelatin, use of sorbitol, mannitol and liquid glucose. Surgical dressings sutures, ligatures –pharmaceutical packaging –selection of packaging –packaging material auxiliary materials – packaging machinery quality control of packaging materials.

Module IV (4Hrs) Legal aspects of drugs: Important FDA , WHO Schedules, IPR, Patents (brief idea only)

1. A text book of pharmaceutics- Nirali Prakashan.
2. Burger. Medicinal Chemistry and Drug Discovery, Vol-1, Ed. M. E. Wolff, John Wiley (1994).
3. Goodman & Gilman. Pharmacological Basis of Therapeutics, McGraw-HilI (2005).
4. S. S. Pandeya & J. R. Dimmock.Introduction to Drug Design, New Age International.(2000).
5. D. Lednicer. Strategies for Organic Drug Synthesis and Design, John Wiley (1998).
6. Graham & Patrick. Introduction to Medicinal Chemistry (3 rd edn.), OUP (2005).
7. Wilson and Gisvold's Textbook of Organic Medicinal & Pharmaceutical Chemistry, Block & Beale, Eds.,11th Ed. 2004.
8. Foye's Principles of Medicinal Chemistry, Williams & Lemke, Eds., 5th Ed. 2002.
9. Burger's Medicinal Chemistry and Drug Discovery,Abraham, Ed., 6th Ed., 2003.
10. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.

SEMESTER VI

Course Code: IC6B05(E2)

Core Course XIII: Elective 2. Introduction to Cheminformatics

Total Hours: 54; Credits: 3; Hours/Week: 3

Course Objective

• The course objectives are to introduce different methods of cheminformatics with particular
emphasis on applications including modern drug discovery.

Course Outcome

• The course will introduce the students preparing for professional work in chemistry must learn how to retrieve specific information from the enormous and rapidly expanding chemical literature.
• The course will provide a broad overview of the computer technology to chemistry in all of its manifestations
• The course will expose the student to current and relevant applications in QSAR and Drug Design.

Module I Introduction to Cheminformatics: 3 hrs
Introduction to cheminformatics, History and Evolution of
cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and Structure Elucidation

Module II Representation of Molecules and Chemical Reactions 7 hrs
Representation of Molecules and Chemical Reactions: Nomenclature; Different types of Notations; SMILES coding; Matrix Representations; Structure of Molfiles and Sdfiles; Libraries and toolkits; Different electronic effects; Reaction classification

Module III. Database Design & their Management. 10 hrs
Database Concepts. Structured Query Language. Design of Chemical Databases, Data Abstraction; Data Models; Instances & Schemes; E-R Model - Entity and entity sets; Relations and relationship sets; E-R diagrams; Reducing E-R Diagrams to tables; Network Data Model: Basic concepts; Hierarchical Data Model: Basic Concepts; Metadatabases; Indexing and Hashing; Basic concepts; Text Databases; Introduction to Distributed Database Processing, Data Security. Intefacing programs with databases;

Structure databases; Reaction Databases; Literature Databases; Medline;GenBank; PIR; CAS Registry; NIH and National Cancer Institute (NCI) Database

Module IV 5 hrs
Searching Chemical Structure: Full structure search; sub structure search; basic ideas; similarity search; Three dimensional search methods; Basics of Computation of Physical and Chemical Data and structure descriptors; Data visualization.

Module V Applications Prediction of Properties of Compounds 7 hrs

Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Model Building; Modeling Toxicity; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design,
Module VI Virtual screening 10 hrs
Computer Assisted Virtual screening design: Structure Based Virtual Screening- Protein Ligand
Docking, Scoring Functions for Protein Ligand docking, Practical aspects of structure based Virtual
Screening; Prediction of ADMET Properties, 2 D and 3D data searching, Chemical databases, Role of
computers in Chemical Research.

Module VII Application of Cheminformatics in Drug Design 12 hrs
Application of Cheminformatics in Drug Design: Quantitative Structure-Property Relations;
Descriptor Analysis; Computer Assisted Structure elucidations; Target Identification and Validation;
Lead Finding and Optimization; Analysis of HTS data; Design of Combinatorial Libraries; Ligand- Based and Structure Based Drug design

Assignments will involve practical using free software

Text Book
1 Andrew R. Leach, Valerie J. Gillet, Cluwer , Introduction to Cheminformatics, Academic Publisher, Netherlands, 2003

Reference Books
1. Lisa B. English (Editor), Combinatorial Library Methods and Protocols, Humana Press Inc, Volume:201, 2002
2. Frank Jensen, Introduction to Computational Chemistry, Wiley Publisher, Second Edition, 2006

SEMESTER VI

Course Code:IC6B06(P)
Core Course XIV: ORGANIC ANALYSIS AND GRAVIMETRY
Total Hours: 90; Credits: 4; Hours/Week: 5 (Semester V)

General Instructions

1. *Micro scale analysis must be adopted for organic qualitative analysis.*
2. *Use safety coat, goggles, shoes and gloves in the laboratory.*
3. *Reactions must be carried out in tiles, wherever possible.*
4. *A minimum number of 8 organic analysis shall be done to appear for the examination.*
5. *The experiments to be be completed in the 5th semester. Practical examination will be conducted at the end of 6th semester.*
6. *For weighing, either electronic balance (preferred) or chemical balance may be used.*

Module I: Analysis of Organic Compounds

Study of the reactions of functional groups from the following list (also prepare the derivatives).

1. Phenols (phenol, α-naphthol, β-naphthol).
2. Nitro compounds (nitrobenzene, *o*-nitrotoluene).
3. Amines (aniline, N,N-dimethyl aniline).
4. Halogen compounds (chlorobenzene, benzyl chloride, *p*-dichlorobenzene).
5. Aldehydes and ketones (benzaldehyde, acetophenone).
6. Carboxylic acid (benzoic acid, cinnamic acid, phthalic acid, salicylic acid).
7. Carbohydrates (glucose, sucrose).
8. Amides (benzamide, urea).
9. Esters (ethyl benzoate, methyl salicylate).
10. Hydrocarbons (naphthalene, anthracene).

Module II

Gravimetric analysis: Estimations of Water of crystallization of barium chloride ,sulphate, barium, Iron,copper, and Nickel

References

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edition, Pearson Education, Noida, 2014.
2. F.G. Mann and B.C. Saunders, *Practical Organic Chemistry*, 4th Edition, Pearson Education, Noida, 2011.

3. Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2nd Edition, Pearson Education, Noida, 2013.

4. V.K. Ahluwalia and S. Dhingra, *Comprehensive Practical Organic Chemistry*, Universities Press, Hyderabad, 2004 (Reprint).

5. J. Mendham. R.C. Denney, J.D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.

6. D.N Bajpai, O.P. Pandey and S. Giri, *Practical Chemistry for I, II & III B. Sc. Students*, S. Chand & Company Ltd., New Delhi, 2012 (Reprint).

7. V.K. Ahluwalia, Sunita Dhingra and Adarsh Gulati, *College Practical Chemistry*, Universities Press (India) Pvt. Ltd., Hyderabad, 2008 (Reprint).

SEMESTER VI

Course Code: IC6B07(P)
Core Course XV: INORGANIC CHEMISTRY PRACTCAL-II
Total Hours: 90; Credits: 4; Hours/Week: 5

General Instructions

1. *Micro scale analysis must be adopted for inorganic qualitative analysis.*
2. *Mixtures containing more than one interfering anions must be avoided.*
3. *If interfering anions are not present, cations may be given from the same group.*
4. *Use safety coat, goggles, shoes and gloves in the laboratory.*
5. *A minimum of 6 inorganic mixtures and 8 inorganic preparations must be done to appear for the examination.*

Module I: Inorganic Qualitative Analysis

1. Study of the reactions of following ions.
   Anions: Carbonate, sulphate, fluoride, chloride, bromide, iodide, acetate, borate, oxalate, phosphate and nitrate.
   Cations: Lead, bismuth, copper, cadmium, iron, aluminium, cobalt, nickel, manganese, zinc, barium, calcium, strontium, magnesium and ammonium.
1. Systematic analysis of mixtures containing two cations and two anions from the above list.
2. *Elimination of interfering anions:* Fluoride, borate, oxalate and phosphate.

Module II: Inorganic Preparations

1. Ferric alum
2. Potash alum
3. Mohr's salt
4. Nickel(II) dimethylglyoximate
5. Potassium trisoxalatoferrate(III)
6. Potassium trioxalatochromate(III)
7. Tris(thiourea)copper(I) sulphate
8. Tetraamminecopper(II) sulphate
9. Microcosmic salt
10. Sodium nitroprusside

References

1. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall, New Delhi, 1996.

2. V.V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd Edition, The National Publishing Company, Chennai, 1974.
3. W.G. Palmer, *Experimental Inorganic Chemistry*, Cambridge University Press, 1970.

SEMESTER VI

Course Code: IC6B08(P)
Core Course XVI: INDUSTRIAL CHEMISTRY PRACTCAL-II
Total Hours: 90; Credits: 4; Hours/Week: 5

Viscometry, refractometry, Polarimetry, Conductometry, Potentiometry. Estimation of aniline, phenol, Glucose.
Non-aqueous titrations-Sodium benzoate, Isoniazid, diazepam, Mebendasole
Limit Test- Chloride, sulphate, iron, lead
Iodine value, Saponification value (Coconut Oil)
Loss of drying of crude drug at 105°C, (Sodium bicarbonate)
Ash Value, Sulphated ash, Acid Insoluble Ash, Total Ash, Ash content, Free alkali in soap ,TFM, Latex analysis- DRC, TSC, Ammonia content

SEMESTER VI

Course Code: IC6B09(P)
Core Course XVII: INDUSTRIAL CHEMISTRY PRACTCAL-II
Total Hours: 90; Credits: 4; Hours/Week: 5

Analysis of alloys- brass, Bronze, Type metal
Assay: Calcium carbonate, Calcium Gluconate, Aspirin, Ascorbic acid, Lactic acidCOD of effluent water, water quality parameters like DO, P H , conductivity refractive index , BOD, bacteriology chromatography(paper or TLC)
Total hardness of water , analysis of bleaching powder
Distillation, Steam distillation, Soxhlet extraction, use of hot water funnel, crystallization, separations using separating funnel (Demonstration only).
Preparation of toilet soap (Cold Process, semi boiled process), Cold cream ,Vanishing cream, Shampoo(Detergent and soap based,) Pain Balm, lipstick , hair dye talcum powder.

SEMESTER VI

Course Code: IC6B10(Pr)
Core Course XVIII: PROJECT WORK
Total Hours: 36; Credits: 2; Hours/Week: 2 (Semester V)

Guidelines

1. Students shall undertake the project work related to industrial chemistry/chemistry.
2. The UG level project work is a group activity, maximum number of students being limited to five. However, each student shall prepare and submit the project report separately.
3. 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.
4. The students must complete the project in the 5^{th} semester. However, the evaluation of the project report will be carried out at the end of 6^{th} semester.
5. Project work can be experimental, theoretical or both.
6. No two groups in the same institution are permitted to do project work on the same problem. Also the project must not be a repetition of the work done by students of previous batches.
7. Each group must submit a copy of the project report to keep in the department.
8. The project report must be hard bound, spiral bound or paper back.
9. 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 suggestions, if any, and Chapter VII: Bibliography.
10. Each student must present the project report before the external examiner during project evaluation.

EVALUATION SCHEME

FOR

CORE COURSES

CORE COURSE THEORY: EVALUATION SCHEME

The evaluation scheme for each course contains two parts: *viz.*, internal evaluation and external evaluation.

1. INTERNAL EVALUATION

20% of the total marks in each course are for internal evaluation. The colleges shall send only the marks obtained for internal examination to the university.

Table 1: Components of Evaluation

Sl. No.	*Components*	*Marks*
1	Attendance	5
2	Test papers: I & II	5 + 5
3	Assignment	2
4	Seminar/ Viva*	3
	Total Marks	20

**Viva:* CHE1B01, CHE2B02, CHE3B03, CHE4B04, CHE5B06, CHE6B10, CHE6B11, CHE6B12 and elective course; *Seminar:* CHE5B07, CHE5B08 and CHE6B09.

Table 2: Percentage of Attendance and Eligible Marks

% of attendance	*Marks*
Above 90%	5
85-89%	4
80-84%	3
76-79%	2
75%	1

Table 3: Pattern of Test Papers

Duration	*Pattern*	*Total number of questions*	*Number of questions to be answered*	*Marks for each question*	*Marks*
1.5 Hours	One word	4	4	1	4
	Short answer	5	4	2	8
	Paragraph	5	3	6	18
	Essay	2	1	10	10
				*Total Marks**	40

*90% and above = 5, 80 to below 90% = 4.5, 70 to below 80% = 4, 60 to below 70% = 3.5, 50 to below 60% = 3, 40 to below 50% = 2, 35 to below 40% = 1, below 35% = 0

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. University examinations will be conducted at the end of each semester.

Table 1: Pattern of Question Paper

Duration	*Pattern*	*Total number of questions*	*Number of questions to be answered*	*Marks for each question*	*Marks*
3 Hours	One word	10	10	1	10
	Short answer	12	10	2	20
	Paragraph	8	5	6	30
	Essay	4	2	10	20
				Total Marks	80

CORE COURSE PRACTICAL: EVALUATION SCHEME

The evaluation scheme for each course contains two parts: *viz.*, internal evaluation and external evaluation.

1. INTERNAL EVALUATION

20% of the total marks in each course are for internal evaluation. The colleges shall send only the marks obtained for internal examination to the university.

Table 1: Components of Evaluation

Sl. No.	*Components*	*Marks*
1	Attendance in the lab	5
2	Punctuality, performance and discipline	4
3	Model tests: I & II	2 + 2
4	Practical Record: Required number of experiments and neatness	4
5	Viva-Voce	3
	Total Marks	20

Table 2: Percentage of Attendance and Eligible Marks

% of attendance	*Marks*
Above 90%	5
85-89%	4
80-84%	3
76-79%	2
75%	1

Table 3: Number of Experiments and Marks for Practical Records

Number of Experiments (Marks in brackets)						
Inorganic Chemistry Practical-I	*Organic & Gravimetry*		*Inorganic Chemistry Practical -II*		*Industrial chemistry*	
	Analysis	*Gravimetry*	*Mixture*	*Preparation*	*Practical I*	*Practical II*
25-28 (4)	9-10 (2)	7-8 (2)	8 (3)	8-10 (1)	12-14(4)	12-14(4)
24 (3)	7-8 (1.5)	6(1.5)	7 (2)		10-11(3)	10-11(3)
23 (2)	6 (1)	5(1)	6 (1)		9(2.5)	9(2.5)
22 (1.5)					8(2)	8(2)
21 (1)					6-7(1)	6-7(1)

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. Practical examinations along with viva-voce will be conducted at the end of 4th and 6th semesters.

PATTERN OF QUESTION PAPERS

Table 1: Inorganic Chemistry Practical - I

Duration	*Pattern*	*Marks*	*Total Marks*
3 Hours	Question on volumetric analysis	8	80
	Procedure	8	
	Result	40	
	Calculation	8	
	Record	8	
	Viva-Voce	8	

Guidelines

1. *Valuation of Volumetric Procedure*: Eight points – 8 marks. 1. Correct intermediate; 2. Preparation of standard solution; 3. Standardisation of intermediate; 4. Indicator and end point of standardization; 5. Making up of given solution; 6. Titration of made up solution; 7. Indicator and end point of estimation; 8. Any other relevant points.
2. *Marks for Result:* For calculating the error percentage both theoretical value and skilled value are considered. The reported values (RV) of the students are compared with theoretical value (TV) and skilled value (SV) to calculate the error percentage. Up to 1.5% error: 40 marks; between 1.51 – 2%: 30 marks; between 2.1 – 2.5%: 20 marks; between 2.51– 3%: 10 marks; greater than 3%: 4 marks.
3. *Marks for Calculation:* Eight points – 8 marks. 1. Equivalent mass of the primary standard substance; 2. Calculation of normality of primary standard; 3. Table for standardization of intermediate with standard substance and indicator at the top; 4. Calculation of normality of the link solution; 5. Table for estimation including standard substance and indicator; 6. Calculation of normality of the given solution; 7. Equivalent mass of the compound/ion in the given solution; 8. Calculation of weight in the whole of the given solution.

Table 3: Organic Chemistry Practical

Duration	*Pattern*	*Marks*	*Total Marks*
3 Hours	Question on organic analysis	8	80
	Procedure for gravimetry	6	
	Organic Analysis	24	
	Gravimetry result	24	
	Calculation	2	
	Record	8	
	Viva-Voce	8	

Guidelines

1. *Organic Analysis:* Aliphatic/aromatic: 1.5 marks, saturated/unsaturated: 1.5 marks, detection of elements: 2 marks, identification test of functional group:3 marks, chemistry of identification test: 2 marks, confirmation test of functional group: 4 marks, chemistry of confirmation test: 2 marks,

suggestion of derivative: 1 mark, method of preparation of the derivative: 1 marks, preparation of derivative suggested by the examiner: 2 marks, chemistry of the derivative preparation: 1 marks, systematic procedure: 3 marks.

2. *Points for Evaluation of Gravimetry Procedure*: Eight points – 6 marks. 1) Making up of the given solution 2) Transferring a definite volume of the made up solution in to a beaker 3) Addition of appropriate reagents 4) Dilution and heating to boiling 5) Precipitation by appropriate reagent and heating to make the precipitate granular 6) Allowing to settle and filtering through quantitative filter paper or previously weighed sintered crucible till the washings are free from ions 7) Incineration in a previously weighed silica crucible or drying the sintered crucible in an air oven 8) Repeating heating, cooling and weighing to constant weight 9) From the weight of precipitate the weight of metal in the given solution can be calculated.
3. *Marks for Gravimetry Result:* The reported value of the student is compared with theoretical value and one skilled value (closer to theoretical value) and error percentage is calculated. Up to 1.5% error: 24 marks; between 1.51 – 2%: 18 marks; between 2.1– 2.5%: 12 marks; greater than 2.51%: 4 marks.

Table 5: Inorganic Chemistry Practical - II

Duration	*Pattern*	*Marks*	*Total Marks*
3 Hours	Question on qualitative analysis	6	80
	Identification tests for ions	12	
	Confirmation tests for ions	12	
	Identification of cation group	2	
	Chemistry of identification tests	6	
	Chemistry of confirmation tests	6	
	Systematic procedure & elimination	3	
	Chemistry of elimination	2	
	Record	8	
	Viva-Voce	8	
	Industrial visit report	15	

Guidelines

1. *Identification Tests:* 4 Marks each for two anions two cations.
2. *Identification of Cation Group:* 1 Mark each.
3. *Confirmation Tests:* 4 Marks each for two anions and two cations.
4. *Chemistry of Identification Tests:* 2 Marks each for two anions and two cations.
5. *Chemistry of Confirmation Tests:* 2 Marks each for two anions and two cations.
6. *Industrial Visit:* Good presentation of any one Chemical Factory / Research centre visit is considered for a maximum of 8 marks. Students are expected to make individual report. So variety must be appreciated. Viva-voce shall be conducted based on the industrial visit.

CORE COURSE PROJECT: EVALUATION SCHEME

Project evaluation will be conducted at the end of sixth semester.

Table 1: Internal Evaluation

Sl. No	*Criteria*	*Marks*
1	Punctuality	2
2	Skill in doing project work	2
3	Project presentation	3
4	Viva-Voce	3
	Total Marks	10

Table 2: External Evaluation

Sl. No	*Criteria*	*Marks*
1	Content and relevance of the project	10
2	Project report	10
3	Project presentation	10
4	Viva-voce	10
	Total Marks	40

MODEL QUESTION PAPERS

FOR

CORE COURSES

FIRST SEMESTER B. Sc. DEGREE EXAMINATION

(UG-CBCSS) Chemistry

CHE1B01; Core Course I: THEORETICAL AND INORGANIC CHEMISTRY - I

Time: 3 Hours **Maximum marks: 80**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. An untested rational explanation of a phenomena generated on the basis of its observation and also previous knowledge is called a ----------
2. A medieval chemical philosophy having the transmutation of base metals into gold as one of its asserted aims was called ----------
3. The first synthesized organic compound is ----------
4. Atoms having different atomic number but the same mass number are called ----------
5. 10 g $CaCO_3$ on heating leaves behind a residue weighing 5.6 g. Carbon dioxide released into the atmospehre at STP will be ----------
6. 4 g of NaOH are dissolved in 90 mL of water. The mole fraction of NaOH in water is --
7. Name an indicator used in complexometric titration.
8. The ionization enthalpy of He^+ is 19.6×10^{-18} J/atm. The energy of the first stationary state of Li^{2+} is ----------
9. The minimum amount of the target material required to sustain a fission chain reaction at a constant rate is called ----------
10. The radiant energy of sun is due to ----------

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. List the different branches of chemistry.
12. What are the components of a research project report?
13. How does scientific hypothesis differ from a scientific theory?
14. Differentiate between molarity and molality.
15. Equivalent mass of $KMnO_4$ in acid medium is 31.6. Justify your answer.
16. Calculate the mass of (a) 2.5 g atom of calcium (b) 1.5 g mol of CO_2.
17. Find out the volume of the following at STP (a) 7 g of nitrogen (b) 6.02×10^{22} molecules of ammonia.
18. Write the nuclear equation for (a) the emission of an α-particle from Th-232 (b) the emission of a β-particle from Ra-228.
19. The half life period of a radionuclide is 4.8 minutes. Calculate its decay constant.
20. How does the nuclear fluid theory explain nuclear forces?
21. HCl is not used to acidify $KMnO_4$ solution in volumetric estimation of Fe^{2+} or $C_2O_4^{2-}$. Why?
22. Calculate the wave length associated with a bullet of mass 1×10^{-3} Kg travelling with a velocity of 3×10^4 m/s.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Differentiate between the terms scientific proof and scientific evidence.

24. What are the objectives of a chemical research?
25. What are redox indicators? Discuss taking a suitable example.
26. Discuss the principles of iodimetric and iodometric titrations.
27. Write short notes on (a) MSDS (b) R & S Phrases
28. What is meant by dual character of an electron? Derive an expression for the wavelength of de Broglie matter waves.
29. (a) Describe radiocarbon dating (b) The amount of ^{14}C present in an old piece of wood is found to be one-sixth of that present in a fresh piece of wood. Calculate the age of the wood. Half life of ^{14}C is 5668 years.
30. Explain with examples how radioisotopes are useful in (a) medical diagnosis (b) radiotherapy.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. Discuss (a) safe laboratory practices (b) treatment for burns due to phenol and bromine (c) disposal of sodium and broken mercury thermometer.
32. What are the postulates of Bohr theory? Derive the Bohr energy and frequency equations.
33. Write notes on (a) Planck's quantum hypothesis (b) Electron diffraction (c) Heisenberg's uncertainty principle.
34. Discuss the principles and salient features of nuclear reactors.

SECOND SEMESTER B. Sc. DEGREE EXAMINATION

(UG-CBCSS) Chemistry

CHE2B02; Core Course II: THEORETICAL AND INORGANIC CHEMISTRY - II

Time: 3 Hours **Maximum marks: 80**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. The kinetic energy part of Hamiltonian operator is ----------
2. 4p orbitals have ---------- radial nodes.
3. The region where there is zero probability of locating the electron between two non-zero probability region is called ----------
4. Sketch the shape of d_z^2 orbital.
5. The most electronegative element in the periodic table is ---------
6. Lithium shows diagonal relationship with ----------
7. The number of pi bonds in acetylene molecule is ----------
8. Among CH_3Cl, CH_2Cl_2 and $CHCl_3$, the dipole moment is maximum for --------
9. A mixture of *o*-nitrophenol and *p*-nitrophenol can be separated by ----------
10. Among B_2, C_2 and N_2 the paramagnetic species is/are ----------

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. What is meant by a well behaved wave function?
12. Write the time independent Schrodinger wave equation and explain the terms.
13. State and explain Aufbau principle.
14. What is the expression for energy of a particle in a one dimensional box? Explain the terms.
15. Ca^{2+} ion is smaller than Ca atom. Why?
16. Electron affinities of noble gases are zero. Why?
17. What are the applications of Born-Haber cycle?
18. Predict the hybridization and shapes of XeF_6, NH_4^+, H_3O^+ and SO_4^{2-}.
19. Write the Born-Lande equation and explain the terms.
20. Discuss any four properties of ionic compounds.
21. What is meant by bond order? What is its significance?
22. Draw the resonance structures of borate, carbonate and nitrate ions. Compare the bond energy.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. What are the postulates of quantum mechanics?
24. Draw the radial probability distribution curves of *2s*, *2p* and *3s* orbitals. Explain.
25. What are Linear and Hermitian operators? Explain.
26. Explain why the ionization energy of transition elements is reasonably constant.
27. Define lattice energy? How is it related to solubility of a compound in water?
28. Discuss the hybridization and structure of (a) ethylene (b) SF_6.
29. Write a note on intermolecular forces.
30. Write the electronic configuration of O_2, O_2^+, O_2^{2+}, O_2^- and O_2^{2-}. Compare their bond length and bond energy.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. What are quantum numbers? Discuss the significance of each quantum number. What are the possible values of l, if $n = 4$.
32. Discuss (a) Electronegativity scales (b) Slater rule and its applications.
33. Discuss in detail Fajan's rule and its applications.
34. Discuss the valence bond theory and band theory of metallic bonding and explain metallic properties based on these theories.

THIRD SEMESTER B. Sc. DEGREE EXAMINATION

(UG-CBCSS) Chemistry

CHE3B03; Core Course III: PHYSICAL CHEMISTRY – I

Time: 3 Hours **Maximum marks: 80**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. For an ideal behaviour, the compressibility factor Z is ----------
2. The temperature below which a gas does not obey ideal gas law is called ----------
3. The maximum efficiency of a steam engine working between 100^oC and 25^oC is -------
4. Entropy of CO at absolute zero is ----------
5. Among volume, temperature, entropy and enthalpy, intensive property is/are ---------
6. The relation between T and P in an adiabatic process is ----------
7. Born-Haber cycle is an application of --------- law.
8. The unit of viscosity in SI system is ----------
9. Surface tension is related to Parachor by the equation ----------
10. The equilibrium constant K_p for the dissociation of PCl_5 is 1.6 at 200^oC. The pressure at which PCl_5 will be 50% dissociated at 200^oC is ------ atm.

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. Calculate the temperature at which O_2 molecule will have the same RMS velocity as CO_2 molecule.
12. Calculate the value of work done when 2g of H_2 expands from a volume of 1 litre to a volume of 10 litres at 27^0C.
13. Write Clapeyron-Clausius equation (integrated form) for liquid-vapour equilibrium and explain the terms.
14. Write Gibbs-Duhem equation and explain the terms.
15. Explain the physical significance of entropy.
16. Define third law of thermodynamics.
17. Calculate the entropy of vapourisation of a liquid which boils at 120^oC. Given enthalpy of vapourisation is 3600 $Jmol^{-1}$.
18. What is optical exaltation?
19. Give the equation for molar refraction of a liquid and explain the terms.
20. Why chemical equilibrium is termed dynamic?
21. State Le Chatelier's principle.
22. What is homogenious equilibrium? Give example.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Derive the relationship between heat capacity at constant volume and constant pressure for an ideal gas.
24. Derive the expressions for critical constants in terms of Vander-Waals constants.

25. Derive the relation between temperature and pressure for an adiabatic process.
26. Calculate the change in freezing point for ice when the pressure is increased by 1 atm. Molar volume of water and ice are 18.0 and 19.6 cm^3 and the enthalpy of fusion for ice is 6008 $Jmol^{-1}$. (IJ = 9.87 x 10^{-3} dm^3.atm.)
27. Discuss the variation of free energy with temperature and pressure.
28. Derive an expression for the relation between entropy and probability?
29. What is Parachor? How is it used for structure elucidation?
30. Derive the relationship between K_p and K_c.

Section D (Essay)

Answer any two question. Each question carries 10 marks

31. What is Joule-Thomson effect? Describe Linde's method and Claude's method for the liquifaction of gases.
32. Derive Gibb's Helmholtz equation. What is its significance?
33. What is Kirchoff`s equation? The enthalpy of reaction for the formation of ammonia from N_2 and H_2 at 25^oC was found to be -91.94 kJ mol^{-1}. What will be the enthalpy of reaction at 50^oC? The molar heat capacities at constant pressure and at 27^oC for nitrogen, hydrogen, ammonia are 28.45, 28.32 and 37.07 joules mol^{-1} respectively.
34. (a) Derive Van't Hoff equation for temperature dependence of equilibrium constant. (b) The equilibrium constant for a reaction is 1×10^5. Calculate the standard free energy change for the reaction in kilojoules at 25^oC.

FOURTH SEMESTER B. Sc. DEGREE EXAMINATION

(UG-CBCSS) Chemistry

CHE4B04; Core Course IV: ORGANIC CHEMISTRY – I

Time: 3 Hours **Maximum marks: 80**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. Propanal and propanone are ---------- isomers
2. The energy difference between staggered and eclipsed conformation of ethane is ----KJ/mol.
3. Most stable conformation of *n*-butane is ---------
4. Homolysis of carbon-carbon bond generates ----------
5. The temporary migration of pi electrons to one of the bonded atom in presence of an attacking reagent is called ----------
6. When isopropyl bromide is warmed with metallic sodium in dry ether, the compound formed is ----
7. When 2-bromo-2-methylbutane is warmed with alcoholic KOH, the major product formed is ----------
8. The electrophile in aromatic sulphonation reaction is ---------
9. What is the product obtained when benzene is first nitrated and then chlorinated?
10. Write the structural formula of 9-methyl anthracene.

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. Define homologous series. What are its characteristics?
12. Write a note on keto-enol tautomerism taking a suitable example.
13. Write any four unique properties of carbon.
14. Draw any two stable conformations of methyl cyclohexane.
15. Explain the isomerism exhibited by maleic acid and fumaric acid.
16. Compare the basicity of aniline, *p*-nitroaniline and *p*-anisidine. Justify your answer.
17. What is meant by a free radical substitution reaction? Give an example.
18. Write the mechanism of dehydration of neopentyl alcohol catalysed by mineral acids.
19. Starting from carbon and hydrogen, how is 2-pentyne synthesized?
20. What is meant by *cis* hydroxylation? What are the reagents used for this reaction?
21. An organic compound with molecular formula C_4H_8 on ozonolysis yield acetone as one of the product. Write the structural formula of C_4H_8 and explain the reaction.
22. Discuss the Haworth synthesis of naphthalene.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Write a note on the optical activity of biphenyls.
24. Discuss any two methods for the resolution of a racemic mixture.
25. What are the postulates of Baeyer's strain theory?
26. Compare the electron densities in benzene, toluene, phenol, chlorobenzene and nitrobenzene. Justify your answer.
27. Differentiate between singlet carbene and triplet carbene.
28. Why are 1-alkynes acidic? Write any three reactions for their acidity.

29. How does 2-butyne reacts with (a) H_2/Lindlar's catalyst (b) H_2/Na/liquid ammonia (c) Baeyer's reagent (d) O_3/Zn/H_2O.
30. What is Huckel's rule? How is it used to explain the aromaticity of tropylium cation and cyclopentadienyl anion.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. (a) Discuss with suitable example the E,Z system of nomenclature of geometrical isomers.
    (b) Discuss the optical isomerism in tartaric acid.
32. Discuss the structure, hybridization and stability of carbocations.
33. Using suitable examples discuss in detail the mechanisms of Markownikov and Anti-Markownikov addition in alkenes.
34. Discuss the mechanism of (a) nitration and sulphonation of naphthalene (b) bromination of benzene.

FOURTH SEMESTER B. Sc. DEGREE EXAMINATION

(UG-CBCSS) Chemistry

CHE4B05(P); Core Course V: INORGANIC CHEMISTRY PRACTICAL - I

Time: 3 Hours **Maximum marks: 80**

Section A

Answer the following questions in 10 minutes.

1. Calculate the mass of crystalline oxalic acid required to prepare 250 mL of its 0.5 N solution?
2. Calculate the normality of Mohr's salt solution when 1.96 g of it is dissolved in water in a 100 mL standard flask?
3. When 100 mL 1N $ZnSO_4$ solution is diluted to 500 mL the normality of the resulting solution will be ----------
4. Name the indicator used for the titration of Na_2CO_3 against H_2SO_4.
5. Write the structure of N-Phenyl anthranilic acid.
6. The titration of Fe^{2+} solution against $KMnO_4$ is a ---------- titration.
7. What is the role of $SnCl_2$ in the estimation of Fe^{3+} during dichrometry?
8. Write the balanced chemical equation for the titration of I_2 solution against $Na_2S_2O_3$.

(1x8 = 8 Marks)

Section B

Answer the following question in 10 minutes

9. Give a brief outline of the method for the volumetric estimation of Mg^{2+} in the whole of the given solution of $MgSO_4$, being provided with AR $ZnSO_4$ crystals.

(8 Marks)

Part C

10. Estimate the weight of Fe^{3+} in the whole of the given solution of ferric alum, being provided with AR Mohr's salt. *(48 Marks)*

Part D

Viva-Voce *(8 marks)*

Record *(8 marks)*

FIFTH SEMESTER B. Sc. DEGREE EXAMINATION

(UG-CBCSS) Chemistry

CHE5B07; Core Course VII: ORGANIC CHEMISTRY - II

Time: 3 Hours **Maximum marks: 80**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. The IUPAC name of allyl chloride is --------
2. 100% pure alcohol is called ----------
3. Ethyl phenyl ether when boiled with HBr form ---------
4. The isomerism exhibited by 1-methoxypropane and 2-methoxypropane is called ------
5. Oxidation of secondary alcohol to ketone with aluminium ter-butoxide is known as --
6. The chemical test used to distinguish acetophenone and benzophenone is ----------
7. Acetic acid is treated with Br_2/P followed by aqueous KOH. The product formed is ----
8. Rosenmund's reduction of propionyl chloride gives ---------
9. Aniline on benzoylation gives ----------
10. N,N-Dimethyl aniline on reaction with nitrous acid yield ----------

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. How is alkyl fluoride prepared?
12. How are nuclear and side chain halogenated hydrocarbons distinguished? Justify your answer.
13. How is rectified spirit converted to absolute alcohol?
14. How is phenolphthalein prepared?
15. Explain Zeisel's method of estimation of methoxy groups.
16. Starting from benzonitrile how is acetophenone synthesized?
17. What is Etard's reaction?
18. Starting from benzaldehyde how is cinnamaldehyde prepared?
19. Compare the nucleophilic addition rate of formaldehyde, acetaldehyde and acetone. Justify your answer.
20. Give the method of preparation of eosin.
21. Outline the synthesis of saccharin.
22. Discuss the mechanism of Kolbe's electrolysis.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Discuss the addition–elimination mechanism in aromatic nucleophilic substitution.
24. What is Pinacol–pinacolone rearrangement? Discuss the mechanism of the reaction.
25. Describe the structure and importance of crown ethers in organic synthesis.
26. Explain (a) Reformatsky reaction (b) Corey-House synthesis.
27. Starting from ethyl magnesium chloride how are the following compounds synthesized? (a) 2-methyl-2-butanol (b) propanoic acid (c) propanal (d) 3-pentanol.
28. Discuss the mechanism of (a) Cannizarro reaction (b) Aldol condensation
29. Discuss the reduction products of nitrobenzene under different media.
30. Discuss the structure of pyridine and comment on its electrophilic and nucleophilic reactions.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. Explain S_N^1 and S_N^2 mechanisms with special reference to stereochemistry and solvent effects.
32. (a) Compare the acidity of alcohols and phenols. (b) Discuss the effect of substituents on the acidity of phenol.
33. Give a detailed account of the effect of substituents on the acidity of aliphatic and aromatic carboxylic acids.
34. (a) Discuss the synthetic uses of benzene diazonium chloride?
    (b) How urea is estimated by hypobromite method?

FIFTH SEMESTER B. Sc. DEGREE EXAMINATION

(UG-CBCSS) Chemistry

CHE5B08; Core Course VIII: PHYSICAL CHEMISTRY - II

Time: 3 Hours **Maximum marks: 80**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. The rate of a chemical reaction doubles for every 10^oC rise in temperature. If the rate is increased by 60^oC, the rate of reaction increased by about ---------- times.
2. Quantum yield of Hydrogen-Chlorine reaction is ----------
3. Phosphorescence is due to transition from ----------
4. Conversion of a precipitate to colloidal state is called ---------
5. Name one optical property of colloid.
6. ---------- is an example for a system with incongruent melting point.
7. For the decomposition of $CaCO_3$, the number of components is equal to ---------
8. The principle of column chromatography is ----------
9. The basic requirement for a molecule to be micro wave active is the presence of ------
10. The zero point energy of a molecule undergoing simple harmonic oscillation is --------

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. Order of a reaction need not be whole number always. Account.
12. Give one example each for (i) a parallel reaction; (ii) a consecutive reaction.
13. What is chemiluminescence? Give one example.
14. Explain Bredig's method for the preparation of gold sol.
15. What is meant by Dorn Effect?
16. Name the different symmetry elements implied by C_6 axis.
17. Discuss the principle of gel permeation chromatography.
18. What type of molecules gives rotational Raman spectra?
19. What is Frank – Condon principle?
20. Write any two advantages of Raman spectra over IR spectra.
21. Discuss the ESR spectra of methyl radical.
22. What is proper axis of rotation?

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Discuss briefly the activated complex theory of reaction rates.
24. Certain reactions have very high quantum yield whereas others have very low quantum yield. Explain.
25. Draw phase diagram of sulphur system. Explain it.
26. Draw and explain the phase diagram of Zn-Mg system.
27. Explain the term chemical shift?
28. Explain how rotational spectroscopy can be used to find the bond length.
29. Draw the group multiplication table of C_{2V} point group.
30. What is meant by inverse of an operation? Explain with suitable examples.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. (a) Derive an expression for the rate constant of a bimolecular gaseous reaction using collision theory (b) The activation energy of a first order reaction is 250 $KJmol^{-1}$. The half life of the reaction is 6.5×10^6 second at 450^oC. What will be the half life at 550^oC?
32. (a) Give methods for purification of colloids (b) Derive Langmuir isotherm.
33. Discuss the principle and applications of high performance liquid chromatography.
34. a) Derive an expression for energy of a rigid rotator b) The pure rotational spectrum of gaseous HCl consists of a series of equally spaced lines separated by 20.80 cm^{-1}. Calculate the bond length of HCl. (The atomic mass of Hydrogen = 1.008 and that of Chlorine = 35.5 g/mol).

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

(UG-CBCSS) Chemistry

IC6B03; Core Course X: INORGANIC CHEMISTRY - II

Time: 3 Hours **Maximum marks: 80**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. The expression for the solubility product of magnesium phosphate is --------
2. The group III cations are precipitated as their ----------
3. Write the order of density of alkali metals.
4. The thermal stability of alkaline earth metal carbonates follow the order ----------
5. The hybridization in diamond is ----------
6. Among the hydrides of nitrogen, the highest bond angle is shown by ----------
7. The hybridization of iodine in IF_5 is ---------
8. Write the auto-ionization of liquid SO_2.
9. The compound responsible for Bhopal tragedy is ----------
10. Environmentalists perceive a grave threat to the pristine Silent Valley ecosystem in the ----- Project proposed to be built on the Kunthippuzha river.

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. How is borate in a mixture eliminated?
12. How does fluoride interfere in cation analysis?
13. What is meant by co-precipitation? How is the error due to co-precipitation minimized?
14. What is inorganic graphite? Why is it called so? Mention its uses.
15. Give any four diagonal relationships between lithium and magnesium.
16. Arrange HClO, $HClO_2$, $HClO_3$ and $HClO_4$ in the increasing order of acidic strength. Give reasons for your answer.
17. Give any four similarities between pseudohalides and halides.
18. What are phosphazenes? Give the structure of $P_3N_3Cl_6$.
19. Discuss the properties and structure of S_4N_4.
20. Explain the formation of acid rain. What are its harmful effects?
21. What are the harmful effects of SO_2?
22. Differentiate between BOD and COD.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Describe how the solubility product principle and common ion effect are applied in inorganic qualitative analysis.
24. Give any one method for the preparation of borazine. How does it differ from benzene in chemical reactions?
25. Discuss the following properties, taking boron family as example (a) ionization energy (b) inert pair effect (c) melting point.
26. Comment on the electropositive character of iodine.
27. Explain the charcoal adsorption method for the separation of noble gases.
28. Discuss the structure and applications of silicones.
29. Discuss the formation, effects and control of photochemical smog.

30. Write a note on impacts of medical waste and its disposal.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. Discuss the preparation, properties and uses of sulphuric acid.
32. Discuss the reactions taking place in liquid ammonia solvent.
33. (a) CO_2 is an inert and harmless gas, yet it is considered to be a serious pollutant. Discuss.
    (b) What are the sources of thermal pollution? How does it affect the aquatic environment?
34. Discuss various methods of solid waste management.

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

(UG-CBCSS) Chemistry

CHE6B11; Core Course XI: PHYSICAL CHEMISTRY - III

Time: 3 Hours **Maximum marks: 80**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. In the electrolysis of dilute H_2SO_4 using platinum electrode ---------- is liberated at the cathode.
2. At 25^{o}C, the molar conductance at infinite dilution of HCl, CH_3COONa and NaCl are 26.1, 91 and 126.4 Sm^2mol^{-1}. Molar conductance of acetic acid at infinite dilution in Sm^2mol-^{1} is ----------
3. The standard electrode potential values of the elements A, B and C are 0.68, -2.50 and -5.0 V respectively. The order of their reducing power is ----------
4. In the lead-acid battery, during charging, the cathode reaction is ----------
5. The standard reduction potential of the following four metals with its metal ion is given as follows. Na/Na^+ = -2.75 V, Zn/Zn^{2+} = - 0.76 V, Cd/Cd^{2+} = - 0.40V, Sn/Sn^{2+} = -0.15 V. The order of the reducing power is ----------
6. Conjugate base of HCO_3^- is ---------
7. pH of an aqueous solution containing H^+ ion concentration 3 x 10^{-3} M is ---------
8. The value of Van't Hoff factor of potassium ferrocyanide in H_2O, assuming complete dissociation, is ----------
9. The freezing point of 0.1 M aqueous solution of glucose is -------- (cryoscopic contant of water = 1.86).
10. Number of particles per unit cell of fcc is ----------

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. Explain Debye – Falkenhagen Effect.
12. State the Debye-Huckel limiting law.
13. What is liquid function potential? How it can be eliminated?
14. Calculate the pH of 10^{-8}M HCl.
15. What is Ostwald's dilution law?
16. What is salt hydrolysis? What types of salts undergo hydrolysis?
17. Calculate the relative lowering of vapour pressure of 0.1 M aqueous solution of glucose.
18. Define coordination number of a particle in a crystal. What is the CN of Ca in CaF_2?
19. What is radius ratio? How does coordination number vary with the radius ratio?
20. What is a Frenkel defect? Explain.
21. Calculate the number of unit cells present in one gram of an ideal crystal of NaCl.
22. Calculate the Miller indices of a plane which cuts the X,Y and Z axis at 2*a*, 4*b* and 3*c* respectively, where *a*, *b* and *c* are unit intercepts.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. State and explain Kohlrausch's law. How this law is useful for the calculation of molar ionic conductance at infinite dilution of weak electrolytes?
24. Explain the variation of equivalent conductance with dilution.
25. Write a note on H_2-O_2 fuel cell.
26. Quinhydrone electrode behaves as a reversible hydrogen electrode. Explain in detail.

27. What are the advantages of potentiometric titrations?
28. Derive the Henderson equation.
29. Write a note on non-stoichiometric defects in crystals.
30. Describe the powder method of X-ray diffraction of solids.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. Discuss the application of conductivity measurements.
32. (a) What are concentration cells? How are they classified? Give examples. (b) Write the mechanism of rusting of iron. Which are the important methods for preventing corrosion?
33. (a) Define osmotic pressure. Describe a method for its measurement. (b) What are non-ideal solutions? Explain their classification with examples.
34. (a) Derive Bragg's equation (b) When a metal crystallizes in fcc, the edge length of the unit cell is found to be $4A^{o}$ and crystallized in bcc, the edge length is $3A^{o}$. Calculate the ratio of the densities of the metal in fcc and bcc forms.